Managing Multicultural R&D Teams -
An In-Depth Case Study of a Research Project at CERN

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der Universität St. Gallen,
Hochschule für Wirtschafts-, Rechts- und Sozialwissenschaften (HSG)
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vorgelegt von

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aus
Frankreich

Genehmigt auf Antrag der Herren

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Die Universität St. Gallen, Hochschule für Wirtschafts-, Rechts- und Sozialwissenschaften (HSG), gestattet hiermit die Drucklegung der vorliegenden Dissertation, ohne damit zu den darin ausgesprochenen Anschauungen Stellung zu nehmen.


Der Rektor:

Prof. Dr. Peter Gomez
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With the following words, I want to thank all the people without whom the completion of the present dissertation would not have been possible.

First of all, I wish to express my gratitude to my supervisors, Prof. Dr. Martin Hilb and Prof. Dr. Hugo Tschirky, for the freedom they granted me. Studying multicultural R&D teams was something that lied very close to my heart: On the one hand, my international upbringing instinctively compelled me to write about multiculturalism. On the other one, as the majority of my relatives have an engineering background, I felt the need to pay tribute to my family and to make up for this lack of “scientific” education. So the theme of multicultural R&D teams emerged quite naturally and it was a real pleasure to focus on the subject for such a long time.

Moreover, I am very grateful to CERN, who provided me unrestricted access to its collaborators, infrastructure and records. The Organization’s co-operativeness surpassed by far all my expectations and dreams, its enthusiasm about my project instilling me great a load of confidence. Without the participation and help of my interviewees there, in particular Dr. Peter Schmid, I would never have been able to carry out the empirical study the way I ultimately did.

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Then, I would like to thank my parents for supporting me emotionally. Their encouragement, in good times and bad times, has been extremely comforting and stimulating. The regular phone calls from other family members have done me a lot of good as well.

My last thoughts here shall be dedicated to Martin Hilb, but this time not as a professor, not as my supervisor, but as a person: By frequenting him, by having his regu-
lar presence in the office, by observing him, I learned what life, work, and career really are about and how they should be thought of. In these terms, he contributed to my personal development towards a more “humane” employee and potential manager – or as Melvin Udall (Jack Nicholson’s character in As Good As It Gets) would say: He made me want to be a better man.

Olivier Maugain

La Chaux-de-Fonds, July 2003
Table of contents

Table of contents........................................................................................................................I

Index of figures ...........................................................................................................................VI

Index of tables ...........................................................................................................................VIII

Index of abbreviations ...............................................................................................................IX

1 Introduction ............................................................................................................................ 13
  1.1 Research plan ................................................................................................................... 16
    1.1.1 Relevance of the subject ...................................................................................... 19
      1.1.1.1 From a practical perspective ................................................................... 19
      1.1.1.2 From a theoretical perspective ............................................................... 21
      1.1.1.3 The research gap ...................................................................................... 22
    1.1.2 Research objectives and question ........................................................................ 23
    1.1.3 The core of the analysis ...................................................................................... 25
  1.2 Definitions ....................................................................................................................... 26
    1.2.1 Teams .................................................................................................................. 26
    1.2.2 Culture and multiculturalism ............................................................................. 30
    1.2.3 Research & Development .................................................................................. 34
    1.2.4 Management ...................................................................................................... 36

2 Conceptual part ..................................................................................................................... 39
  2.1 The reasons (why?) ....................................................................................................... 39
    2.1.1 Global R&D management .................................................................................. 40
      2.1.1.1 The transnational company .................................................................... 42
      2.1.1.2 The basic drivers in the internationalisation of R&D ............................... 45
      2.1.1.3 The organisation of international R&D ................................................. 48
    2.1.2 Group dynamics ................................................................................................. 55
      2.1.2.1 Synergy ..................................................................................................... 57
      2.1.2.2 Interpersonal processes ........................................................................... 59
      2.1.2.3 Conflict .................................................................................................... 62
      2.1.2.4 Global virtual teamwork: A discussion ................................................ 64
2.1.3 Diversity .............................................................................................................. 69
  2.1.3.1 Exploring diversity. .................................................................................. 70
  2.1.3.2 ...From di–worse–ity... ............................................................................... 72
  2.1.3.3 ...To di–worth–ity ....................................................................................... 75
2.2 The actors (who?) ......................................................................................................... 76
  2.2.1 Country nationals .......................................................................................... 77
    2.2.1.1 General ways to apprehend the concept of national culture .............. 78
    2.2.1.2 Theoretical models outlining national culture ...................................... 80
    2.2.1.3 Summary and discussion ........................................................................ 88
  2.2.2 Researchers ..................................................................................................... 90
    2.2.2.1 ...In general ............................................................................................ 92
    2.2.2.2 ...As employees ..................................................................................... 96
    2.2.2.3 ...As team members .............................................................................. 100
    2.2.2.4 ...As managers ....................................................................................... 102
  2.2.3 Integrating both dimensions ............................................................................. 104
    2.2.3.1 Variations in technological orientations ............................................. 105
    2.2.3.2 Culture’s consequences on scientific approaches ................................... 106
    2.2.3.3 When cultures collide ............................................................................. 109
2.3 The purpose (what?) ................................................................................................. 110
  2.3.1 The technology time path .............................................................................. 111
    2.3.1.1 From research through development... .................................................... 113
    2.3.1.2 ...To innovation .................................................................................... 116
  2.3.2 Knowledge co-creation ................................................................................... 120
    2.3.2.1 Co-creating knowledge: the macro perspective.................................... 121
    2.3.2.2 Co-creating concepts: the micro perspective ........................................ 125
    2.3.2.3 Enabling knowledge co-creation ............................................................ 128
2.4 The means (how?) .................................................................................................... 130
  2.4.1 Co-operation ................................................................................................... 130
    2.4.1.1 Teamwork .............................................................................................. 130
    2.4.1.2 Teamwork .............................................................................................. 132
    2.4.1.3 Interaction ............................................................................................... 134
  2.4.2 Communication ............................................................................................. 136
    2.4.2.1 Language ............................................................................................... 137
    2.4.2.2 Communication in R&D teams ............................................................... 139
2.4.2.3 Cultural aspects of communication .......................................................... 142
2.4.3 Mutual understanding .................................................................................... 146
  2.4.3.1 Leading diversity ...................................................................................... 147
  2.4.3.2 Controlling conflict .................................................................................. 150
  2.4.3.3 Cultivating trust ........................................................................................ 153
2.5 Implications ........................................................................................................... 158
  2.5.1. Defining the success of multicultural R&D teams ........................................... 158
    2.5.1.1 Scientific performance .............................................................................. 159
    2.5.1.2 Team performance .................................................................................... 163
  2.5.2 The six C’s for success .................................................................................... 163
    2.5.2.1 Composition ............................................................................................. 164
    2.5.2.2 Connection ............................................................................................... 165
    2.5.2.3 Co-opetition .............................................................................................. 165
    2.5.2.4 Conversation ............................................................................................ 166
    2.5.2.5 Captaining ................................................................................................ 167
    2.5.2.6 Chemistry ................................................................................................. 168
    2.5.2.7 Indicators ................................................................................................. 168
3 Empirical part ............................................................................................................ 171
  3.1 Objectives ........................................................................................................... 171
  3.2 Configuration of the fieldwork ............................................................................ 172
    3.2.1 Research strategy .......................................................................................... 172
      3.2.1.1 Qualitative approach .............................................................................. 173
      3.2.1.2 Case study ............................................................................................... 174
    3.2.2 Field study parameters .................................................................................. 176
      3.2.2.1 Target group ............................................................................................. 176
      3.2.2.2 Operating context .................................................................................... 177
    3.2.3 Data collection ............................................................................................... 178
      3.2.3.1 Instruments ............................................................................................... 178
      3.2.3.2 Execution ................................................................................................ 179
    3.2.4 Commentary ................................................................................................... 183
  3.3 Case study: Multicultural research teams at ATLAS ........................................... 184
    3.3.1 CERN: The host laboratory .......................................................................... 185
    3.3.2 Technical aspects of the ATLAS Experiment ................................................. 187
      3.3.2.1 Particle physics ........................................................................................ 187
3.3.2.2 The Large Hadron Collider ................................................................. 189
3.3.2.3 The ATLAS detector ....................................................................... 191
3.3.3 The Constitution of ATLAS ................................................................. 195
3.3.4 The six C’s at ATLAS .................................................................
  3.3.4.1 Composition .............................................................................. 197
  3.3.4.2 Connection ............................................................................... 202
  3.3.4.3 Co-opetition ......................................................................... 208
  3.3.4.4 Conversation ............................................................................ 213
  3.3.4.5 Captaining ................................................................................ 219
  3.3.4.6 Chemistry .............................................................................. 223

4 Implications........................................................................................................... 229
  4.1 Construction of the theoretical model ........................................... 229
    4.1.1 Discussion and propositions .................................................. 229
      4.1.1.1 Composition ...................................................................... 229
      4.1.1.2 Connection ........................................................................ 231
      4.1.1.3 Co-opetition ................................................................... 232
      4.1.1.4 Conversation .................................................................. 233
      4.1.1.5 Captaining ....................................................................... 235
      4.1.1.6 Chemistry ....................................................................... 236
    4.1.2 The model ...................................................................................... 237
  4.2 Suggestions for further research .................................................... 241
  4.3 Practical recommendations ............................................................... 244
    4.3.1 Activities ....................................................................................... 245
      4.3.1.1 Common objectives ............................................................. 245
      4.3.1.2 Moderating .......................................................................... 246
    4.3.2 Structures ...................................................................................... 247
      4.3.2.1 Multicultural R&D team structure .................................... 247
      4.3.2.2 Configuration .................................................................... 248
      4.3.2.3 Selection and staffing ......................................................... 250
    4.3.3 Behaviour ...................................................................................... 253
      4.3.3.1 Team integration ................................................................. 253
      4.3.3.2 Inspiration .......................................................................... 255

5 General conclusions........................................................................................... 257
# Table of contents

**Appendices**  
Appendix A: Fields of science and technology ................................................................. 259
Appendix B: Consequences of differences in national culture ........................................... 261
  Appendix B.1: Low vs. High Power Distance societies ................................................... 261
  Appendix B.2: Weak vs. Strong Uncertainty Avoidance societies ................................. 263
  Appendix B.3: Collectivist vs. Individualist societies ..................................................... 265
  Appendix B.4: Feminine vs. Masculine societies ............................................................. 266
  Appendix B.5: High- vs. Low-Context societies .............................................................. 268
  Appendix B.6: Monochronic vs. Polychronic societies ................................................... 269
Appendix C: Hofstede index values and rank of fifty countries .......................................... 270
Appendix D: General attitudes of multinational companies ............................................... 271
  Appendix D.1: Stages in the evolution of multicultural HRM ......................................... 271
  Appendix D.2: Comparison of ethno-, poly-, regio- and geocentric attitudes .................... 272
Appendix E: The performance of selected ATLAS teams ................................................... 273
Appendix F: Cover letter .................................................................................................... 274
Appendix G: Interview guidelines ..................................................................................... 275
Appendix H: Questionnaire regarding the interviewees ..................................................... 278
Appendix I: Portrayal of interviewees (case study) ......................................................... 279
Appendix J: CERN’s organisation chart .......................................................................... 280
Appendix K: The Standard Model .................................................................................... 281
Appendix L: Examples of accelerators’ spin-offs .............................................................. 282
Appendix M: The Management of ATLAS ....................................................................... 283

**Sources** ......................................................................................................................... 284

Bibliography ....................................................................................................................... 284
Index of interviews (pilot study) ....................................................................................... 309
Index of interviews (case study) ....................................................................................... 310
Index of meetings (case study) ....................................................................................... 311
Index of websites ............................................................................................................ 312
Index of additional sources ............................................................................................ 313
Index of figures

Figure 1.1: Integration of three research areas ................................................................. 16
Figure 1.2: Research plan .................................................................................................. 17
Figure 1.3: Literature about the three main research areas .............................................. 21
Figure 1.4: Structure of the thesis .................................................................................... 27
Figure 1.5: Levels of culture ............................................................................................. 32
Figure 1.6: Interacting cultural spheres of influence ......................................................... 34
Figure 1.7: The St. Gallen Management Model ................................................................. 38
Figure 2.1: Configuration for the theoretical argumentation .......................................... 40
Figure 2.2: Classification of global R&D management ...................................................... 41
Figure 2.3: The four types of organisations in the Integration – Responsiveness grid ......... 43
Figure 2.4: Modes of technical co-operation .................................................................... 45
Figure 2.5: The Allen curve ............................................................................................. 54
Figure 2.6: Classification of group dynamics .................................................................... 56
Figure 2.7: Symptoms and consequences of groupthink .................................................. 61
Figure 2.8: The impact of modern ICT on the Allen curve .............................................. 65
Figure 2.9: Strategy for maintaining confidence ............................................................... 68
Figure 2.10: Classification of diversity .............................................................................. 69
Figure 2.11: Classification of national cultures’ analysis ................................................... 78
Figure 2.12: Classification of researchers’ characterisation .............................................. 92
Figure 2.13: Integrating national and professional cultures ............................................. 105
Figure 2.14: Classification of technology generation ....................................................... 111
Figure 2.15: Closing the research loop .......................................................................... 113
Figure 2.16: The technology timepath ............................................................................ 114
Figure 2.17: The innovation process .............................................................................. 119
Figure 2.18: Classification of knowledge co-creation ..................................................... 121
Figure 2.19: Spiral of organisational knowledge creation ................................................. 123
Figure 2.20: Classification of co-operation ...................................................................... 131
Figure 2.21: Classification of communication .................................................................. 137
Figure 2.22: Classification of mutual understanding ....................................................... 146
Figure 2.23: The success of multicultural R&D teams ..................................................... 159
Figure 3.1: Four categories of R&D represented at CERN ................................................ 180
Figure 3.2: The ATLAS detector ....................................................................................... 193
Figure 3.3: The interaction of various particles with the different components of a detector ................................................................................................. 194
Figure 3.4: ATLAS’ two hierarchies ................................................................. 203
Figure 4.1: Interrelations between the six success factors and their sub-factors ... 238
Figure 4.2: Interconnected spheres of cultural influence ................................ 243
Figure 4.3: Classification of global R&D management ..................................... 245
Figure A.1: Stages in the evolution of multicultural HRM .............................. 271
Figure A.2: CERN organisation chart ............................................................. 280
Figure A.3: Particle families ............................................................................ 281
Figure A.4: ATLAS organisation chart ............................................................. 283
Index of tables

Table 1.1: Communities but not teams ........................................................................................................... 30
Table 2.1: Organisational characteristics of the International, Multinational, Global and Transnational companies ..................................................................................................................... 44
Table 2.2: Motives for the internationalisation of R&D .................................................................................. 48
Table 2.3: Centralisation vs. decentralisation .................................................................................................. 50
Table 2.4: Advantages and disadvantages of teams .......................................................................................... 57
Table 2.5: Positive and negative effects of conflict ...................................................................................... 64
Table 2.6: Kluckhohn / Strodtbeck’s basic cultural orientations ................................................................. 80
Table 2.7: Characteristics of selected national cultures ................................................................................... 89
Table 2.8: Differences in vocational interests of scientists and engineers .................................................. 96
Table 2.9: Stereotypes about researchers from selected national cultures .................................................. 108
Table 2.10: Main differences between research and development ............................................................ 117
Table 2.11: Types of innovations .................................................................................................................. 118
Table 2.12: Enablers and stumbling blocks of knowledge co-creation ...................................................... 129
Table 2.13: Relational and behavioural aspects in the team development process ................................... 135
Table 2.14: Communication patterns of selected national cultures .......................................................... 145
Table 2.15: A classification of performance measures .................................................................................. 162
Table 2.16: Indicators for the 6 C’s .................................................................................................................. 170
Table 3.1: Tactics for increasing the case study’s validity and reliability .................................................. 184
Table 3.2: Countries involved in the construction of the ATLAS detector .............................................. 200
Table 4.1: Multicultural and team skills ......................................................................................................... 252
Table 4.2: Essential skills of the multicultural R&D team captain ............................................................... 254
Table A.1: Low vs. high power distance societies ......................................................................................... 262
Table A.2: Weak vs. strong uncertainty avoidance societies ........................................................................ 264
Table A.3: Collectivist vs. individualist societies ........................................................................................... 265
Table A.4: Feminine vs. masculine societies .................................................................................................. 267
Table A.5: High- vs. low-context societies ..................................................................................................... 268
Table A.6: Monochronic vs. polychronic societies ......................................................................................... 269
Table A.7: Comparison of ethno-, poly-, regio- and geocentric attitudes .................................................. 272
Table A.8: Self-evaluation of team performance ............................................................................................... 273
Table A.9: Selected characteristics of the interviewees .................................................................................. 279
Table A.10: Practical applications of particle accelerators ............................................................................ 282
# Index of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<td>ATI</td>
<td>ATLAS Infrastructure</td>
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<td>AUT</td>
<td>Austria or Austrian</td>
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<td>BMW</td>
<td>Bayerische Motoren Werke AG</td>
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<td>Celsius</td>
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<td>Cal.</td>
<td>Calorimeter</td>
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<td>Collaboration Board</td>
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<td>Corporate development</td>
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<td>CEO</td>
<td>Chief Executive Officer</td>
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<td>CERN</td>
<td>Conseil Européen pour la Recherche Nucléaire / European Organization for Nuclear Research</td>
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<td>Cf.</td>
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<td>Compact Muon Solenoid</td>
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<td>km</td>
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<td>Local area network</td>
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<td>Liquid Argon</td>
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<td>LEP</td>
<td>Large Electron Positron Collider</td>
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<td>MNC</td>
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<td>RC</td>
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<td>R&amp;D</td>
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<td>Technical Co-ordinator</td>
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<td>Transition Radiation Tracker</td>
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1.1 Research plan
1 Introduction

Multicultural teams – curse or blessing?1 With this provocative question, Lianne Roembke presents in a rather drastic manner the spectrum of the possible outcomes of multicultural teamwork. What makes this remark so powerful is that it applies not only to missionaries (as originally implied by the author), but to any groups which may include members from several cultures or nations: diplomats, soldiers, consultants, marketers, sportspeople, flight attendants, scientists, or engineers. Indeed, managing multicultural teams can be a tightrope walk: on the one hand, when not handled properly, such teams can turn into extremely irksome stumbling blocks for a company or a project. On the other hand, companies and leaders who recognise the potentials of cultural diversity and find the right cultural mixture among the team members can achieve some substantial comparative advantages. The recent success in certain fields (for instance information technology) of “cultural melting pot” countries such as the USA or Canada testifies to the positive correlation between diversity and innovativeness.

It is above all the increasing globalisation of business that requires employees from various cultures to work together:

“Even in purely domestic operations, firms are being forced to form cross-functional, inter-departmental, cross-divisional, and interorganizational alliances in order to make maximum use of scarce resources and thus increase their competitive advantage.”2

Parallel to the emergence of multiculturalism, the business world has therefore emphasised the use of teams as organisational sub-units. “Teams are in fashion”3, wrote Thomas, Ravlin and Barry to qualify the increasing prevalence of small groups.

Both elements taken together have led to a genuine boom in the use of multicultural teams. The main problem, however, is that through globalisation, companies are not given the choice anymore of how they want to constitute their staff. A few years ago, Iles observed that “more and more organizational workforces [would] be multicultural

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1 Roembke (2000)
2 Shaw / Barrett-Power (1998), p. 1308
3 Thomas / Ravlin / Barry (2000), p. 11
and multinational," while Snow and Davison declared that “transnational teams [were] at the heart of the globalization process”. And today indeed, multicultural organisational units, such as teams, task forces, departments, committees, boards, or whole corporations have become a fact of life. Managers must cope with them, and try to achieve the best results possible with the diverse human resources they have their disposal. Consequently, many companies draw on cross-cultural teams, although this use clearly involves some serious risks.

In their study of 70 global teams, Govindarajan and Gupta found out that only 18% of such teams perceived their own performance as “highly successful”, while a third felt that their co-operation had been utterly unsuccessful. Obviously, the ambiguity related to multiculturalism does not prevent managers from employing it extensively, constituting more and more multicultural global teams and continually increasing their diversity. The rationale behind such enthusiasm is usually one of hope for outstanding results, be it in knowledge creation, creativity, or innovation. Hence, the whole issue is crucial for research and development (R&D) teams in particular. At the same time, scientific activity in general has steadily become multicultural, for two main reasons: first, globalisation (again!) has accelerated the pace of technology transfer around the world, thus extending the exchange of knowledge and human resources between countries. Second, corporations and research institutes have recognised that multiculturalism could have enriching effects on R&D. However, due to the superior education and to the strong professional culture of engineers and scientists, the problem of multicultural teams might be less severe for this type of employees. It is often taken for granted that e.g. a French and a U.S. engineer will mix well with one another, since they automatically focus on the professional values they have in common (hard work, achievement orientation, intellectual curiosity, etc.) because of their similar scientific background. This may well be so, until the day when they have to face a problem that emerges because of their different national cultures: For example, the pragmatic U.S. researcher could go for a solution with great financial promises, but whose outcome is

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5 Snow / Davison (1996)
7 Birnbaum-More / Rossini / Baldwin (1990), p. 3
very uncertain, while his more risk adverse French colleague might prefer to base his
decision on purely scientific arguments. If they are unable to find a consensus, such a
disagreement can lead to a wasteful deadlock. In that case, their collaboration may
deteriorate even more rapidly than it was built up.

Therefore, managing multicultural R&D teams must be perceived as a delicate task,
involving skills from various areas, in particular R&D management, multicultural
management and team management. From a theoretical perspective, a thorough ana-
lysis of the issue requires a study and integration of these three areas. But given that
those three fields are derivatives of a much broader discipline, namely general mana-
gement, the present investigation cannot proceed without an analysis of this subject as
well.

“In spite of some significant cultural and logistic obstacles, diverse global teams are
the future of innovation”, believes Pascal Zachary. Many academics and R&D pro-
fessionals, in spite of the difficulties to prove such a claim, share this opinion. Based
on this very conviction, this dissertation intends to shed some light on the topic, and
help theorists and practitioners to find some enlightenment about how to manage the
micro-organisations known as multicultural R&D teams.

This research work aims at clarifying questions related to multicultural R&D teams.
Three main areas need to be covered and synthesised: R&D management, multicul-
tural management and team management, which will be regarded as specialised
disciplines of general management, a branch of learning that has spawned a large
amount of theory so far. In this approach, the main task will be to find a common
denominator among all four areas (figure 1.1).

Although the answer lies in an integrated explanation of the former three subjects
altogether (general management shall be considered as the theoretical concept provi-
ding the guidelines), the element that presents the most treacherous pitfalls is un-
doubtedly the one connected with multiculturalism. Observing that it is difficult
enough to make monocultural teams work effectively, Jon Werner asks the question of
how much harder it would be to reach the same result with team members of different

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8 Please also read she / her when he / him / his is written.
nationalities. Does this require a factor of two? Three? Four?\textsuperscript{10} Of course this is not a problem that can be answered precisely and in a definite way. Nevertheless, it shows that the difficulties are real and substantial.

![Diagram of research areas]

\textit{Figure 1.1: Integration of three research areas}

\textbf{1.1 Research plan}

Together with the fuzziness of the concept of culture itself, the worries generated by the interaction of three quite distinct areas necessitate a pragmatic research design systematically recombining theoretical and practical approaches. Figure 1.2 depicts the research plan to be employed in this thesis:

\textsuperscript{9} Zachary (1998), p. 33
\textsuperscript{10} Werner (1995), p. 1
The research design consists of 9 steps:

**1) Identify practical problems:**

The analysis starts with the examination of practical obstacles that arise when researchers from diverse cultures collaborate. Personal experience, cases of famous flop stories, etc. are used as evidence for such difficulties. Furthermore, this first part discusses possible causes of the problems.
2) **Explore the theory:**

The second part shows the relevance of the issue from a theoretical perspective. It offers some theoretical suggestions about how to solve problems that emerge over and over again.

3) **Identify a gap between practical needs and theoretical contributions:**

Comparison of existing practical problems on the one hand and the suggestions provided in the literature on the other, reveals two gaps (a theory and a practice gap) that must to be filled by further research. It is the primary purpose of this thesis to satiate such unsatisfied needs.

4) **Define research objectives:**

This section utilises the insight of the previous three parts to identify some broad research objectives. In addition, it also defines the community to whom the study is addressed and describes its expected outcomes.

5) **Formulate a concrete research question:**

The research objectives set out above are rather broad. Consequently, they are refined in a fifth step, so that a main research question can be derived.

6) **Develop a conceptual framework:**

The conceptual part of the dissertation will provide a referential framework for answering the research question and for giving direction to the empirical investigation. The outcome of this step is a relatively broad theoretical outline with a limited number of ideas, which is going to be the lodestar guiding the in-depth empirical research.

7) **Experiment the research area through empirical fieldwork:**

Together with the conceptual framework, the empirical part constitutes the core of the dissertation. It aims to discover contributions made by practice which help to solve the problems identified at the beginning of the process. The study here is more detailed than in the theoretical part, as it aspires to strengthen and enrich its insights. In this way, the conceptual and empirical components of the inquiry will assist one another in elucidating the research problem. Both types of implications are employed in order to set up a model interconnecting the constructs and factors identified in the sixth and
seventh steps. Each such conjunction is then made explicit with a series of propositions, open for discussion and later proof.

8) **Analyse the results from the previous two parts:**

Then follows the dissection of the conceptual and the empirical sections with the discussion whether and how far these findings can be decisive for answering the research question.

9) **Derive some implications for both theory and practice**

Independent of the outcome of the previous section, some implications are drawn for practical as well as further theoretical work, which are then fed back into the existing body of experience and literature, which was originally tapped at the beginning of the procedure.

This feedback loop completes and closes the circle, a characteristic procedure for the research design employed. The practical suggestions concern rather pragmatic issues and are intended to be best practice benchmarks. However, each reader is required to think over the proposals before he adapts and applies them to his multicultural R&D teams.

**1.1.1 Relevance of the subject**

*1.1.1.1 From a practical perspective*

A whole range of stories of how international mergers, acquisitions or joint ventures failed, can be taken as examples to illustrate the troubles that may arise when people from different cultures have to work together. The disastrous marriage between BMW and Rover or DASA’s acquisition of Fokker are only two of them. But such flops cannot be explained only by strategic miscalculation. They may also be the result of mediocre integration of the companies’ personnel, especially on the engineering level. According to a European consulting firm, “cultural differences are the biggest source of difficulty in integrating European acquisitions.”\(^1^1\) The same applies to transatlantic alliances or partnerships between Western and Asian companies. From one day to the

\(^1^1\) Cited in: Schneider / Barsoux (1997), p. 9
next, researchers have to work with a group of people with different values and mindsets. It is true that the compatibility of corporate cultures may also play a major role in explaining the success or failure of such types of co-operation, but many arguments speak in favour of the national culture as being the crucial factor, since different languages, educational systems, history, etc. often bring up insuperable obstacles that even the most optimistic synergy prospects (in economic terms) or the best managerial intentions cannot overcome. Nevertheless, the brutal encounter of dissimilar cultures is not the only conceivable reason for the failure of cross-cultural teams. The interaction of people from different units within one company (for example between headquarters and a foreign subsidiary, or between two subsidiaries) can also create an important basis for friction among the member of the same organisation.

More specifically, common difficulties encountered in the context of managing trans-cultural R&D teams include language obstacles, beliefs, stereotypes, cultural clashes resulting from misunderstandings, conflicts about work processes and scientific approaches, leadership problems, and so on. These worries are not only added to the “regular” problems plaguing teams in general (such as the misalignment of team members’ goals or lack of clarity about team objectives)\(^\text{12}\). The cultural contrast, generating different understandings and cognitions, may even exacerbate those “domestic” dilemmas and amplify the complexity of managing the group. So the manager of such a multicultural R&D team is not only responsible for the composition of the team (i.e. selecting the team members, designing a team structure, integrating new members, etc.) but he also has the duty to make the members work together, to create a harmonious climate, to settle disputes, to encourage communication, to maintain a balance, while taking into account and respecting the cultures involved. It is a veritable managerial challenge to understand the cultures of each participant and to reap the benefits of in-house diversity, a challenge that calls for a deep acquaintance with multicultural issues and a whole range of soft skills.

\(^\text{12}\) Govindarajan / Gupta (2001), p. 64
1.1.1.2 *From a theoretical perspective*

As mentioned above, the issue of cross-cultural R&D teams covers four basic areas: R&D management, multicultural management, team management, and general management. The latter branch of learning will serve as a shared frame of reference for the analysis of the question. The literature about the other three fields taken separately is quite comprehensive, especially when other sub-issues are taken into account as well. Some major contributions are shown in figure 1.3.

![Figure 1.3: Literature about the three main research areas](image)

Publications about **R&D management** cover a whole range of themes that are not relevant for the present analysis. What need to be closely scrutinised in the context of this thesis are primarily those elements regarding the organisation of R&D in foreign locations. Another point to be gone through with a fine-tooth comb is the comprehensive characterisation of researchers, because after all, they represent the protagonists in the whole discussion. Other domains to be considered here are the interplay between research, technology and innovation, or knowledge creation.
Much research concerning **multicultural management** aims at a qualitative or quantitative characterisation of cultures. Based on extensive inquiries, it seeks to arrange national cultures in country clusters. Other publications treat issues such as how to exploit multicultural diversity in organisations. The primary goal of such studies is then to investigate how people from different cultures interact in given environments (e.g. the workplace). Other research efforts focus on the search for regularities that are valid across several cultures. Many such efforts find their roots in ethnology or anthropology. Then, a whole range of books targeted at practitioners compare cultures systematically by analysing customs, beliefs and models of behaviour in foreign countries and then derive guidelines for expatriates and managers (business etiquette).\(^{13}\)

The bulk of **team management** theories deals with group dynamics, interpersonal processes or searches for ways of maximising synergy effects within teams. The *leitmotif* in such studies is to find explanations for the success of so-called “high-performing”\(^{14,15,16}\) teams. In this context, areas that allude to the topic of team management are communication, team leadership, the fitness of given cultures for teamwork, and so on.

In treating the question of the management of multicultural R&D teams, some important findings could emerge which may only affect the three basic areas (as described above) together, but which can also bring about some interesting insights about each one of them independently. Consequently, the analysis of such a wide-ranging issue offers promising prospects of generating new theory related to several fields.

### 1.1.1.3 The research gap

The previous review unveils substantial discrepancies between existing practical problems and possible clarifications provided in the literature. Chapter 1.1.1.1 showed that there is an actual demand for solutions to existing difficulties in *practice*. From a purely *theoretical* point of view, however, there is virtually no literature covering simultaneously the three basic fields as described in the previous section.

\(^{13}\) Earley / Gibson (2002), p. 16  
\(^{14}\) Thamhain / Wilemon (1987)  
\(^{15}\) Katz (1988b)  
\(^{16}\) Davison (1994)
Moreover, multicultural management focuses too much on managers or diplomats as target groups. Most cross-cultural guidebooks give the impression that practical advice is limited to issues such as negotiation, chairing meetings, decision making, marketing, etc. Other categories of people, who also have to work with colleagues from other cultures on a daily basis, such as soldiers or professional sportspeople, officials serving in international organisations (such as the United Nations or the European Commission) seem to be neglected. However, failed mergers and acquisitions are not always due to poor integration and cultural mismanagement on the managerial level; poor management in research laboratories, design offices, on shop floors, and so on also plays its part.\textsuperscript{17,18,19}

In other words, there are important research gaps offered to the academic community, and the ambition underlying this dissertation is to fill at least some of them.

1.1.2 Research objectives and question

This dissertation focuses on the intersection of multicultural management, team management and R&D management, which are themselves to be considered as elements of the general management discipline. So its primary intent is to make some contributions to developing a theoretical framework, which will explain the interaction of the former three subjects. Based on the research gaps identified above, this study intends to offer a number of solutions to the problems generated by the co-operation of people coming from different countries, but who at the same time have a comparable educational background (namely engineering or natural sciences) as well as common scientific tasks and goals. It seeks to discover specific factors determining the performance of intercultural R&D teams. This does not necessarily mean designing a thorough model governing the whole system of “multicultural R&D teams”. This could not be achieved in one single dissertation. Rather, the insights from the analysis should facilitate achieving practical recommendations on how to improve the collaborative work of researchers in a transcultural context, or more generally, how to develop high

\textsuperscript{17} Tyldesley (1997)
\textsuperscript{18} Heerkens / Ulijn (1999), pp. 18-19
\textsuperscript{19} Hambrick (2001)
performing international teams of researchers. In this endeavour, two important points need to be kept in mind:

- The issue is not only to describe the nature and the implications of national cultural differences within the team (i.e. answering *what*-questions), but also to show simultaneously *how* to exploit and leverage the diversity inherent to cross-cultural teams.

- The framework developed here and the recommendations drawn from the theoretical and empirical examination of the theme will primarily concern scientists and engineers. The assumptions and assertions made here will not necessarily be applicable to other types of employees.

As the dissertation takes into account theoretical and practical matters equally, it addresses academics as well as practitioners. Among the latter, scientists and engineers, project team leaders, but also human resource managers and executive officers responsible for technology or research and development belong to the primary target groups. This work may guide them in their task of developing effective multicultural teams.

Owing to the research objective stated above, the fundamental research question underlying this analysis may be formulated as follows:

*Which factors explain the success or failure of multicultural R&D teams, and how do they interrelate?*

Obviously the question is worded in a very broad way. Indeed, by answering it, it is intended to attain far-reaching insights on several domains. Yet, all of them should be applicable to multicultural R&D teams. The whole work remains descriptive (as opposed to prescriptive), in the sense that it ought to uncover *what* multicultural teamwork necessitates, and *how* people do what they do, and only secondarily to answer the *why* behind outcomes, events and behaviours.20

Existing literature will be used to filter out a certain number of concepts about multicultural management, R&D management and team management. These models will constitute the backbone of the study, as they will help to determine the investigation

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analysis of the question of multicultural R&D teams, which all in all is an empirical phenomenon. Taken all together, the concepts constitute a referential frame, which ought to facilitate the understanding and interpretation of the problem to be solved. Also, the theoretical construction supports the empirical study, which itself complements the enquiry with insights from a more practical standpoint.

This research design reveals that the theorising process will be inductive. The empirical research brings up some new elements to be organised in such a way that specific rules and connections are generated. Then, it must be emphasised that this system of rules is only applicable to a limited number of cases and under certain conditions. A special section in this study will seek to shape the conceptual and empirical insights into a proper theoretical model. The propositions suggested there will however not be tested in this dissertation. Therefore, to be valid, the theoretical model has either to be generalised or at least gradually and systematically tailored to other settings and situations. In any case, this is an endeavour that could not be accomplished in one single dissertation.

1.1.3 The core of the analysis

Chapter 2 presents different theoretical patterns in the form of answers to basic questions about the issue of multicultural R&D teams, in particular, questions concerning the why, who, what, and how of such teams:

- Why do multicultural teams exist in companies?
- Who participates in cross-cultural R&D teams?
- What are the purposes of multicultural teamwork?
- How do the teams operate?

The chapter closes with a discussion of the findings and lists a number of factors appropriate for explaining the success of multicultural R&D teams.

Chapter 3 investigates the research problem from an empirical perspective. It starts with a brief description of the methodology employed. Next, the findings derived from the theoretical part are commented on by members of multicultural R&D teams and summarised in the form of a case study. The objective here is neither to confirm nor to
refute those results, but to provide evidence and bring in more substance. As opposed to the previous part, which covers the whole range of R&D activities, this section will have a restrained focus, concentrating on one particular scientific discipline only.

In Chapter 4, the results of the previous two sections are anatomised, examined and discussed in order to be synthesised into a true theoretical model, which should assemble all the variables identified before and interconnect them. This chapter also puts forward practical recommendations, derived from the remarks and observations made in chapter 3, which will relate in particular to the managerial functions\(^{21}\) in the context of multicultural R&D teams.

Chapter 5 recapitulates the key findings of the thesis and concludes with a view of theory and practice in the field, which raises open questions.

The structure of the work is illustrated in figure 1.4.

### 1.2 Definitions

In order to understand the analysis and discussion developed here, it is essential to clarify the terminology employed in the study. Consequently, this section provides a precise definition of each term employed in the title of the dissertation.

#### 1.2.1 Teams

Teams and teamwork are used in many different instances, e.g. in sports, in schools, during military interventions, in arts, research and development, etc. In its broadest sense, the definition of a team as “people doing something together”\(^{22}\) is rather simple. When taken more narrowly, the concept generates divergent interpretations. Here are some examples from selected authors:

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\(^{21}\) These functions are to be defined in section 1.2.4.

\(^{22}\) Robbins / Finley (1995), p. 10
Figure 1.4: Structure of the thesis
Harris / Harris (1996):

“A team is a work group or unit with a common purpose through which members develop mutual relationships for the achievement of goals / tasks. Teamwork, then, implies co-operative and co-ordinated effort by individuals working together in the interests of their common cause.”\textsuperscript{23}

Bubshait / Farooq (1999):

“A [...] team is a collection of individuals with different needs, backgrounds, and expertise.”\textsuperscript{24}

Moore (1999):

“A group of people can be described as a team if they all have commitment to a set of shared values and objectives, together with an acceptance of how those objectives are to be met.”\textsuperscript{25}

These three definitions have some elements in common which each author weights differently. Apparently, the notion of teams then encompasses the following constituents:

- **A limited number of people involved:** The number of participants lies at the core of the idea. A team has to have at least two people. But a genuine team should have no more than 10-15 people. Otherwise, the group is more prone to break into sub-teams rather than operate as a single unit.\textsuperscript{26}

- **A common purpose:** A team is task-oriented and is destined to achieve something. Thus, the members must have some common goal(s) or interest(s). For example, in the case of R&D teams, such a purpose can be a scientific breakthrough or the development of a new product.

- **Complementary skills:** In order to carry out their assignment in an effective and creative way, the team members should have varied and if possible complementary competences, backgrounds, or methods.

\textsuperscript{23} Harris / Harris (1996), p. 23
\textsuperscript{24} Bubshait / Farooq (1999), p. 34
\textsuperscript{25} Moore (1999), p. 210
\textsuperscript{26} Katzenbach / Smith (1993a), p. 114
• **A common approach**: The team members should share a common approach of how they want to perform and reach their goal.

• **Co-operation and co-ordination**: Successful teamwork requires the members to interact and to collaborate, meaning that they have to communicate with (speaking and listening to) each other, work together and influence one another to reach their common goal.27

• **Commitment**: Commitment is the essence of teamwork. This involves:
  
  - Team consciousness: Members think of themselves as a unity – rather than as an assembly of individuals – with which they identify. Consequently, they are all able to act in a unitary manner.
  
  - Interdependence and mutual obligation: The members should acknowledge that they need to help each other, and must be ready to provide support to their partners.28 By the same token, they are mutually responsible and liable for each other.
  
  - Loyalty: The members must be willing to keep the team intact and be prepared to work conflict through.29

The above considerations mean that the word “team” can be defined as follows:

“A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable.”30

Several forms of co-operation might fulfil the criteria as mentioned above, but still cannot be considered as teams in the narrower sense. Table 1.1 lists a few examples.

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27 Adair (1986), p. 6
28 Adair (1986), p. 6
29 Palmer (1998), p. 36
30 Katzenbach / Smith (1993b), p. 45
The following groupings are not teams:

| Groups... | ... are “less” than teams, as groups only require contact among their members. |
| Squads... | ... have repetitive assignments, but no specific goal as such. |
| Task forces... | ... have a temporary character and operate within the scope of a larger group (e.g. a commission).31 |
| Quality circles... | ... are small groups of employees regularly gathering on a voluntary basis in order to solve problems and to continually improve the quality of products, services, jobs, etc.32 |
| Networks... | ... are nettings of people who usually have no personal contact to one another, but who depend and can rely on the other members when questions or problems emerge, or when information, advice, or specific counsel is sought.33 |
| Microcommunities of knowledge... | ... are small, loosely organised, informal gatherings of like-minded professionals who share ideas, respectively knowledge with each other.34, 35 |
| Committees... | ... periodically unite people who have to fulfil specific functions (one-time projects, co-ordination tasks, etc.).36 |

Table 1.1: Communities but not teams

1.2.2 Culture and multiculturalism

“Culture can be likened to a giant, extraordinary complex, subtle computer. Its programs guide the actions and responses of human beings in every walk of life.”37

Due to its extremely intangible character, the idea of culture is very difficult to grasp, the main problem being that its meaning may vary according to the context in which the word is being employed and applied. So, the interpretation of culture is itself culturally biased. Therefore, any endeavour to elucidate the concept requires great sensi-
tivity. Rather than trying to fix the meaning of the word into one single definition, it makes more sense to look at various attempts from specialists in the area, and to extract recurrent or particularly relevant elements:

Kluckhohn (1951):

“Culture consists in patterned ways of thinking, feeling and reacting, acquired and transmitted mainly by symbols, constituting the distinctive achievements of human groups, including their embodiments in artifacts; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values.”

Harris (1979):

“Culture refers to the learned repertory of thoughts and actions exhibited by members of social groups – repertories transmissible independently of genetic heredity from one culture to the next.”

Hofstede (1980):

“[Culture is] the collective programming of the mind which distinguishes the members of one group or category of people from another.”

Trompenaars (1993):

“Culture is the way in which a group of people solves problems.”

Herbig (1994):

“Culture is an all inclusive system of communications which incorporates the biological and technical behavior of human beings with their verbal and non-verbal systems of expressive behavior. Culture is the sum total of a way of life, including such things as expected behavior, beliefs, values, language, and living practices shared by members of a society.”

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40 Hofstede (1980), p. 25
41 Trompenaars (1993), p. 6
42 Herbig (1994), p. 49
Figure 1.5 depicts various levels of cultures, differentiating between observable and non-observable elements.

![Levels of Culture Diagram](source)

*Figure 1.5: Levels of culture*

(Source: Adapted from: Chaney / Martin (1995), pp. 18-40; Schein (1981), p. 380)
These contributions lead to the following insights:

- Culture “is always a collective phenomenon”\(^{43}\). Jandt requires that the collectivity be large enough be self-sustaining and produce new generations of members.\(^{44}\)

- Culture implies a set of values shared by all members of a group.\(^{45}\) Such common values can be manifested in distinctive beliefs, assumptions, experiences, customs, artefacts, symbols, habits, morals, usages, rituals, traditions, rules, etc.

- Culture is a pattern governing or at least influencing the way people think and behave. It also implies that people from the culture are inclined to evaluate and interpret situations in a similar way.\(^{46}\)

- Culture needs to be passed on by the members (to new entrants, to following generations, etc.)

Under this delineation, culture is clearly not limited to nationality, as is often implied. Affiliation to a given culture can stem from membership in several groups (simultaneously), depending on one’s origins, job, pastimes, etc. Hence, an individual does not belong to one single culture, but to a multitude of cultures, such as national, regional, industry, corporate, functional, and professional cultures. Each type of culture has its own set of components, as shown in figure 1.6.\(^{47}\)

The individual is thus shaped by interconnected and interacting spheres of cultural influence inherent to each membership (figure 1.6). In this thesis, however, the primary focus will be laid on national culture, although the analysis will look at selected aspects of professional culture as well. In other words, those values that can be attributed to people’s **nationality**, **function** (here research and development) or **profession** (here researcher) will lie at the centre of the inquiry.

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\(^{43}\) Hofstede (1991), p. 5  
\(^{44}\) Jandt (1995), p. 8  
\(^{45}\) Mead (1992), p. 14  
\(^{46}\) Earley / Gibson (2002), p. 6
In accordance with this terminology, “multicultural” shall be interpreted as “comprising or involving several cultures.” Moreover, a multicultural team is a team with members of multiple national cultures.

### 1.2.3 Research & Development

For the sake of clarity, the definitions of “research” and “development” shall be adopted from those used by the Organization for Economic Co-operation and Development (OECD).

The academic body speaks of “research and experimental development”, for which it proposes the following definition:

> “Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including

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47 The “systems” element is obviously an exception to it, as it is only relevant in a context of national or regional cultures.

48 Notice: In order to avoid misunderstandings, the expressions “multicultural”, “cross-cultural”, “transcultural”, “intercultural”, etc. will be employed as synonyms throughout the dissertation.

49 As the main emphasis of the thesis is laid on national culture, all terms related to culture and multiculturalism will refer to national culture specifically. Or else, it will be made explicit what type of culture is meant.
knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.”

More precisely, the OECD distinguishes three types of R&D activities:

- **Basic research:**
  
  “Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.”

- **Applied research:**
  
  “Applied research is [...] original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.”

- **Experimental development:**
  
  “Experimental development is systematic work, drawing on existing knowledge gained from research and / or practical experience, that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.”

Activities that should be excluded from R&D are for example: education and training, production and related activities, scientific and technical information services, testing and analysis (of materials, components, etc.), medical care…

R&D can be conducted by private corporations as well as by public organisations. Furthermore, R&D is normally not limited to natural sciences (which embrace physical sciences and life sciences) and engineering, but also comprises the fields of social sciences and humanities. For the purposes of the present thesis, however, only natural sciences and engineering will be dealt with.

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50 OECD (1994), p. 29
51 OECD (1994), pp. 68-70
52 Appendix A lists disciplines for six different fields of science and technology.
53 OECD (1994), pp. 30-32
54 OECD (1994), p. 21
Moreover, R&D teams are functional teams whose members are R&D professionals (“researchers”):

“[...] Professionals engaged in the conception or creation of new knowledge, products, processes, methods, and systems, and in the management of the projects concerned.”

For reasons of clarity, R&D professionals will be separated into two categories, although this distinction may sometimes become blurred in practice:

- **Scientists** focus on basic research; and
- **Engineers** are involved in applied research and experimental development.

In their scientific efforts, researchers are supported by technicians who, however, will not be included in the analysis.

### 1.2.4 Management

The definition of general management to be applied here is rooted in the “St. Gallen Management Model”. This pattern provides a frame of reference for a modern understanding of business administration. It is based on the following assumptions:

- **Systems approach**: The reflection is heavily influenced by systems theory and cybernetics;
- **Holistic mind-set**: The company is contemplated from a holistic perspective;
- **Integration**: The company is believed to be affected by manifold influences, which are integrated into a network of relationships (held by stakeholders).

Through the model, executives are endowed with a pattern of thought that allows them to find their way towards a modified management philosophy. The paradigm identi-

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55 OECD (1994), p. 86
56 Boutellier / Gassmann / von Zedtwitz (2000), p. 31
57 “Technicians [...] are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences, or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.” (OECD (1994), p. 86)
58 Ulrich (1970), p. 100
60 Bleicher (2001), p. 71
fies two forms of integration, by means of which managerial actions may be systematised – the horizontal and the vertical integration:

- The **horizontal** integration lays emphasis on the problems that management has to tackle. These issues are positioned on three distinct layers of abstraction:
  - The *normative* layer concerns the ethical legitimation of corporate action.
  - The *strategic* layer relates to the long-term protection of the company’s future. In this connection, issues regarding competition lie at the centre of the interest.
  - The *operational* layer deals with the immediate execution of the tasks that emerge in the day-to-day running of the business. The crucial issue at this involves the efficient handling of scarce resources.

- The **vertical** integration marks the assimilation of managerial functions into three separate dimensions: structures, activities and behaviour.

Figure 1.7 depicts how both types of integration interrelate.

According to its creator, the model aims to establish a dimensional arrangement of the decisions managers face. It offers a map for orienting oneself, facilitating the comprehension of administrative and executive tasks in their proper context. As such, it constitutes a support for personal reflection about managerial issues. This is precisely the state of mind that will be required to engage in the questions related to general management in this dissertation.

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61 Rüegg-Stürm (2002), pp. 17-22
62 Bleicher (2001), p. 71
63 Rüegg-Stürm (2002), p. 71
64 Bleicher (2001), pp. 81-83
65 Bleicher (2001), p. 73
Figure 1.7: The St. Gallen Management Model
(Source: Bleicher (2001), p. 77)
2 Conceptual part

The referential framework to be generated in this chapter will be kept as broad as possible, focussing only on the most pertinent issues related to the management of multicultural R&D teams. In addition, no theoretical paradigm will be favoured in the train of thought. This ensures that the empirical research, which follows from it, and which is intended to bring about more detailed insight, remains unbiased.

The conceptual part is structured in four sections, each of them answering one general question about cross-cultural R&D teams: Those questions are deliberately very general in order to provoke a large variety of comments. The goal is to generate enough theoretical material so that the research question can be framed properly.

Although each part (or question) looks at different topics, the manifold answers provided here constitute an integral whole. Furthermore, the questions (and consequently the answers) all refer to problems more or less closely related to the three research areas distinguished in the introductory section: R&D management, multicultural management and team management (figure 2.1). As the objective is to provide insight into their intersection, special attention will be paid to accurate treatment of those points that affect two or more disciplines simultaneously.

2.1 The reasons (why?)

This chapter deals with the question why multicultural R&D teams exist, to be more precise, with the following points:

- Why is it important to have multicultural R&D teams?
- Why do they emerge?
- Why work in teams at all?
- Why compose culturally diverse R&D teams?

The answers will be given in three parts, addressing respectively the topics of global R&D management, group dynamics and diversity.
2.1 The reasons (why?)

2.1.1 Global R&D management

Debate about the globalisation of R&D can be classified in the area of R&D management (figure 2.2). However, the discussion will also include some elements from other fields, such as the existence of multinational (or transnational) companies (MNCs) in general.

As one of the main factors for establishing a company’s competitive advantage, R&D also plays a crucial role in its global expansion strategy. In the globalisation process, internationalisation of R&D accompanies that of other activities such as sourcing or manufacturing. Reger distinguishes three categories of processes in internationalising research and technology.\textsuperscript{66}

\textsuperscript{66} Reger (1999), p. 1
The international creation of innovations: Multinational companies generating innovations in countries other than their home base are central to the process. Typical vehicles of change are cross-border R&D projects, the exchange of research specialists within the same MNC, the acquisition of foreign R&D units or the establishment of foreign R&D laboratories.

The technological co-operation of partners from distinct countries: Here, two or more partners (which can be corporations, universities or research institutions) work together in order to generate know-how and/or innovations. However, they keep their autonomy and identity. Widely used instruments in the process include building common R&D projects, exchanging technical information, creating joint ventures, forming strategic alliances as well as exchanging researchers or students.

The international utilisation of technologies that have been developed domestically: Companies try to exploit their technology internationally by exporting innovative products, manufacturing abroad or issuing licenses.

Since the focus of the study lies on the R&D process (i.e. how know-how is being generated in multicultural teams), only the first two categories will be considered.
2.1.1.1 The transnational company

Any discussion about the internationalisation of R&D activities, that is, the effort to develop external sources of R&D expertise,\textsuperscript{67} needs the elucidation of the internationalisation of the firm itself.

World-wide technology production is clearly in the hand of MNCs, as the 150 largest technology-intensive companies provide 70-80\% of the total investment in R&D, which is in fact remarkably concentrated, especially in the Triad. In Japan, for example more than 57\% of total R&D expenditure is attributed to the 50 top-spending companies. In Europe, the figure is 42\% and in the USA, one third.\textsuperscript{68} Internationalisation of R&D (measured as the share of foreign affiliates in manufacturing R&D), varies quite dramatically from country to country, ranging from 1.3\% in Japan to 68\% in Ireland (USA: 12\%, German: 14.5\%, France: 21\%, United Kingdom: 39.5\%). On average, more than 12\% of total expenditure on industrial R&D in the OECD area is carried out abroad and by foreign affiliates.\textsuperscript{69} This increased internationalisation of the R&D effort is also reflected in the results of the R&D process: In the mid 1990s, 9\% of all patents were invented in collaboration with foreign researchers (up from 5\% eight years earlier) and the share of scientific publications edited with a foreign co-author was already 26\% in 1995.\textsuperscript{70}

Main objectives linked to the internationalisation process of firms are the following:

- Growth (access to larger markets);
- Diversification of markets (different maturity of markets, business cycles, economic conditions, etc.);
- Lower dependence on local markets (input and output);
- Increased possibilities to benefit from transfer and allocation of resources;
- Access to local markets;
- Easier access to international capital and labour markets;

\textsuperscript{67} Mowery / Rosenberg (1989), p. 275
\textsuperscript{68} von Zedtwitz (1999), p. 29
\textsuperscript{69} OECD (1999), p. 74
\textsuperscript{70} OECD (1999), p. 74
• Better access to sources of raw materials.\textsuperscript{71}

Prahalad and Doz developed a framework capturing the pressures on a given business. Their so-called Integration – Responsiveness grid allows corporate strategies (and thus companies themselves) to be mapped according to their need for local responsiveness on the one hand and their need for global integration on the other.\textsuperscript{72} Bartlett and Ghoshal elaborated the model and found a way to characterise a company’s approach to internationalisation. They identify four types of organisations: The international, multinational, global and transnational organisation (figure 2.3).

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{Integration_Responsiveness_grid.png}
\caption{The four types of organisations in the Integration – Responsiveness grid}
\end{figure}


\textsuperscript{70} OECD (2000), pp. 5-6

\textsuperscript{71} Granstrand (1979), pp. 170-171
Table 2.1 outlines their main characteristics:

<table>
<thead>
<tr>
<th>Organisational Characteristics</th>
<th>Multinational</th>
<th>Global</th>
<th>International</th>
<th>Transnational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration of assets and capabilities</td>
<td>Decentralised and nationally self-sufficient</td>
<td>Centralised and globally scaled</td>
<td>Sources of core competences centralised, others decentralised</td>
<td>Dispersed, interdependent, and specialised</td>
</tr>
<tr>
<td>Role of overseas operations</td>
<td>Sensing and exploiting local opportunities</td>
<td>Implementing parent company strategies</td>
<td>Adapting and leveraging parent company competences</td>
<td>Differentiated contributions by national units to integrated world-wide operations</td>
</tr>
<tr>
<td>Development and diffusion of knowledge</td>
<td>Knowledge developed and retained within each unit</td>
<td>Knowledge developed and retained at the centre</td>
<td>Knowledge developed at the centre and transferred to overseas units</td>
<td>Knowledge developed jointly and shared world-wide</td>
</tr>
</tbody>
</table>

Table 2.1: Organisational characteristics of the International, Multinational, Global and Transnational companies

(Source: Bartlett / Ghoshal (1989), p. 65)

Brechje found out that greenfield sites were the dominant mode of entry when internationalising a firm’s R&D, but that joint ventures and acquisitions were catching up as the prevalent instruments. However, foreign direct investment (FDI), which implies a capital transaction between the two entities involved in the partnership, is not the only way to co-operate with foreign organisations. As technology alliances proliferated in the 1990s, firms now increasingly choose to join together with foreign partners. The evidence available, however, indicates that deals among domestic companies still dominate inter-firm collaboration scene. Figure 2.4 displays a spectrum of modes of technical co-operation.

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73 Brechje (1999a), p. 15
74 Benefits from the participation of firms in innovation networks include the following: increased scale and scope of research activities, the sharing of cost and risk, a higher flexibility and efficiency, an enhanced ability to deal with complexity, greater speed, superior learning effects, etc. (OECD (2000), p. 13)
75 OECD (2000), p. 14
2.1.1.2 The basic drivers in the internationalisation of R&D

The globalisation of R&D activities usually goes hand in hand with the internationalisation of the company itself, characterised by a world-wide consolidation and bundling of the business activities. The wide variety of leading edge technologies and their combination, together with the rapidly escalating pace and costs of technological development call for a rapid and straightforward access to a broader spectrum of scientific skills and know-how than is available at home. Hence, setting up R&D sites in foreign countries has become a necessity for the creation and maintenance of technological competitive advantage. More specifically, there is a multitude of potential

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[Table: Modes of technical co-operation]

<table>
<thead>
<tr>
<th>Mode of co-operation</th>
<th>Organisational interdependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint ventures</td>
<td>Extensive</td>
</tr>
<tr>
<td>Joint R&amp;D (research pacts, joint development agreements)</td>
<td>Medium</td>
</tr>
<tr>
<td>Technology exchange agreements (mutually), technology</td>
<td>Low</td>
</tr>
<tr>
<td>sharing, cross-licensing, mutual second-sourcing</td>
<td></td>
</tr>
<tr>
<td>Direct investment, minority and cross-holding</td>
<td></td>
</tr>
<tr>
<td>Customer-supplier relations, R&amp;D contract, co-production,</td>
<td></td>
</tr>
<tr>
<td>co-makership</td>
<td></td>
</tr>
<tr>
<td>One-directional technology flow, second sourcing, licensing</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 2.4: Modes of technical co-operation*
(Source: Hagedoorn (1990), p. 18)

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77 Brechje (1999a), p. 7
reasons justifying R&D internationalisation. These can be broken down into motives internal and external to the company, as the following table shows:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Motives</th>
</tr>
</thead>
</table>
| Personnel       | • Increase possibilities to recruit managers and R&D personnel  
|                 | • Localise management resources  
|                 | • Access to the best R&D professionals world-wide  
|                 | • Circumvent limitations in quality and supply of domestic technical talent  
|                 | • Access to complementary expertise available elsewhere  
|                 | • Leverage globally-based access to creative inputs  
|                 | • International ambitions among managers and engineers  
|                 | • Reap the benefits of a diverse workforce  
| Know-how        | • Tap local knowledge and technology  
|                 | • Access to up-to-date research findings  
|                 | • Source know-how in centres of technological excellence  
|                 | • Get closer to universities and research institutes  
|                 | • Access to regional centres-of-excellence  
|                 | • Globalise local knowledge  
|                 | • Acquisition of knowledge  
|                 | • Need for world-wide learning  
|                 | • Improve the transfer of technology  
|                 | • Learn from local R&D approaches and values  
|                 | • Transfer of knowledge through spill-over effects  
| Internal motives| Efficiency                                                                                                                                 |
|                 | • Support of manufacturing and distribution efforts with local R&D activities (in order to reap cost, productivity and flexibility advantages)  
|                 | • Reduce labour costs for R&D  
|                 | • Achieve economies of scale and scope  
|                 | • Reach a critical size  
|                 | • Integration with manufacturing and / or marketing functions  
|                 | • Reduce costs of doing R&D, especially contract R&D  
|                 | • Carry out global project launches  
|                 | • Make use of different time zones  
|                 | • Exploit country-specific cost advantages  
|                 | • Risk-sharing in large-scale R&D projects  
|                 | • Adapt to local production processes  
|                 | • Ride down the learning curve  
|                 | • Stimulates internal competition through parallel development  
<p>|</p>
<table>
<thead>
<tr>
<th>Factor</th>
<th>Motives</th>
</tr>
</thead>
</table>
| **Partnerships**       | • Proximity to suppliers  
                         • Seek partners with complementary skills  
                         • Access to scientific networks  
                         • Achieve synergy with foreign partners |
| **Infra-structure**    | • Access to modern R&D infrastructure  
                         • Lower infrastructure costs  
                         • Reduce communication costs  
                         • Seek stable information and communication networks  
                         • Offer cultural, leisure and educational infrastructure for R&D workforce |
| **Business strategy**  | • Global Sourcing  
                         • Accomplish the corporate philosophy and vision (e.g. of developing the global company)  
                         • Establish global networks  
                         • Set global standards and establishing dominant designs  
                         • Closer orientation towards market  
                         • Strategic supplier integration  
                         • Integrate R&D units as a result of corporate mergers and acquisitions  
                         • Tap the technological sophistication of foreign subsidiaries  
                         • Promote flexibility through novel transnational organisation |
| **Market**             | • Adaptation of products to local requirements and needs (locally responsive R&D)  
                         • Respond to the trend of the globalisation of customers and markets  
                         • Increase customer proximity |
| **Image**              | • Gather ideas and impulse about specific customer needs (to be included in the innovation process) due to on-site presence  
                         • Create good-will locally  
                         • Polish image with the aim of recruiting high potentials and facilitating interaction with the international scientific community  
                         • Avoid low domestic acceptance for particular technologies |
2.1 The reasons (why?)

### Table 2.2: Motives for the internationalisation of R&D


<table>
<thead>
<tr>
<th>Factor</th>
<th>Motives</th>
</tr>
</thead>
</table>
| Legal and Regulations | • Become an insider in regulatory networks  
|                  | • Utilise tax advantages for R&D activities  
|                  | • Benefit from national and international programmes for the promotion of R&D (e.g. subsidies)  
|                  | • Favourable conditions for performing R&D (e.g. biotechnology, genetic engineering)  
|                  | • Favourable legal conditions in the protection of intellectual property (e.g. patenting laws)  
|                  | • Favourable legal conditions for the regulatory approval of products (e.g. pharmaceuticals)  
|                  | • Access to attractive institutional scientific and technological environments  
|                  | • Meet foreign government requirements (in particular country-specific regulations and standards)  
|                  | • Comply with local content requirements  
|                  | • Avoid protectionist barriers (e.g. red tape)  
|                  | • Evade prohibitive domestic legal conditions  
| External motives | • Counteract the complexity of emerging technologies  
|                  | • Tradition and attitudinal preferences for different nations  
|                  | • Adapt to peer pressure and competition  
| Other            | • Counteract the complexity of emerging technologies  
|                  | • Tradition and attitudinal preferences for different nations  
|                  | • Adapt to peer pressure and competition  

2.1.1.3 The organisation of international R&D

The previous section showed that there are plenty of arguments in favour of the internationalisation of R&D activities. However, the approach can vary across several factors, such as the industry or the stage in the value chain. For example, the pharmaceutical business is known for being particularly advanced in the globalisation process of R&D. The reasons for that are the various national regulatory approval procedures for its products, together with the clinical development in each country. Both elements call for an accelerated pace of internationalisation for those companies that want to preserve their technological advance or their market share. Likewise, firms from the computer industry tend to globalise certain development activities in order to react to
local market and regulation trends. In contrast, other high-tech branches, such as the aeronautical or semiconductor industries, carry out their R&D in their headquarters or at least in their home country – although the distribution and manufacturing are markedly globalised.78

The issues related to the organisation of global R&D management revolve around three main points: the localisation (centralisation vs. decentralisation) and the integration (global vs. local) of the R&D system, as well as the implementation of the global R&D network.

1) Centralisation:

The previous section described the drivers for the internationalisation of R&D. However, not every company may decide to globalise its research activities, for there are also several arguments against the expansion of R&D beyond national borders. The question of the degree of centralisation of R&D also concerns the decision of how far the research effort shall be concentrated in the parent company.

Centralised R&D, which is still the predominant strategy today, emphasises the parent company as the chief R&D location. Resources are directed towards headquarters, while subsidiaries have only limited means at their command, rarely operating their own R&D units. The parent company dominates the co-ordination of the activities through express directions, instructions and regulations. The subsidiaries have only a passive role and are not allowed to take any decision on their own. They take orders and have only a minor influence on the innovation process.

In a decentralised function, R&D is carried out in individual subsidiaries, each enjoying extensive autonomy over its R&D activities. The co-ordination exercised here is quite loose, so that the affiliates play an active role in the innovation process. They dispose of meaningful resources, which they employ for the development of products destined for local markets, including that of the parent company.79

The following table presents the arguments for centralisation against those for decentralisation of R&D:

78 Gerybadze (1997), pp. 36-37
### Arguments for R&D **centralisation**

- Moderate requirements concerning information, communication and coordination (avoidance of inefficiencies and delays in the transmission of information)
- Higher communication intensity
- Avoidance of the duplication of innovation efforts
- Better control over one’s own know-how
- Economies of scale in R&D, critical mass (lower R&D costs)
- Realisation of synergies
- Offer of higher career potential for R&D employees
- Reduction of R&D costs and development time
- Enhanced control over research results
- Better protection of core technologies
- Better legal protection of intellectual property
- Possibility to establish global product standards
- Development and nurturing of a common R&D culture
- Avoidance of redundancies
- Absence of political risks
- Better protection of firm-specific technology
- Better response to home market conditions
- Respect of history and tradition

### Arguments for R&D **decentralisation**

- Compliance with host market requirements
- The involvement of the subsidiaries contributes to a better climate within the firm (promotes the innovative and entrepreneurial spirit)
- Exploitation of (labour) cost differentials
- Utilisation of the competences of foreign affiliates and employees
- Attain spatial proximity to foreign research sites
- Enlargement of the pool of ideas
- Exploitation of spill-over effects
- Better response to foreign markets and demand side-factors (because of proximity and higher sensibility)
- Possibility to employ highly skilled labour (which usually is barely mobile)
- Better access to external technology
- Better access to knowledge and new research results (from foreign universities and competitors)
- Avoidance of the NIH syndrome
- More flexible organisation
- Promotion of creativity and flexibility
- Use of local resources
- Promotion of organisational learning across many locations
- Exploitation and refining of local strengths

<table>
<thead>
<tr>
<th>Table 2.3: Centralisation vs. decentralisation</th>
</tr>
</thead>
<tbody>
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<td>• Respect of history and tradition</td>
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<td>• Compliance with host market requirements</td>
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<td>• Promotion of organisational learning across many locations</td>
</tr>
<tr>
<td>• Exploitation and refining of local strengths</td>
</tr>
</tbody>
</table>


### 2) Integration:

The term integration of a firm’s R&D activities refers to the intensity of the exchange of information between the parent company and its subsidiaries.
Thus, the denomination of a company as *local* (i.e. one with a low integration) implies that the parent company and the different subsidiaries are rather independent of each other in technology and innovation matters. Each unit has its own R&D department and there is only little interaction between them. The subsidiaries, which enjoy a broad autonomy from the parent company, use their own resources to develop products tailored to their respective local markets. The main advantage of the local strategy is the low need for co-ordination measures between the partners involved in the innovation process. However, this often comes with a costly duplication of efforts and investment, given that all functions must be covered in all R&D sites. In addition, it can lead to redundancies and thus to inefficiencies.

Conversely, a company with *global* R&D (characterised by high integration) considers the world as one single market, and renounces dividing it in several national segments. The parent company and its affiliates co-operate closely together in order to develop a standardised product, which takes into consideration the needs and preferences of each local market. All innovation activities happen on a co-ordinated basis. Consequently, the resources are dispersed across the parent and the subsidiary companies, in such a way that participants supplement each other. With this integration approach, the firm may realise great synergies. On the other hand, the global strategy requires significant co-ordination efforts, which lead to higher costs and delays in the R&D process.

3) **Implementation of the international R&D network:**

Companies with a decentralisation or a global strategy have to set up their R&D sites abroad. In doing this, they have a choice between two types of foreign laboratory sites, as portrayed by Walter Kuemmerle: 80

- **Home-base-augmenting sites** aim to tap knowledge from local competitors and universities spread around the world. The newly created information and knowledge flow from the foreign source to the central R&D site at home.

- **Home-base-exploiting sites** aim to support the manufacturing facilities and marketing efforts in foreign affiliates and to tailor the company’s standard products to

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80 Kuemmerle (1997), pp. 62-63
local needs. Information and knowledge are transferred from the central R&D site to the different locations abroad.

Generally, to transfer knowledge on an international scale, companies have to move their own people. There are two common ways of sending an R&D specialist from one site to the other.\(^8^1\)

- **Expatriates** are delegates from the parent company who are sent to foreign R&D sites in order to diffuse corporate knowledge. This channel is also beneficial to the expatriate himself, as the assignment constitutes a valuable cultural experience and fosters his management skills and personality.

- **Visiting researchers** are foreign experts sent by a foreign subsidiary to the central R&D site so they acquire research knowledge critical to the company’s business.

After deciding on the type of R&D sites to be established abroad, the next point is to agree on where the new facility has to be set up. Determinants for the choice of location are the following:

- Market characteristics: size and attraction of the local market (growth potential, similarity with home market);

- Availability of human resources: size and quality of the R&D talent pool;

- Quality, modernity and adequacy of the technological infrastructure (including information and communication technology);

- Potentials to reduce costs (personnel, infrastructure, etc.);

- Proximity to universities and other research institutions;

- Proximity to suppliers and competitors;

- Friendliness of the scientific, political, legal and regulative environment;\(^8^2\)

- Potentials for learning and knowledge spillovers;\(^8^3\)

\(^8^1\) Gassmann (1997), p. 208  
\(^8^2\) von Boehmer (1995), pp. 18-19  
\(^8^3\) Völker (1996), p. 51
• Specific strengths of the host country or region in the scientific and technical area considered.\textsuperscript{84}

Centres of innovation often provide exactly the advantages required above. Many companies have recognised the merits of such clusters of scientific excellence and have chosen to establish foreign sites in technological hot spots known as Silicon Valley (Northern California) or Route 128 (Boston, Massachusetts). Their great success has generated several attempts to reproduce this sort of achievement. Silicon Hills (Austin, Texas), Golden Triangle (San Diego, California), Sunset Corridor (Portland, Oregon) in the US and Sophia Antipolis (Southern France), Cité Scientifique (south of Paris) or Tétrapôle (Grenoble) in Europe are only a few examples of “baby hot spots.”\textsuperscript{85}

Such regions are extremely interesting areas for locating foreign R&D sites, since they assemble competing firms from the same industry\textsuperscript{86} and concentrate not only highly-trained workers, but also provide access to cutting-edge technology. Companies seek the proximity to great scientists (labour market pooling) and prestigious academic institutions (e.g. the University of California at Berkeley and Stanford University for Silicon Valley) as well as a great number of specialised suppliers of raw material and technological equipment.\textsuperscript{87} Other factors propitious to the development of centres of excellence are the presence of government sponsored research laboratories, abundant venture capital, modern physical infrastructure (such as ports, airports, roads, etc.), a positive attitude towards risk, entrepreneurship and business.\textsuperscript{88} In some instances, the presence of special facilities essential to the business can also play an important role. This is notably the case for the pharmaceutical industry, which relies on sick people (and thus on hospitals) to carry out clinical trials.

Other branches known for typically gathering in innovation clusters to perform their research activities include the semiconductor, the computer and the biotechnology sectors. Those are all industries where (the creation of) knowledge is critical to the

\textsuperscript{84} Brechje (1999a), p. 16
\textsuperscript{85} Herbig (1994), p. 249
\textsuperscript{86} Pouder / St. John (1996), p. 1194
\textsuperscript{87} Krugman / Obstfeld (1997), p. 147-148
\textsuperscript{88} Herbig (1994), pp. 237-240
success of the firm. Hence, one implicit motive for companies to settle down in geographic clusters is the expectation of knowledge spillovers. The hope to absorb knowledge from external sources (e.g. competitors) drives firms to establish sites where they can look forward to intercepting some of the knowledge flowing through the region, hence achieving substantial learning effects. In addition, it appears that immediate vicinity of organisations with similar interests encourages and nurtures the exchange of ideas across the networks established, which can be formal or informal.89 Besides this, there is evidence that spatial distance can have significant inhibitory effects on communication, impeding the sharing and transfer of knowledge. Indeed, the probability of communication decreases exponentially with the physical distance between the interlocutors.90 This relationship, which has been proven in the micro- (meter distances, e.g. in the same building) as well as in the macro-range (kilometre distances), is depicted in the so-called Allen curve, named after the author of the original study (figure 2.5). As a consequence, gathering in centres of excellence allows firms to reduce the distance between their own researchers and those from competitors or other scientific institutes, hence minimising losses in communicative efficiency.

Figure 2.5: The Allen curve
(Source: Adapted from: Boutellier / Gassmann / von Zedtwitz (2000), p. 188)

89 DeCarolis / Deeds (1999), pp. 955-956
Still, innovative clusters are not only attractive for the companies themselves but also for the people working there, who benefit from the knowledge spillovers, the attractive working conditions and a challenging environment. As specialists go where they can find the most promising conditions to practise their job, i.e. where they have access to the necessary resources (labs, funds, tools, but also large facilities such as nuclear plants or launching ramps for space shuttles), centres of excellence are magnets for brilliant researchers from all over the world. As a matter of fact, the scientific community has witnessed a veritable brain drain to large centres of innovation, especially after the fall of the Iron Curtain. This phenomenon has definitely contributes to an accelerated constitution of cross-cultural R&D teams. Teams established in such locations are particularly valuable because they are very heterogeneous as far as nationalities and cultures are concerned, but are highly homogeneous from a functional perspective.

2.1.2 Group dynamics

Back in the late fifteenth century, at the beginning of the Renaissance, scientists used to work for themselves, hiding behind large walls of secrecy. There were no specialised journals and all discoveries and results were resentfully kept for reasons of potential profit or precedence. The French monk Marin Mersenne was the first to breach those barricades, by establishing a regular correspondence amongst renowned scientists in Western Europe and by organising intellectual circles. Ever since, researchers have sought to collaborate in the name of scientific advancement and in order to leverage their efforts. Nowadays, hardly any researcher would even think of working alone. Indeed, “there is a widely held belief that teams are critical tools for solving problems […] in a highly complex, international environment.”

This section deals with the question of why research is systematically performed in teams rather than by isolated scientists. Before some theories explaining the formation of groups and teams are presented, here is a summary of the main constitutive characteristics of teams:

- A complex common task or portfolio of tasks lies at the centre of the collaboration;

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91 From: http://www.zdnet.co.uk/pcmag/columns/2000/07/jackson.html
92 Shaw / Barrett-Power (1998), p. 1308
2.1 The reasons (why?)

- The common task requires close co-operation;
- Accordingly, the partnership is characterised by a high degree of interdependence;
- Collaboration necessitates high interaction density, which renders frequent interaction indispensable;
- Teamwork is justified by the integration of dispersed competences and expertise.93

The advantages and disadvantages of teams are listed in table 2.4.

Group dynamics, a concept founded by the German social psychologist Kurt Lewin, “refers to a field of inquiry dedicated to achieving knowledge about the nature of groups, the laws of their development, and their interrelations with individuals.”94

Hence, group dynamics investigates the phenomenon of groups and team management (figure 2.6). Consequently, it is closely linked to questions such as the identification and exploitation of synergies in groups or the interpersonal processes taking place within teams. In addition, one distinctive matter to which particular attention shall be paid is that of global virtual teamwork.

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93 Gomez / Rüegg-Stürm (1997), p. 143
94 Cartwright / Zander (1968), p. 4

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*Figure 2.6: Classification of group dynamics*
# Advantages of teams

- Stronger productivity
- More effective and efficient use of organisational knowledge and expertise
- Higher efficiency in solving problems
- Higher-quality decisions
- Enhanced quality of goods and services
- Tougher resilience
- Reduced costs
- Superior flexibility and reactivity
- Better solutions (because of a variety of opinions)
- Improved communication as a result of higher information flow
- Greater creativity, imaginativeness and resourcefulness owing to a broader mix of skills and know-how
- Collective wisdom
- Enriching experience for team members: Personality development through continual contacts with other team members, frequent communication, socialisation, exchange of ideas, fun, etc.
- Promotion of tolerance within the organisation
- Deeper commitment and identification with the organisation as a whole
- Enhanced economic and administrative aspects of work thanks to a common social dimension

# Disadvantages of teams

- Loss of time because of meetings
- Longer decision making processes
- Rise of conflict potentials
- Increased training costs
- Risk of inhibiting members' personalities due to pressure toward conformity
- Difficulties in managing (compared to single individuals)

<table>
<thead>
<tr>
<th>Advantages of teams</th>
<th>Disadvantages of teams</th>
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<tbody>
<tr>
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<td>Loss of time because of meetings</td>
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<td>Higher-quality decisions</td>
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<tr>
<td>Enhanced economic and administrative aspects of work thanks to a common social dimension</td>
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</tbody>
</table>

Table 2.4: Advantages and disadvantages of teams


## 2.1.2.1 Synergy

One main driver for the use of teams in R&D is the anticipation of achieving sizeable synergy, a term which refers to the positive effects that follow as a consequence of the interconnection of several members from the same team working towards the same
goal. It should result from the optimal co-ordination and integration of each member’s individual knowledge and skills. Hence, the outcome of the team as a whole should exceed by far that of the aggregated performances of each member taken separately.\textsuperscript{95} The fundamental idea behind this is that the whole is necessarily greater than the sum of its parts, a principle that underlies the concept of group dynamics, as coined by Lewin.\textsuperscript{96} A team gets into motion when the members’ activities are accurately assembled and amalgamated to a symbiotically working unit.\textsuperscript{97} In other words, the whole is not only greater but also somewhat different from the sum of its parts.\textsuperscript{98}

An explanation for the existence of synergy effects may be found in the common observation that, while an employee believes individually that he has attained the best result possible, he might nevertheless even improve his performance once he gets assimilated into a group of people with equal rights.\textsuperscript{99} Hensey relates synergy to the “tangible support given to one member by another.”\textsuperscript{100} One distinctive benefit of teams directly connected to synergy is the fact that each member has the opportunity to leave his own narrow perspective by getting different opinions, grasping his team-mates’ difficulties and understanding how they approach common problems. Consequently, synergy leads not only to more efficient results in the continuous treatment of repetitive tasks, but also to superior solutions to complex problems.\textsuperscript{101} So the advantages related to synergy have more of a qualitative than a quantitative nature.

The creation of synergy requires that each member’s performance be higher when integrated rather than simply added together. This in turn can only be accomplished if their operations, efforts and behaviours are effectively co-ordinated and combined. Finally, the goal is for the team members to work together as well as possible and to maximise each one’s contribution to the whole group’s achievements. According to Hensey, this includes: commitment, the use of straight talk, the ability to manage

\textsuperscript{95} Schneider (1996), p. 94
\textsuperscript{96} Mink / Mink / Owen (1990), p. 6
\textsuperscript{97} Preston / Armstrong (1991), p. 66
\textsuperscript{98} Schneider / Knebel (1995), p. 19
\textsuperscript{99} Schneider (1996), p. 31
\textsuperscript{100} Hensey (1992), p. 68
\textsuperscript{101} Schneider (1996), pp. 32-33
conflict, permeable job boundaries, the affirmation and celebration of the success of members as well as of the team as a whole.\textsuperscript{102}

2.1.2.2 Interpersonal processes

As maintained by Jarvenpaa and Leidner (1999), groups have to fulfil three functions simultaneously and continuously:

1) **Production** (problem solving and task performance);

2) **Member support** (member inclusion, participation, loyalty, commitment);

3) **Group well-being** (interaction, member roles, power, politics).\textsuperscript{103}

All three functions require intense interpersonal processes, which means that teams are not only problem solvers but exist through the social interaction among their members’ personalities.

Interpersonal processes, which inevitably occur when different people meet in order to co-operate, go far beyond the mutual influence of those involved. In addition, they do not necessarily imply active procedures. On the contrary, such processes may also concern unconscious relations between individuals. Social interaction stems above all from people exchanging ideas, experiences or impressions. In that case, the interaction is deliberate and the object is to share personal wisdom and to generate knowledge.

Comparing them to viruses, Völpel declares that ideas are spread across the organisation by its members. According to him, this transfer takes place on the basis of weak ties. Those weak ties, which direct and concentrate information on new ideas and opportunities, connect people from different clusters within or beyond the formal organisation. These clusters, in turn, are built by the co-existence and dealings of people with whom they have more or less strong social relationships. So the more bridging bonds an individual holds, i.e. the more tightly he is linked to others, the more varied his own data and information will be.\textsuperscript{104} In line with this logic, it is no surprise that the construction of networks is actually stimulated in research organisations. Other than the promotion of science-industry partnerships and co-ope-

\textsuperscript{102} Hensey (1992), p. 68
\textsuperscript{103} Jarvenpaa / Leidner (1999), pp. 792-793
\textsuperscript{104} Völpel (2002), p. 123
ration in research, great emphasis is laid on incentives for researchers and on policies to boost the mobility of scientific staff.105

Sharing is definitely the most important social process occurring in teams. When sharing, two or more people give to and receive from each other in a context of common interest, task or area of concern. Sharing is often the foundation of a tied collaboration and thus constitutes a basic ingredient for effective teamwork: Each member is drawn into the social life of co-operation, when he realises that the others share his particular interests. Such an insight of a collective (in the sense of shared or common) ground is the starting point for a lasting fellowship.106

The aspiration of any team member and in particular of the leader should be to influence the team in such a way that the interpersonal interaction is realised with as little friction as possible. In other words, the chief purpose is to turn this plain interaction into true collaboration, able to leverage the skills and potentials of each member. From this perspective, Smith and Berg’s words describing the balance that needs to be struck for effective teamwork are remarkably accurate:

“To be an individual, each person must integrate the variety of groups to which he or she belongs. To be a group, a collection of individuals must integrate the array of individual differences that the members represent, many of which are a product of the multiple groups to which each individual belongs. Identity formation for both individuals and groups requires the simultaneous integration of differences and similarities.”107

The nature of teams itself holds much potential for failure. The fact that a number of people have to work together creates potential social turbulence, which can hamper the work flow within the group, thus jeopardising the whole project. The examples of factors of disturbance are the dragging of the team’s weakest element, clustering, self-profiling,108 social loafing (i.e. the observation that individuals in groups reduce their

106 Adair (1986), pp. 55-56
108 Schneider / Knebel (1995), pp. 44-46
own effort with the increasing number of team members, because their own performance becomes less observable, and social pressure. Another interpersonal process with negative effects is groupthink. This phenomenon is typical for highly homogenous teams and refers to

“[The mode of thinking that persons engage in when concurrence-seeking becomes so dominant in a cohesive ingroup [(sic)] that it tends to override realistic appraisal of alternative courses of action. [...] The symptoms of groupthink arise when the members of decision-making groups become motivated to avoid being too harsh in their judgments of the leader’s or their colleagues’ ideas. They adopt a soft line of criticism, even in their own thinking. At their meetings, all the members are amiable and seek complete concurrence on every important issue, with no bickering or conflict to spoil the cozy, ‘we-feeling’ atmosphere.”

Figure 2.7 depicts the symptoms and consequences of groupthink.

**Figure 2.7: Symptoms and consequences of groupthink**

(Source: Adapted from: Janis / Mann (1977), p. 132)

<table>
<thead>
<tr>
<th>Symptoms of groupthink</th>
<th>Consequences of groupthink</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Illusion of invulnerability</td>
<td>1. Incomplete survey of alternatives and objectives</td>
</tr>
<tr>
<td>2. Collective rationalisation</td>
<td>2. Failure to examine risks of preferred choice</td>
</tr>
<tr>
<td>3. Belief in inherent morality of the group</td>
<td>3. Poor information search</td>
</tr>
<tr>
<td>4. Stereotypes of out-groups</td>
<td>4. Selective bias in processing information at hand</td>
</tr>
<tr>
<td>5. Direct pressures on dissenters</td>
<td>5. Failure to re-appraise alternatives</td>
</tr>
<tr>
<td>6. Self-censorship</td>
<td>6. Failure to work out contingency plans</td>
</tr>
<tr>
<td>7. Illusion of unanimity</td>
<td></td>
</tr>
<tr>
<td>8. Self-appointed mind guards</td>
<td></td>
</tr>
</tbody>
</table>

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110 Schneider (1996), p. 51
111 Janis (1971), p. 333
Such in-group pressures are extremely counterproductive as they reduce the mental efficiency of the team, prevent the team members from testing the reality, and weaken their moral judgement. For those reasons, groupthink corrupts teamwork and is extremely harmful, inhibiting innovation, restraining creativity and resulting in lower-quality solutions.

Furthermore, the lack of clarity and comfort in each member’s role breeds insecurity, lack of confidence, irritation, and anxiety within the whole group, troubles which can work against any form of collaboration. Therefore, ignoring such group dynamic phenomena can lead to very destructive power struggles.

2.1.2.3 Conflict

Clashes involving internal authority are not the only form of conflict to be found in teams. In fact, conflict is common in any collaboration. Conflict can be defined as

“A situation where the goals, values, interests, and perceptions of one individual or group are incompatible with another individual or group. In general, conflict may range from mild disagreement to a complete breakdown in relationship.”

With reference to multicultural R&D teams, common causes of conflict comprise competition for and allocation of limited resources or poorly defined organisational responsibilities, semantic difficulties, inappropriate communication channels, staff heterogeneity. Most conflicts however find their roots in purely personal or behavioural matters: people’s aggressiveness, personal dislikes, mutual distrust, clashes of role values, disagreements among peers on objectives and methods, misunderstandings, contradictory interests or feelings, differing opinions, varying personalities, deficient role satisfaction, false status perception, opposite personal goals, etc. Phillip Lewis notices that “ultimately, all conflict is caused by people’s emotions when their goals cannot be achieved. If those emotions produce action, conflict normally occurs.” So conflict does not necessarily involve antipathy, but is no more than the

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112 Adair (1986), p. 35
113 Lumma (1994), p. 41
114 Hensey (1992), p. 68
115 Lewis (1987), pp. 298-299
expression of difference\textsuperscript{116}, and as such “is an absolutely inevitable part of being alive and working with others”\textsuperscript{117}. This is particularly true for multicultural teams, for which diversity is the cardinal characteristic.

Usually, authors differentiate between dysfunctional and beneficial conflict. \textit{Dysfunctional} conflict (also known as competitive conflict) refers to

“A relationship where the disagreeing persons choose to define their own positions vigorously and attempt to win over others. [...] In this way, conflict results in a failure to reach an agreement and, in its place, a solution may be imposed by the more powerful.”

On the other hand, \textit{beneficial} conflict (or co-operative conflict) designates the situation where

“Two or more employees have opposing ideas and interests but are motivated to explore and understand the views and interests of the other.”\textsuperscript{118}

This distinction makes it clear that conflict also offers opportunities and can have beneficial effects on a team’s performance (table 2.5). Where the balance ends up will mostly depend on the team members’ and leader’s capacity to cope with, or to manage, that conflict.

\textsuperscript{116} Graham (1991), p. 78
\textsuperscript{117} Hensey (1992), p. 68
\textsuperscript{118} Yeatts / Hyten (1998), pp. 89-90
2.1 The reasons (why?)

<table>
<thead>
<tr>
<th>Positive effects of conflict</th>
<th>Negative effects of conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of new energy and activities</td>
<td>Prevailing of instability and confusion</td>
</tr>
<tr>
<td>Development of new ideas</td>
<td>Stress and discontentment</td>
</tr>
<tr>
<td>Arousing interest</td>
<td>Disorders in the organisational process</td>
</tr>
<tr>
<td>Prerequisite for creativity and innovation</td>
<td>Perturbation of communication and co-operation</td>
</tr>
<tr>
<td>Stimulation to think over one’s own situation and position (improvement of the individuals’ and groups’ perception)</td>
<td>Waste of resources</td>
</tr>
<tr>
<td>Foundation for organisational change</td>
<td>Cognitive distortion due to worsening communication</td>
</tr>
<tr>
<td>Progression of emotionality</td>
<td>Reduction of rationality</td>
</tr>
</tbody>
</table>

Table 2.5: Positive and negative effects of conflict

2.1.2.4 Global virtual teamwork: A discussion

In the wake of the internationalisation of R&D, companies have introduced original concepts of interaction for their employees spread across the world. Virtual teams, i.e. temporary, geographically, and organisationally dispersed, electronically communicating work groups, are one of those. They have been set up in several companies as a means to harvest the benefits of global R&D while avoiding its drawbacks. Also, recent advances in information and communication technology (ICT) have allowed teams to function in multiple locations, no matter the distance separating them. ICT includes tools such as the telephone, electronic mail, video-, teleconferencing, R&D databases, groupware, document conferencing, electronic libraries, electronic whiteboards, and so on. It is made possible and supported by systems like local area networks (LANs), laptops, mobile phones, internet / intranet or collaborative software. Modern ICT is expected to alter the shape and to generate an upward shift of the Allen curve, denoting a higher probability of communication between physically

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120 Gassmann (1997), pp. 200-205
121 Haywood (1998), p. 52
122 McDermott / Brawley / Waite (1998), p. 281
123 Townsend / DeMarie / Hendrickson (1998), pp. 19-20
separated R&D employees (figure 2.8). Finally, the increasing popularity of flat organisational structures and shifts in employees’ expectations concerning organisational participation have equally contributed to the trend.\footnote{Townsend / DeMarie / Hendrickson (1998), p. 18}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure2_8}
\caption{The impact of modern ICT on the Allen curve \textit{(Source: Boutellier / Gassmann / von Zedtwitz (2000), p. 188)}
}
\end{figure}

With this new type of collaboration, “work can be done almost anywhere and anytime.”\footnote{Boutellier / Gassmann / von Zedtwitz (2000), p. 32} Furthermore, virtual teams offer many other advantages. Specifically, they:

- Enable organisations to combine human resources that might not otherwise be able to work together;\footnote{Townsend / DeMarie / Hendrickson (1996), p. 124}

- Enlarge the talent pool, as people can be hired and retained in different locations;

- Are smarter than traditional teams, because most of the communication occurring between their members is digitally encoded. The information shared (emails, documents, postings on web sites, etc.) can be stored and retrieved thereafter;\footnote{Alexander (2000), pp. 55-56}

- Reduce the costs caused by frequent travelling: monetary (e.g. travelling expenses) and social costs (stress, less time to spend with one’s family or friends)\footnote{Boutellier / Gassmann / von Zedtwitz (2000), p. 188}
Nonetheless, the effectiveness of dispersed teams has remained rather controversial. Many critics highlight the difficulties related to the deficient personal contact between members. Indeed, dispersed teams are forced to operate in spite of being separated by physical distance, different time zones, and very often multiple national cultures. Therefore, team members have to rely on computer-mediated technologies to interact, communicating almost exclusively via the ICT tools presented above. Consequently, the members of a dispersed team rarely or never come to see each other in person; they act virtually, i.e. *almost* as a team. Although modern ICT has positive effects on the Allen curve, the problem remains the same, namely that physical distance hampers communication between the searchers involved. Many authors have stressed that individual, face-to-face communication still constitutes the backbone of efficient information flow. While it is undeniable that researchers have to read, this necessity is limited to the studying of textbooks and professional journals, as a means of refreshing their own memories or determining how the competitors are doing. In their daily business, scientists and engineers rely on information that is rarely to be found in scientific publications, databases, or documents, for the facts and figures they need are mostly embodied in people themselves. So, to exchange information, they “have to talk to each other – in each other’s presence.” During this vital process, team members exchange feedback, integrate contributions and listen to one another, absorbing not only the information content, but also issues of trust, disclosure and sharing. Electronic transmission is far inferior to face-to-face communication, because it is purged of all traditional communicative cues, such as the facial expression, the gesture, or the vocal inflection. However, it undermines the sight in general, the touch, or the ability to interrupt and give feedback. As a consequence, it fails to carry fundamental components of communication in teamwork, such as emotions, to name only one. In globally dispersed teams, where the difficulty of non-verbal communication adds to

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130 Jarvenpaa / Knoll / Leidner (1998), p. 30  
132 De Meyer (1991), p. 49  
133 Iles / Hayers (1997), p. 96  
135 Jarvenpaa / Leidner (1997), p. 22
those of different languages and cultures, this downside of virtuality is likely to be even aggravated, especially if participants of high-context cultures are involved.\textsuperscript{136,137} Furthermore, the absence of regular face-to-face contacts undermines the team’s ability to install or keep up social cohesion and trust.\textsuperscript{138} Here, the value of chatting between researchers cannot be overrated. Such informal and open-ended conversations help the members to establish the trust that is essential for successful collaboration. The development of trust, the “glue of the global workspace”\textsuperscript{139}, is facilitated by several factors, including geographical proximity, shared social norms, repeated interactions, from similarity in backgrounds and experience, the anticipation of future association, etc., all factors that are often largely absent in virtual teams.\textsuperscript{140} Furthermore, mutual trust requires a certain level of confidence between the team members.\textsuperscript{141} This confidence, which is absolutely necessary to promote effective teamwork, can only be maintained on a certain level with repeated face-to-face contact (figure 2.9). In this regard, all electronic communication can do is to contribute to a postponement of the decay of confidence.\textsuperscript{142,143} One might ask the question, however, of how people can build up an atmosphere of confidence where every bit of communication can be digitally monitored and stored. Along with clear policies concerning communication privacy, installing an organisation-wide sentiment of confidence calls for a huge effort to persuade group members to accept that the virtual team system is a safe medium for sharing ideas and concerns.\textsuperscript{144}

\begin{enumerate}
\item[137] The various aspects of communication, in particular the concept of context in verbal and non-verbal communication, will be treated in further detail in chapter 2.4.2.
\item[138] Grove / Hallowell (1998), p. 25
\item[140] Jarvenpaa / Leidner (1999), p. 792
\item[141] De Meyer (1993), p. 46
\item[143] De Meyer (1991), pp. 56-57
\item[144] Townsend / DeMarie / Hendrickson (1998), p. 27
\end{enumerate}
One other main difficulty related to dispersed teams is that differences in work habits and the necessity to bridge time zones place additional demands on co-ordination and synchronisation.\textsuperscript{145} In this context, the virtual approach encompasses a great potential for structural resistance, because it presupposes organisational restructuring and the introduction of new ICT. This can lead to a certain technophobia or eventually to stress and burnout.\textsuperscript{146} Moreover, not all researchers are ready to work in a virtual way. Some employees need work routine and camaraderie they can only find in a traditional office situation.\textsuperscript{147} Finally, the flexible, if not fluid membership, which is characteristic of virtual teams constitutes another threatening factor: Since the work units are not permanent and the relationships and tasks interdependent, there is never enough time to exchange national or organisational beliefs, values, assumptions or customs.\textsuperscript{148} Stated differently, the team members never come to shape a common team culture.

Therefore, the introduction of virtual teams for R&D purposes needs to be pondered very carefully, which involves taking into consideration topics such as corporate organisation, technology, leadership, communication and culture. Above all, one

\begin{figure}[h]
\centering
\includegraphics[width=0.6\textwidth]{strategy_for_maintaining_confidence.png}
\caption{Strategy for maintaining confidence}
\textit{(Source: De Meyer (1991), p. 57)}
\end{figure}

\textsuperscript{145} Boutellier / Gassmann / Macho / Roux (1998), p. 13
\textsuperscript{146} Townsend / DeMarie / Hendrickson (1998), pp. 27-28
\textsuperscript{147} Alexander (2000), p. 55
\textsuperscript{148} Meschi (1997), p. 217
should never forget the people-side of virtuality and be aware that IT-based communication is definitely not a viable substitute for face-to-face contact.

2.1.3 Diversity

The previous section showed that conflict could have positive effects on the generation of novel ideas and on creativity in general. Also, one of the main origins of (beneficial and dysfunctional) conflict is cultural diversity. The following chapter probes the concept of diversity and establishes in how far diversity can be considered as a main factor in explaining why multicultural R&D exists. In the present context, diversity has nothing to do with equal opportunity matters as habitually implied. Rather, diversity here will refer to “the amount of cultural heterogeneity represented in a team”\(^\text{149}\). As such, it emerges when a certain number of people with complementary talents, dissimilar demographic characteristics (age, race, gender, etc.) or from various cultures gather together or, more specifically, when they form a team\(^\text{150}\). Therefore the term concerns simultaneously the areas of multicultural management and team management (figure 2.10).

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\(^{149}\) Thomas (1999)

\(^{150}\) Jent (2002), p. 19

*Figure 2.10: Classification of diversity*
2.1.3.1 Exploring diversity...

Diversity is mostly the result of miscellaneous skills and needs due to disparate backgrounds, demographic origins, or talents. But one construct that is closely intertwined with the notion of diversity is culture. On the one hand, diversity appears as soon as several individuals from various cultures live or work together. On the other, a meeting of cultures or their representative will always lead to a pooling of beliefs, experiences, habits, etc. inherent to those cultures, hence generating heterogeneity.

In the introductory section, culture was defined as a fuzzy construct encompassing many different elements. Moreover, each individual seems to be influenced by what José Santos called cultural spheres. These spheres constantly interfere with one another, so that people do not have one single culture, but are carried by a nexus of national, regional, industry, company, functional and professional cultures. Consequently, diversity emerges from the contact between people with at least one distinct culture or subculture. Given that culture is constituted by dimensions such as common norms, assumptions, customs, artefacts, morals, and so forth, diversity inevitably leads to converse opinions, expectations, preferences, and interests. At the workplace, this means that diversity may trigger contrary responses and reactions to the same set of management practices and processes. Therefore, diversity in a multicultural company will include issues such as dissimilar problem solving methods, thinking modes, research methods, approaches, behaviours, co-operation patterns, leadership styles, attitudes towards work, risk, performance, or conflict, and so on. The magnitude of these differences varies widely according to the amount of diversity.

The degree of a group’s diversity comprises two main constituents: the cultural distance (as opposed to cultural similarity) between the members and the number of cultures represented in the team:

**Cultural distance** is the perceived distance between two cultures. The more facets cultures have in common, the smaller the cultural distance, and *vice versa*. Analog-

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152 Cf. chapter 1.2.2
gously, when the cultures can be characterised quantitatively (as is the case for national and regional cultures),\textsuperscript{155} cultural distance refers to the numerical difference between the parameter values qualifying them. Generally, a significant discrepancy in only one of several cultural dimensions is enough to speak of cultural distance and therefore of diversity. Consistent with this interpretation, the cultural distance between a German and a Dane or a Dutchman should be smaller than that between a German and an Italian or between a Spaniard and a Japanese. Besides, cultures separated sometimes by only a small distance are often combined into one cluster, as for example Scandinavians, Arabs or Latin Americans. Still, it is worth noticing that cultural distance should not simply be equated with geographic distance. Rather, other elements should be taken into consideration, such as the language or the historical background. Indeed, animosities between two neighbouring countries resulting from past warfare can engender a huge cultural distance, in spite of similar languages and values (e.g. Korea and Japan, Iran and Iraq, Greece and Turkey).\textsuperscript{156}

The number of cultures represented in a group is the second main determinant of diversity. The case is quite evident: The more cultures involved in the group the more diverse it is going to be. Based on this view, Nancy Adler identifies three types of culturally diverse teams:

- **Token** teams in which all but one member comes from the same national culture;
- **Bicultural** teams, which are constituted by two or more members representing each of two distinct cultures;
- **Multicultural** teams whose members represent three or more national backgrounds.\textsuperscript{157}

The distinction between the two factors of the degree of diversity can be summarised in the following sentence:

“[...] A group that consists of Norwegians and Swedes is not as diverse as a group that consists of Norwegians and Saudis [(cultural distance)], which in turn is not

\textsuperscript{155} A detailed description of theoretical models quantifying national cultures will be provided in chapter 2.2.1.2.

\textsuperscript{156} Hambrick / Davison / Snell / Snow (1998), p. 191

\textsuperscript{157} Adler (1991), p. 127
as diverse as a group of Norwegians, Saudis, and Americans [(number of cultures represented)].\footnote{158}

The expression above reveals a certain preponderance of the second type of diversity over the first, a judgement, which, however, should be understood as purely quantitative, and not qualitative. Harvesting the benefits of diversity involves a very careful and mature use of the different cultures in a team. That means that the number of cultures should not be inflated indefinitely for the sake of increasing diversity. Rather, the cultural distance and compatibility of the participating cultures should always be evaluated in order to leverage the group’s diversity in a positive direction.

2.1.3.2 ...From di–worse–ity...

The previous section depicted what sort of differences diversity can generate. All these differences may have positive (synergies) as well as negative effects (misunderstandings, cultural clashes). Literature on this question has produced quite inconsistent findings concerning the effectiveness of diversity within organisations and groups, yet it is widely recognised that multicultural teams perform either exceptionally well or exceptionally badly.\footnote{159} On the one hand, managers expect diversity to bring about better solutions, thus leading to premium achievements. On the other, diversity is known to be extremely difficult to handle, while it can lead to inferior performance when not properly managed.\footnote{160,161,162,163,164} This section (and the next) describe respectively the threats and the opportunities related to diversity in R&D teams.

The fact that diversity comes along with difficulties is apparent. As stated in an earlier chapter, interpersonal processes in teams are always associated with struggles among the participants. Cultural heterogeneity adds one dimension to this complexity, exacerbating those problems. Indeed, “differences in attitudes, values, behaviour, experience,
background, expectations, language and location create far more complex dynamics in international teams than most national ones.\footnote{Davison (1994), p. 89}

The reasons for such potential troubles are manifold. First, diversity renders collaboration among group members more difficult, because everybody has different expectations and opinions about how to get things done. In addition, people are inclined to be shy and to feel hesitant about how to behave when immersed in a culturally different environment.\footnote{Thomas / Ravlin / Barry (2000), pp. 17-18} Then, incompatible values and beliefs about principles such as punctuality, consensus, or hierarchy can give rise to serious misunderstandings. Furthermore, diversity inhibits homogeneity, which is an important element for the promotion of integration and trust among team members.\footnote{Hambrick / Davison / Snell / Snow (1998), p. 188} Likewise, at least some similarity and commonalities are necessary to guarantee a minimum level of cohesion within the team, without which effective work is practically not possible.\footnote{Knouse / Dansby (1999)}

In addition, diversity usually leads to attitudinal struggles (dislike or mistrust) and perceptual problems (stereotyping), which can obstruct successful co-operation. These troubles emerge primarily as the result of different priorities, different statuses, and different assumptions about each other’s constituencies. Such rivalries are fairly common in multicultural co-operation, but they become really serious when they degenerate to becoming plain narrow-mindedness, manifested in a reciprocal blaming for crises, or a mutual stereotyping of one another’s competences and contribution.\footnote{Iles (1995), p. 44} One of the worst forms of such bigotry is the so-called “Not Invented Here” (NIH)-syndrome, that is

\begin{quote}
“The tendency of a project group of stable composition to believe it possesses a monopoly of knowledge of its field, which leads it to reject new ideas from outsiders to likely detriment of its performance.”\footnote{Katz / Allen (1982), p. 293}
\end{quote}

The NIH-syndrome can be observed both on an organisational and on a team level. Consequently, teams affected by the NIH-syndrome “are more likely to see only the
virtue and superiority of their own ideas and technical activities while dismissing the potential contributions and benefits of new technologies and competitive ideas and accomplishments as inferior and weak.”\textsuperscript{172} As a natural result, the syndrome distorts the knowledge creation process, forming a grave barrier to innovation.

Along the same line, cultural diversity is frequently the origin of misunderstandings. For the same reasons as those given above, stereotypes and prejudices distort or block communication,\textsuperscript{173} impeding effective multicultural collaboration. Yet, such predispositions and misconceptions are not the only barriers to communication. Different languages and codes in non-verbal communication can equally be the spring of misperception, misinterpretation, or misevaluation.\textsuperscript{174} Partial comprehension, failed and illusionary cognisance\textsuperscript{175} make the team members believe they understand each other, while inaccuracy and an illusionary harmony in reality expose the group to severe risks (e.g. inefficiencies, orientation toward the wrong direction).

Altogether, these factors (increased complexity, prejudices, miscommunication, and so on) are major sources of dysfunctional conflict within the team. Although the problems mentioned here are not all critical, they nevertheless encompass a certain potential for interpersonal friction. But as soon as the disagreements and tensions turn into idle clashes, and disputes become personal, the creative process breaks down\textsuperscript{176} and diversity develops into an obstacle. Frustration, disappointment, stress, uncertainty, etc. are the immediate effects for the people involved. But also for the team as a whole, the consequences are quite painful: process losses, decreased effectiveness, difficulties in reaching agreement, failure to develop sufficient trust to delegate or share responsibilities,\textsuperscript{177} slower decision making velocity,\textsuperscript{178} just to name a few.

\textsuperscript{172} Katz / Allen (1985), p. 448
\textsuperscript{173} Jandt (1995), p. 53
\textsuperscript{174} Kopper (1996), pp. 230-233
\textsuperscript{175} von Raffler-Engel (1985), pp. 66-71
\textsuperscript{176} Leonard / Straus (1997), p. 111
\textsuperscript{177} Adler (1991), p. 130
\textsuperscript{178} Neck / Smith / Godwin (1997), p. 192
2.1.3.3 ...To di–worth–ity

It would be nonsense to believe that diversity only causes problems. In fact, it has many advantages. One obvious benefit is that each extra culture adds a different way of seeing the world. This allows one to approach problems from a wider variance of angles, which in turn has an extremely broadening effect on the scope within which the teams operate. The difference in cultural backgrounds itself does not automatically lead to unique designs and beliefs, however, it definitely increases the chance to find diverse standpoints and opinions in workgroups. Such a mixture in perspectives in turn can be associated with superior ideas, which could eventually spawn richer and more imaginative solutions and a greater variety of proposals.\footnote{McLeod / Lobel (1996)} Therefore, diversity enhances creativity, problem solving, and innovation in qualitative as well as quantitative ways. In view of that, Adler considers cultural diversity is expected to be all the more valuable for teams with complex, discretionary tasks requiring innovation.\footnote{Adler (1991), p. 136}, \footnote{Shaw / Barrett-Power (1998), p. 1309}

Furthermore, the expanded range of perspectives inherent to multicultural teams is supplemented by the advantage of manifold technical expertise because of dissimilar education, training, or work experiences. Consequently, culturally diverse teams are likely to show more complementary skills than homogeneous ones. Diversity thus increases the group’s potential for synergy as defined in a prior section, and the by same token, the knowledge base of the team or the whole organisation is expanded with every new culture entering it.

As Leonard and Straus declare, “the energy released by the intersection of different thought processes will propel innovation.”\footnote{Leonard / Straus (1997), p. 121} This positive correlation is not only the result of a variety of perspectives, ideas, and skills \textit{per se}, but can also be explained by the attenuation of groupthink.\footnote{Shaw / Barrett-Power (1998), p. 1320} It seems evident that multicultural teams are less prone to such behaviour, since the various views represented go against the tendency to adapt one’s ideas to those of the majority. In the absence of a single dominant culture, the team members will be less inclined to follow the rest of the group. Instead,
they are more likely to present their own perspective and concepts.\textsuperscript{184} So by actively avoiding the “clone syndrome”\textsuperscript{185}, which develops when an organisation features an excessive degree of similarity, homogeneity, and cohesion among its members, companies remove a chief stumbling block to creativity, boosting their potential for innovativeness.

The enhanced capacity to be creative and to innovate leaves culturally diverse firms more flexible.\textsuperscript{186} But such an organisational sensibility and adaptability to environmental changes and challenges\textsuperscript{187} is not only attributable to the openness characteristic of heterogeneous groups. Thanks to the numerous network contacts among its members, the team naturally benefits from an improved interaction with the corporate and customer environment.\textsuperscript{188} Likewise, heterogeneity obliges people to concentrate in order to understand others’ ideas, meanings and arguments.\textsuperscript{189} Diversity therefore improves the organisation’s understanding of its customers’ preferences and its market responsiveness.\textsuperscript{190}

Finally, authors have praised diversity in teams for:

- Encouraging greater commitment to the company (owing to a focus on the organisation rather than on nationalities);\textsuperscript{191}
- Motivating the workforce, especially representatives of minorities;\textsuperscript{192}
- Broadening managers’ interpersonal skills.\textsuperscript{193}

\section*{2.2 The actors (who?)}

The object of this chapter is to answer the question of who participates in multicultural R&D teams. The emphasis lies on the analysis of team members’ affiliation to two

\begin{flushleft}
\textsuperscript{184} Stüdlein (1997), p. 149  \\
\textsuperscript{185} Leonard / Straus (1997), p. 112  \\
\textsuperscript{186} Iles (1995), p. 47  \\
\textsuperscript{187} Powell (1998)  \\
\textsuperscript{188} Knouse / Dansby (1999)  \\
\textsuperscript{189} Adler (1991), p. 130  \\
\textsuperscript{190} Iles / Hayers (1997), p. 106  \\
\textsuperscript{191} Iles / Hayers (1997), p. 98  \\
\textsuperscript{192} Certo (1994), p. 576
\end{flushleft}
types of cultures, namely the national and the professional culture. The rationale behind this separation into two cultural bodies is clear: Every employee, independent of his function or rank within the company, has a nationality. As meant here, nationality is not necessarily a synonym of citizenship. Rather, it refers to a cultural belonging, as it is influenced by the upbringing or living in a given country. For example, somebody with a French passport, but who has spent most of his childhood in Germany, who went to a German school, and has always frequented German-speaking people, is more likely to have a German culture than a French one. In this case, such an individual will be considered as a German country national.

The second main element is the profession. R&D teams are mostly staffed by researchers, i.e. scientists and / or engineers, who usually present specific characteristic traits, depicting favourable predispositions for creativity and inventiveness. And to understand the R&D process in multicultural teams, a thorough investigation of their professional culture is indispensable. Finally, the inquiry of the “who” of multicultural R&D teams concludes with a synthesis of two national cultures and R&D. This part will integrate both dimensions and will offer a general survey of how innovation is conceived in different national cultures, describing how this shapes the values and styles of local researchers.

2.2.1 Country nationals

The following examination digs into the issue of national culture in general. It is a general starting point for multicultural management (figure 2.11).

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193 Davison (1994), p. 81
2.2 The actors (who?)

2.2.1.1 General ways to apprehend the concept of national culture

Attempting to qualify cultures with a catalogue of nouns and adjectives is a rather doubtful method, for such terms usually reflect simple stereotypes of the cultures outlined, and are definitely not appropriate to capture the richness of the notion of culture. On the other hand, there is a widespread conviction that culture should not or cannot be measured quantitatively. The argument is that, since culture is an extremely intangible concept, it can only be described or circumscribed with words, not with figures. However, quantitative approaches make it possible to distinguish the different mindsets guiding people in their research and problem solving approaches, a point that is particularly meaningful when dealing with an issue such as R&D. Once specific dimensions have been identified and indices established, it is considerably easier to derive certain patterns of behaviour corresponding to a given rating on this dimension. Furthermore, cultures can be compared much more effectively by using procedures that involve hard facts. For these reasons, quantitative techniques are going to be the modus operandi for characterising and interpreting cultures in this section.

However, some qualitative elements will be included now and then as a way of bringing in some illustrative material. Characteristics of cultures can be described in a much richer manner. In any case, Martin Hilb recommends reconciling quantitative
and qualitative approaches in a multi-method design, for such a combination generates different results and enables scholars to cover both sides of the coin, thereby broadening the picture.\footnote{Hilb (1985), pp. 13-14}

Likewise, blending etic and emic approaches on culture is equally necessary when doing cross-cultural research.\footnote{Bird (2000)}\footnote{Shuter / Wiseman (1994), p. 5}\footnote{Herche / Swenson / Verbeke (1996), p. 84}

- Founded on the assumption that certain national cultures share common values and behaviours, the etic method aims at formulating generalisations across societies and at grouping them into value classifications. The goal is to discover culturally universal measures applicable to multiple cultures and to understand variations among them. In this endeavour, the etic approach adopts a position outside the cultural organisation, comparing several such systems through the imposition of a structure based on “universal” dimensions.

- The emic approach, in contrast, attempts to understand each culture on its own unique terms. Accordingly, emic measures are those that the specific culture regards as meaningful. The emphasis is habitually laid on explaining differences and drawing conclusions about organisational dynamics within that culture. Consequently, the cross-cultural researcher has to discover the structure of the culture. This implies that emic studies must be carried out within that particular cultural system.

Most research has an etic character. The fact that this approach looks at situations involving interaction among people from two or more cultures makes it more useful for international managers. Consequently, the bulk of the cross-cultural theory employed here will be of etic nature. In addition, however, the emic style will also play a role. In particular, it will be needed to describe cultural communication patterns or the attitude of different societies towards technology and scientific work.\footnote{Cf. chapter 2.2.3.1, 2.2.3.2 as well as table 2.14}
2.2.1.2 *Theoretical models outlining national culture*

In recent decades, several essays meant to illuminate the concept of culture have been published. Some were limited to aggregating certain nationalities into clusters.\(^{199}\) This approach, though useful in some instances, does not go far enough, and has been criticised for equating geographic and cultural proximity.\(^{200}\) The models that follow go one step further and endeavour to categorise cultures according to pertinent dimensions:

1) **Kluckhohn / Strodtbeck (1961):**

The model by Kluckhohn and Strodtbeck is chronologically the first comparative model for cultures. It is founded on the assumption that cultures, in essence, are stable and that their representatives expose invariable orientations towards the world. Logically, since different cultures have different orientations, they may then be compared with one another. The authors identify six such basic orientations, which they differentiate on the basis of answers given to a set of ideological questions. Table 2.6 outlines these six cultural orientations.

<table>
<thead>
<tr>
<th>Orientations</th>
<th>Range of variations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nature of people</strong></td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Changeable</td>
</tr>
<tr>
<td><strong>Relationship to nature</strong></td>
<td>Dominance</td>
</tr>
<tr>
<td><strong>Relationship to other people</strong></td>
<td>Lineal (hierarchical)</td>
</tr>
<tr>
<td><strong>Modality of human activity</strong></td>
<td>Doing</td>
</tr>
<tr>
<td><strong>Temporal focus of human activity</strong></td>
<td>Future</td>
</tr>
<tr>
<td><strong>Conception of space</strong></td>
<td>Private</td>
</tr>
</tbody>
</table>

*Table 2.6: Kluckhohn / Strodtbeck’s basic cultural orientations*


\(^{199}\) Cf. for example Ronen / Shenkar (1985) or Huntington (1996)
2) Hofstede (1980):

In his landmark study based on a survey among 116,000 IBM employees, Geert Hofstede analyses work-related values across a range of national cultures, compiling criteria able to determine cultural differences. Employing a quantitative approach, he originates a set of indices portraying no fewer than 64 countries.

A prominent applier of the etic approach, Hofstede identifies four dimensions, mostly independent of each other, across which he draws the comparisons between the different national cultures. These are power distance, uncertainty avoidance, individualism vs. collectivism, and masculinity vs. femininity:

- **Power distance** is “the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally”\(^{201}\). This concept is closely connected to the extent of centralisation of authority, the tolerance of the hierarchy, and the amount of status consciousness existing within the society.\(^{202}\)

- **Uncertainty avoidance** refers to “the extent to which the members of a culture feel threatened by uncertain or unknown situations.” This attitude is articulated through nervous stress and in a strong need for predictability, i.e. a desire for clearly defined, formal rules (written and / or unwritten) rules and conventions.\(^{203}\) This dimension measures people’s tolerance for uncertainty and ambiguity and shows how a culture induces its representatives to feel either uncomfortable or comfortable when they face unstructured (in the sense of unknown, unusual, or unexpected) situations.\(^{204}\)

- **Individualism (vs. collectivism)** “reflects the extent to which individuals value self-determination as opposed to their behaviour being determined by the collective will of a group or organization”\(^{205}\). The ties between persons in individualist socie-
ties are loose, as everybody is supposed to look (primarily) after himself and his immediate family. In collectivist cultures, conversely, individuals are from birth on integrated in strong, cohesive in-groups (e.g. extended families, i.e. including uncles, aunts, cousins, grandparents, etc., or the employing company), which protect them in exchange for absolute loyalty.\textsuperscript{206}

- The **masculinity vs. femininity** contrast deals with the distribution of roles between the sexes in society. It “measures assertiveness, competitiveness values (masculine) versus nurturing, interpersonal relationships, helping, caring values (femininity) within a society”\textsuperscript{207, 208, 209}.

3) **Hall / Hall (1990):**

Edward and Mildred Hall’s approach resembles Kluckhohn and Strodtbeck’s more than it does Hofstede’s. They remain rather general in approach, explaining people’s actions as shaped by larger systems of behaviour. They develop a conceptual framework destined to call attention to different patterns of thought and behaviour, i.e. structures underlying culture. In doing this, they identify three key concepts – context (closely connected to communication), space, and time:

- **Context** designates “the information that surrounds an event; it is inextricably bound up with the meaning of that event.” Thus, events and context are combined to deliver a certain meaning. As national culture influences an individual’s understanding of the context, it also determines the proportion of each element in the creation of meaning. Members of cultures are programmed so that they depend upon the context when they communicate or establish relationships. In high-context cultures, the communication or message is already embodied in the person issuing it, whereas the coded, explicitly transmitted message is less important. The external environment and situation, the non-verbal behaviour (eye contact, body posture, gestures, etc.) are the fundamental elements generating the information. So the sense of the communication is conveyed implicitly, through verbal and non-

\textsuperscript{206} Hofstede (1998), p. 11
\textsuperscript{207} Herbig (1994), p. 103
\textsuperscript{208} Appendix B shows the key differences between societies according to selected dimensions presented in those models.
verbal codes. In low-context communication, in contrast, the bulk of the message is passed on in the explicit code, i.e. in words of precise and unambiguous meaning.\textsuperscript{210,211,212} As a result, differences in high and low context cultures influence several aspects of communication, such as attitudes in conflict resolution or interaction between superiors and subordinates.\textsuperscript{213}

- The perception of space also varies across the national cultures. Societies tend to react differently to other people’s infiltration in two sorts of spaces: territory and personal space. Territoriality refers to the feeling of ownership of a certain place, such as a child’s room or a cook’s kitchen. This place is then considered as one’s own and ought not to entered or even touched. Culture will influence behaviours such as leaving the workplace’s door open or closed, or the location of senior executives’ offices in the building. Personal space is the invisible bubble surrounding a person. It is regarded as very intimate and can generally only be intruded in by a few people (e.g. family members) and only for a short period of time. The relationship with people nearby, someone’s emotional state, cultural background, or his current activity may contract or expand this bit of mobile territory. In southern Europe, Latin America, or Arab countries, where personal space is quite small, people have a tendency to stand close to each other while speaking, regularly touching each other. In northern Europe, conversely, people maintain a certain physical distance and feel extremely uncomfortable when others get too close.

- Cultures differ quite considerably in the way they experience time. Two main systems have emerged in the world, two systems that are totally antithetical to each other: monochronic and polychronic time. Monochronic cultures feel and use time in a linear way. They instinctively divide it into segments, schedule and compartmentalise, so people can concentrate on one thing at a time. Consequently, agendas are considered as fixed, have an absolute priority over everything else, and ought

\textsuperscript{209} Appendix C displays Hofstede’s index values and the respective rank of fifty countries.
\textsuperscript{210} Hall / Hall (1990), p. 6
\textsuperscript{211} Mead (1994), p. 57
\textsuperscript{212} Tayeb (2001), p. 93
\textsuperscript{213} Earley / Gibson (2002), pp. 104-105
not to be modified. For such societies, time is practically tangible, and people are likely to speak of it in terms of money, “spending”, “saving”, “wasting” or “losing” time. On the other hand, the simultaneous occurrence of many things and the impressive involvement with people are typical for *polychronic* cultures. In these, the achievement of human transactions is regarded as more important than blindly abiding by schedules. Accordingly, polychronic people will not bother doing many things at once, and will change plans often and easily.\(^{214}\)

4) Trompenaars (1993):

Fons Trompenaars’ approach is quite similarly to Hofstede’s. Based on his definition of culture (“culture is the way in which a group of people solves problems”), the author identifies three types of problems human beings have to deal with: 1) Those which are the result of their relationships with other people; 2) those which are directly related to the passage of time; and 3) those which concern the environment. Corresponding to the solutions people find to each universal problem, there are seven fundamental dimensions of culture:\(^{215}\)

- **Relationships with people:**
  - *Universalism vs. particularism:* This contrast indicates the emphasis laid either on rules or relationships. The universalist approach advocates that “what is good and right can be defined and always applies.” Consequently, universalists apply rules and procedures universally to ensure equity and consistency. Particularists, on the other hand, pay greater attention to obligations of relationships (e.g. friendship) and unique circumstances, rather than to abstract societal codes.
  - *Individualism vs. collectivism:* The two orientations differ in how people regard themselves – as individuals or primarily as part of a group? While individualism promotes individual freedom and responsibility, collectivism encourages individuals to work for consensus in the interest of the whole group.

\(^{214}\) Hall / Hall (1990), pp. 10-15

\(^{215}\) Trompenaars (1993)
Neutral or emotional: The attitudes referred to here concern the question of whether interaction between people should be objective and detached, or whether expressing emotion is acceptable? Representatives of neutral cultures keep quiet about their feelings, which they prefer to control. On the contrary, people from emotional (or affective) cultures exhibit their feelings by laughing, grimacing, and gesturing. They also try to find immediate channels to manifest those feelings.

Specific vs. diffuse: These divergent orientations distinguish the extent to which people engage others in specific areas of life and single levels of personality, or diffusely in multiple areas of our lives and at several levels of personality at the same time. In terms of business relationship, this dimension is about how far there is a real and personal contact between the partners, as opposed to explicit relationships fixed by a contract.

Achievement vs. ascription: This aspect contrasts the way in which status is accorded to individuals. On the one hand, some societies confer status by virtue of their achievements (achieved status), thus focusing on doing factors. Other societies insist more on being factors by according status on the basis of age, class, gender, education, and so forth (ascribed status).

Attitudes to time: One important dimension to be considered is the perception of time, and how we manage it. Some cultures consider what somebody has achieved in the past as inconsequential and ascribe more importance to the plans he has worked out for the future. In other cultures, people’s past is more a point of reference than the accomplishments of today. Equally worth mentioning is the difference between the sequential and the synchronic view of time. The sequential orientation sees time as a series of passing event, while in the synchronic perspective, past, present and future are all interconnected, so that thoughts about the future and memories of the past both affect present action.

Attitudes to the environment: The way people relate to nature and the role they assign to their natural environment is also an essential aspect in the differentiation of nationalities. In fact, mankind is separated into two camps. One contains those
who assume that people can and should control nature by imposing their will upon it. For them, the epicentre of action affecting their lives and the origins of vice and virtue dwell within the person (the inner-directed orientation). The other faction is represented by those who believe that the world is more powerful than men. As the human being is only a part of nature, he must go along with its forces, caprices, and laws. This outer-directed orientation thus requests people to respect, if not to fear, nature.

5) House (1999):
Robert House, the main author of the momentous GLOBE (Global Leadership and Organization Effectiveness) project, operationalises culture with nine quantitative dimensions. Although the analysis focuses on leadership issues, the dimensions he employs carry highly interesting elements for capturing the whole concept. Six of them are derived from Hofstede’s work, and the last three have their origins in other existing studies. House’s compilation can thus be considered as a first serious attempt to integrate several approaches into one single model. The nine dimensions are the following:

- **Power distance**: See Hofstede.
- **Uncertainty avoidance**: See Hofstede.
- **Collectivism I** is defined as “the degree to which organizational and societal institutional norms and practices encourage and reward collective distribution of resources and collective action.”
- **Collectivism II** is “the degree to which individuals express pride, loyalty, and cohesiveness in their organizations or families.”
- **Gender Egalitarianism** refers to “the extent to which an organization or a society minimizes gender role differences.”
- **Assertiveness** reflects “the degree to which individuals in organizations or societies are assertive, confrontational, and aggressive in social relationships.”

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216 House et al. (1999), p. 192
• **Future Orientation** indicates “the degree to which individuals in organizations or societies engage in future-oriented behaviors such as planning, inventing in the future, and delaying gratification.”

• **Performance Orientation** designates “the extent to which an organization or society encourages and rewards group members for performance improvement and excellence.”

• **Humane Orientation** stands for “the degree to which individuals in organizations or societies encourage and reward individuals for being fair, altruistic, friendly, generous, caring, and kind to others.”

6) **Triandis (2002):**

Harry Triandis recently developed his own list of dimensions, calling them “cultural syndrome”. Some of them were adopted from other authors, but others present original views of cross-cultural management: 217

• **Complexity**: Here, the author distinguishes between relatively simple (hunters and gatherers) and relatively complex cultures (information societies). In the former, there tends to be consensus about people’s beliefs and attitudes, whereas this is not the case in complex societies. Consequently, cultural uniformity and conformity are more pronounced in simple than in complex cultures, a fact that is for instance reflected in the number of jobs and specialisations to choose among.

• **Tightness**: Cultures differ in the amount of rules, norms, and ideas regulating individuals’ behaviour in given situations. In tight societies, i.e. societies with many such norms, one may become upset when others do not respect them. In those societies with fewer rules, people are likely to be more tolerant of others’ digression from normative behaviour.

• **Individualism and collectivism**: See Hofstede.

• **Vertical and horizontal cultures**: This dimension constitutes a complement to Hofstede’s power distance indices. Here, Triandis differentiates between cultures that acknowledge hierarchy as a given (vertical cultures), and those that take equa-

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217 Triandis (2002), pp. 17-19
lity for granted (horizontal cultures). In the former type of society, hierarchy is an accepted state, and those at the top naturally enjoy more power and privileges than those at the bottom. In horizontal cultures, conversely, individuals are fundamentally similar. Moreover, if any resource is to be divided, it should be done equally and equitably.

- **Active-passive cultures**: The active-passive spectrum resembles Trompenaars’s differentiation between the inner and the outer directed attitude towards environment: In active societies, people seek to change the environment to fit them. Individuals are known for being competitive and action-oriented, valuing self-fulfilment. The passive ones, on the other hand, are more cooperative, appreciate the experience of living, and care very much about getting along with other people.

- **Universalism-particularism**: See Trompenaars.

- **Diffuse-specific**: See Trompenaars.

- **Ascription-achievement**: See Trompenaars.

- **Instrumental-expressive**: Cultures differ in the way they lay emphasis on instrumental versus expressive attributes. In expressive societies, the social relationship (e.g. spending time chatting with a friend) is much more important than the instrumental relationship (for example, the attitude to “get things done”).

- **Emotional expression or suppression**: This dimension covers the inclination of people to express their sentiments. That means that people may articulate their emotions unreservedly, or on the contrary control their manifestation of feelings.

### 2.2.1.3 Summary and discussion

Table 2.7 offers a condensed presentation of the characteristics of four (arbitrarily chosen) cultures anchored in the dimensions as defined by Hofstede, Hall and Hall, and Trompenaars.
Table 2.7: Characteristics of selected national cultures


The theoretical models outlined have been the objects of harsh disapproval. Apart from the “inappropriateness” of quantitative methods, major critical points include the recurring inconsistencies in the empirical findings of several authors. Another frequent complaint – which was brought up and acknowledged by Hofstede himself – is that trying to explain culture by using a limited number of dimensions leads to an oversimplification of the matter. Such a complex concept cannot be compounded in paradigms that allow only broad assertions about cultures and cultural differences.  

Tayeb brings up the argument that such a method may result in a myopic and incomplete picture of a nation, saying that “national culture cannot really be simplified and reduced to a handful of boxes into which some nations are placed and from which others are
excluded.”219 Those boxes, i.e. the dimensions and indices used to attribute cultural characteristics to societies, are merely an abstraction of certain patterns and relationships prevailing in given cultures, but do not tell too much about the reasons underlying each particular configuration.220 Then, adversaries object that one cultural dimension necessarily holds dissimilar connotations when it is applied to different nationalities.221 Put differently, cultural research is itself always culture-bound, since the researchers, members of one such culture, are unavoidably biased.

Still, the models seem to have established themselves in the academic community. Their combined value as a tool for portraying, demarcating and comparing cultures is indisputable. They helped to draw attention to potential clashes owing to differing orientations and instilled a certain cultural awareness in companies. “Applied intelligently and not slavishly”222, they constitute a crucial wellspring of information and do provide convenient points of reference for analysing cultures.

2.2.2 Researchers

The introductory section mentioned that a person’s culture embraced more than just nationality. The function at work and the profession itself belong to spheres that influence the behaviour and way of thinking of individuals and groups.

Professional culture encompasses the same elements as the national culture, i.e. assumptions, values, attitudes, artefacts, behaviour and so on. And just as for any other type of culture, the characteristics may differ widely across the professions. For example, bankers and researchers do not necessarily share the same views about the environment (basic assumptions), money (values), and hierarchy (attitudes); also, they will probably communicate and lead differently (behaviour), and have different dress codes (artefacts). The professional culture is especially interesting to study: Indeed, the profession has proved to be a major source of personal identification. Not only does it provide status and social recognition, it also affects the way people think and act.

218 Stüdlein (1997), p. 196
219 Tayeb (2001), p. 93
220 Osland / Bird (2000), p. 68
221 Mead (1994), p. 55
222 Mead (1994), p. 76
Familiarity with a given physical and human environment produces a sensibility that is particular to this environment, allowing the insider to distinguish items that are inaccessible to outsiders.

Functional culture is a similar construct, for it is not only shaped by the nature of the task employees have in common at work, but also by the industry they operate in. For example, R&D is likely to be most highly valued in high-tech and pharmaceutical businesses, while in companies in the consumer goods sector the marketing department will often have the biggest say. Accordingly, the workers representing whichever function are regarded differently and do not enjoy the same level of consideration within the company.223

The following chapter shows some of the elements of this culture by offering an overview of common characteristics of researchers’ personalities.224 The analysis will consist of a portrayal of their personality traits as people in general, as employees, as team members, and as managers. The themes treated in this chapter can be classified into the research field “R&D management” and “multicultural management” (figure 2.12).

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223 Schneider / Barsoux (1997), pp. 60-61

224 The same criticism as the one raised in the part about the profiles of national cultures, can be articulated here. Such a characterisation looks like a collection of stereotypes. However, there is no equivalent theory existing on professional cultures as the quantitative ones described above. Moreover, such an analysis reveals researchers’ preferences, beliefs, and objectives, which contributes to the delineation and to the comprehension of their professional culture. In addition, it points out their skills and weaknesses, an insight that can be used to understand the innovation process and how knowledge is created.
2.2.2.1 ...In general

Judging by the high level of identification of scientific workers with their job and field, and the great cohesion within their “guild”, it appears that this professional culture is a very strong one. As a matter of fact, researchers differ greatly from other professionals. Their personal interests (reflected in their hobbies and in their jobs), their education, their motivations, etc. are generally at odds with those of marketers, financiers, or managers. As for no other group of people, the world is ruled by physical laws. Researchers operate in a professional environment dominated by black and white, right or wrong contrasts. They face clear decisions with clear outcomes. The tasks they need to carry out are complex and have a technical nature, requiring creativity, mathematical talent, precision and the application of accurate and confirmed theories. This obliges them to apply a rather mechanical approach to problem solving, where the purpose is to find a single, integrated, durable solution in a high-certainty environment. Accordingly, researchers – knowledge workers par excellence, in the words of Petroni\footnote{Petroni (2000a), p. 15} – are often seen as unemotional people with narrow technical interests and who prefer to deal with things rather than people.\footnote{Harrison (1989), p. 330}
Other often mentioned strengths and weaknesses of researchers include the following:

- Are highly skilled in technical areas and are talented in advanced design;
- Possess good problem solving skills;\textsuperscript{227}
- Have strong quantitative skills and relatively weak verbal skills;\textsuperscript{228}
- Have a passion for knowledge, idle curiosity, as well as an altruistic concern with the benefit to humanity;\textsuperscript{229}
- Usually have a “there is always a solution, so go and find it” attitude\textsuperscript{230}
- Believe that they can and should master nature;
- Are stimulated by problems and puzzles;
- Are rational perfectionists and tend to prefer “people free” solutions;
- Favour linear, simple cause-and-effect, quantitative thinking;\textsuperscript{231}
- Perform well on aptitude and intelligence tests;
- Have some talent for generalising, classifying, summarising, establishing evidence as well as demonstrating and proving;
- Work very hard;
- Are self-confident, assertive, striving, having “self power awareness”;\textsuperscript{232}
- Orient themselves to achievement and acceptance of their own inner impulses;
- Are intellectually adaptable;
- Have the tendency to be sceptical, detached (if not introverted) and critical;
- Have low social, but high growth needs;
- As rather introspective people, they can be regarded as thinkers rather than doers;
- Emphasise empirical logic while loving theoretical models;\textsuperscript{232}

\textsuperscript{227} Johnson / Sargeant (1998), p. 44
\textsuperscript{228} Batley (1998), p. 310
\textsuperscript{229} Jain / Triandis (1990), p. 60
\textsuperscript{230} Canainn (1995)
\textsuperscript{231} Canainn (1995)
\textsuperscript{232}
• Show above-average sensitivity for problems;
• Have a high tolerance for frustration;\(^{233}\)
• And finally, are proud to be researchers.\(^{234}\)

The widely praised professional culture of scientists and engineers is principally a result of this last point (pride) and to the solidarity reigning in the scientific communities. Along with strong common values, researchers have a sort of ethos governed by four clear principles, which should guide their behaviour – universalism, communalism, disinterestedness, and organised scepticism:\(^{235}\)

• **Universalism** refers to the code according to which scientific discoveries are subject to pre-established objective criteria. In particular, the truth and scientific meaning of such achievements shall be conferred independent of the personal or social background of the discoverer.

• **Communalism** requires that all findings be shared among the members of the scientific community. The rationale behind that rule is that discoveries are only made possible by the social collaboration within the scientific community; therefore, the findings should be seen as common property and the rights assigned to the whole body.

• **Disinterestedness** is the demand that scientists do not aim at personal benefit (in terms of financial or commercial compensation) when doing their job.

• **Organised scepticism** is a methodological and institutional mandate of the scientific community to scrutinise cautiously scientific discoveries.

So far in the discussion, scientists (who are involved in basic research) and engineers (who specialise in applied research and experimental development\(^{236}\)) have been regarded as equivalent. Several studies have showed, however, that in fact the two types of

\(^{231}\) Schein (1996), p. 14
\(^{232}\) O’Leary (1999), pp. 243-246
\(^{233}\) Freudenberg (1988), p. 114
\(^{234}\) Petroni (2000a), p. 21
\(^{235}\) Jain / Triandis (1990), pp. 59-60
\(^{236}\) As defined in section 1.2.3
R&D professionals were quite different. Although they share much of the same formal education, they differ in several points such as their career goals, professional activities and styles, occupations, attitudes, orientations, disciplinary ideologies, personal interests, and even in their typical family background. Those differences are not only due to their functional role within the company (i.e. in the value chain), but this factor nevertheless remains one of most central:

- “Scientists generally contribute to new knowledge and document this knowledge through papers to help establish basics and corroborate progress in a major technology area. Research, publishing and presentations are their main output.”

- The main role of an engineer is “to design or develop new or improved products or services to improve the condition of society.”

Therefore, scientists will tend to see themselves as purists, while engineers will be admired for their contribution the social progress. This contrast – responsible for a fierce rivalry, if not a mutual disdain between the two groups – leads to quite a large discrepancy in vocational interests (table 2.8).

As it makes more sense to analyse the two disciplines themselves rather than their representatives, the comparison will not be pursued here. Scientists and engineers will be considered as comparable, while the reader is invited to keep in mind that these dissimilarities are real.

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238 Weaver / Trankina (1996), p. 38
239 McCall (1983), p. 149
240 Klein / Porter (1990), p. 16
241 Bailyn (1985), p. 224
242 Keys (1993), p. 31
2.2 The actors (who?)

<table>
<thead>
<tr>
<th>Scientists: Investigative type</th>
<th>Engineers: Realistic type</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prefer symbolic, creative investigation</td>
<td>• Prefer to manipulate objects</td>
</tr>
<tr>
<td>• Value science, scholarship in problem solving</td>
<td>• Solve problems with realistic competence</td>
</tr>
<tr>
<td>• Adverse to persuasive, social, repetitive activities</td>
<td>• Avoid activities of social occupation</td>
</tr>
<tr>
<td>• Deficient in convincing competence</td>
<td>• Deficient in social competences</td>
</tr>
<tr>
<td>• Avoid enterprising occupations</td>
<td>• Recognise their own low human relations skills</td>
</tr>
<tr>
<td>• See themselves lacking in leadership ability</td>
<td>• Analytical, digital and deductive in their mindsets</td>
</tr>
<tr>
<td>• Synthetic, special, and intuitive in their thinking</td>
<td>• Mostly left-brained</td>
</tr>
<tr>
<td>• Have highly developed right-brain capacities</td>
<td>• Devoted to vertical thinking</td>
</tr>
<tr>
<td>• Employ lateral thinking</td>
<td>• Strong at reactive and adaptive tasks</td>
</tr>
<tr>
<td>• Look for a basic understanding and theories to explain facts</td>
<td>• Usually look for technical solutions good enough to eliminate the problem</td>
</tr>
<tr>
<td>• Long-term oriented</td>
<td>• Short-term oriented</td>
</tr>
</tbody>
</table>

Table 2.8: Differences in vocational interests of scientists and engineers

2.2.2.2 ...As employees

In the same way as researchers are different from other people as human beings, they inevitably also differ as employees. But their position within the company (at the very beginning of the value chain), their tasks, their functions, etc. are not the only factors in this regard. Therefore, they are often viewed by themselves and by managers as being a group apart. And indeed, their expectations (from the job, the company), their motivations and attitudes at the workplace also diverge from those of other types of employees.

As highly educated individuals, scientists and engineers have a certain self-esteem. Qualities that ordinarily come with such a posture are high tolerance of ambiguity (i.e. the capability to endure the tensions and uncertainties arising from the complexity of problems)\textsuperscript{243}, and a pronounced performance orientation.\textsuperscript{244} In addition, they are known

\textsuperscript{243} Freudenberg (1988), p. 114
\textsuperscript{244} Gussmann (1988), p. 90
for being open-minded and flexible in their working style. They are receptive to opportunities to test their own abilities and to prove themselves.\textsuperscript{245} Their remarkably natural task-orientation and flexibility render them very able people for a new job or challenge. Regularly demonstrating the courage to be and to think different, they bring a certain freshness of mind when solving problems. So as creative people themselves, they are logically attracted by creative environments and opportunities.\textsuperscript{246}

Most R&D professionals have an aversion for internal politics and are less interested in matters such as promotion or the planning of their career. They reject any kind of bureaucracy, are reluctant to purely formal authority and control, and have a pronounced inclination for non-conformistic behaviour.\textsuperscript{247} Anyway, looking at formal measures (costs, profit, etc.) does not belong to their main interests. They feel more attracted by matters such as technological progress. After all, this is where they are the most productive, so they insist on being left alone with this role. They are very sensitive to values such as fairness and are not willing to accept any reward that is not based on recognisable professional achievement. Similarly, they feel insulted when they see their own work being evaluated by people whose professional judgement is questionable or for whom they have less than great respect.\textsuperscript{248}

They prefer to stick to their own discipline and spend time on doing research, experimenting, thinking, etc. As Miller indicates, “scientists are usually attracted by the nature of work itself, the freedom to pursue their own research interests, and the people with whom they are associated.”\textsuperscript{249} Therefore, the highest fulfilment for a typical researcher is the realisation of the idea he has been following and promoting in his lab.\textsuperscript{250} So what he expects from the employer is an environment that allows for innovation. In this sense, factors that are crucial to scientists in large organisations are the following:

\textsuperscript{245} O’Leary (1999), p. 244
\textsuperscript{246} Adair (1996), pp. 163-166
\textsuperscript{247} Freudenberg (1988), pp. 114-115
\textsuperscript{248} Badawy (1978), p. 29
\textsuperscript{250} Gussmann (1988), p. 90
• **Autonomy**: Autonomy (specifically scientific autonomy) at work is probably the greatest need of researchers, especially of scientists. Deeply concerned about their own sense of freedom, they perceive organisational life as extremely restrictive, irrational and intrusive of their private life.\(^{251}\) R&D professionals do not like to have outsiders (i.e. managers) tell them what to do and how to do it. They assign a great value to freedom of action, increasing responsibility, and a high degree of control of their own activities.\(^{252}\)

• **Meaningful work**: What researchers also seek is a job where they “have the opportunity to engage in work that is intrinsically interesting.”\(^{253}\) They want their position and tasks to be challenging so they can prove what they can do. Seeking perfection, they wish to be confronted with some real brainteasers. They just yearn for opportunities to be creative and look forward to discovering and developing new theories, products or processes.\(^{254}\)

• **Work variety**: Apart from mental challenge, R&D people also seek variety in their job. If they choose to become scientists, it is mainly because they are curious and eager to learn. When they decide to work for a given company or in a certain industry, they hope to develop their skills and knowledge in the field. But extensive and qualitatively good training is only possible if the employee gains insight into a variety of tasks and disciplines.

Koning summarises what an optimal work environment for scientists looks like: \(^{255}\)

**The scientist:**

- Is assigned a significant problem that is directly related to a specific organizational goal and allows the scientist to grow in his or her specialty;
- Is allowed independence within his or her own specialty area to acquire knowledge to solve the problems;

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251 Schein (1977), p. 491
252 Badawy (1978), p. 29
253 Jones (1996), p. 287
254 O’Leary (1999), p. 244
• *Is supervised by knowledgeable scientists and administrators who show interest in their work, who attempt to fulfil the individual needs of the scientist, and who make it a sincere effort to provide all the physical and technical support needed;*

• *Works in completely open communication networks;*

• *Is generously recognized for work well done, while constructively criticized for work not done well."

The key word here is motivation, yet the question is not so much how to motivate them to do a good job, but how to keep them in the company. Indeed, researchers are typically task and challenge oriented and intrinsically (or self-)motivated. Therefore, they do not really need special programmes or plans that induce them to be productive. On the contrary, they may interpret such schemes as being invasive and disturbing, putting them under pressure. IBM founder Thomas Watson once compared engineers and scientists to “wild ducks”, arguing that wild ducks were not motivated by traditional incentives such as promotion and titles. What they want is freedom together with an opportunity to be creative, and maybe some kind of recognition for their technological breakthroughs.

Connected with motivation, one special attribute of researchers that should be mentioned here is their particular pattern of needs. Indeed, the literature has verified a dominance of high-level needs in Maslow’s five-class hierarchy of needs for this type of employees. Apparently, the need for self-actualisation – which for instance is appeased when a person solves a problem single-handedly and overcomes all obstacles to achieve a creative success – is abnormally pronounced at scientists and engineers. Hofstede explains this phenomenon with the observation that nowadays, researchers

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256 Gussmann (1988), p. 92
257 Caudron (1994), p. 103
258 The five levels are: 1) physiological or biological needs, 2) security or safety needs, 3) social needs (love, affection, belongingness), 4) esteem needs (status, ego), and 5) self-actualisation needs.
259 Freudenberg (1988), p. 117
260 Humphrey (1987), p. 33
“take the fulfillment of their ‘lower’ Maslow needs for granted and therefore rate the corresponding work goal less important”\textsuperscript{261}.

Very often, researchers’ dedication to their profession will supersede their loyalty towards the company. The ethos of the scientific community mentioned above has unquestionably an influence on R&D professionals as employees. For example, values in accordance with that code are the tendency to publish their findings as early as possible or to favour scientific over economic targets.\textsuperscript{262} Therefore, “the best engineers and scientists do not work for a company, a university, or a laboratory; they really work for themselves”\textsuperscript{263}. Moreover, researchers are highly mobile and quickly find work elsewhere if they are not comfortable with their current situation. They articulate their complaints much more directly and promptly than any other workers.\textsuperscript{264} Altogether, these properties of scientists and engineers turn them into quite challenging people to manage. This is not only true on an organisational but, to a lesser extent, also on a team level.

\textbf{2.2.2.3 \ldots As team members}

In the section about researchers in general, these people have been described as quite individualistic people who would rather work with machines, formulas, drawings or calculations than with other human beings; they tend to be introverted and critical towards colleagues. With their typical self-confidence and assertiveness,\textsuperscript{265} they can be extremely disagreeable to work with. So at first sight, scientists and engineers cannot really be considered to be good team players.

Unfortunately, this prejudice can be confirmed when looking at other traits typical of R&D specialists. Several characteristics indicate this weakness. First, researchers are known to have relatively weak writing and communication skills. But this is not only because of their personal nature since their education usually does not include any preparation or instruction in this direction, either on the secondary or tertiary level, and

\begin{flushright}
\textsuperscript{261} Hofstede (1994), p. 34
\textsuperscript{262} Freudenberg (1988), p. 115
\textsuperscript{263} Humphrey (1987), p. 32
\textsuperscript{264} O’Leary (1999), p. 244
\textsuperscript{265} Cf. chapter 2.2.2.1
\end{flushright}
companies often fail to offer proper training. Similarly, researchers badly under-emphasise verbal skills because of their apparent preference for quantitative techniques.\textsuperscript{266} As a result, they not only lack the ability to present themselves or persuade others; they also have difficulties communicating ideas, facts, suggestions, concepts, vision, or opinions to their fellow researchers. All these elements are nonetheless absolutely fundamental when operating in a business where sharing and creating knowledge is the key to success.

This problem also applies to the interpersonal level: Herbig refers to the creative scientist as a “lone wolf”. In doing this, however, the author addresses more the intellectual than the physical isolation of many inventors. This does not mean that they are cut off from the mainstream of ideas, but they have to be paradigm breakers, stubborn questioners, i.e. intellectual iconoclasts to triumph.\textsuperscript{267} This solitary character of R&D professionals does not stem only from the obligatory distance or scepticism towards reality. To profile themselves as true researchers, they have to come up with genuine breakthroughs. Therefore, all researchers “share a basic drive to accomplish something they can point to as their own unique achievement”,\textsuperscript{268} notwithstanding the scientific ethos that holds them together.

The education of scientists and engineers teaches them to tackle projects on their own, though this is not to say that a researcher is not capable of leading a project team. Nevertheless, the collaborative nature of teamwork causes R&D professionals to be uncomfortable as it asks them to function in a mode that is not instinctual to them.\textsuperscript{269} On the contrary, they display traits that suggest a competitive spirit and a quest for perfection. And while they may believe that their inclination to persistently question or challenge and to highlight weak points may be “helpful”, other team members could interpret such behaviour as crude criticism and rampant negativity.\textsuperscript{270}

The fact that researchers insist so much on autonomy, independence and self-sufficiency may indicate that the need for interaction and exchange of ideas with peers or

\textsuperscript{266} Batley (1998), p. 310
\textsuperscript{267} Herbig (1994), p. 13
\textsuperscript{268} Humphrey (1987), p. 32
\textsuperscript{269} Sapienza (1997), p. V
\textsuperscript{270} Thompson (1996), pp. 124-125
subordinates is underdeveloped in this type of employee. Moreover, scientists and engineers are known for having difficulties in delegating effectively, as they often prefer to do the work themselves as a way to ensure it is accomplished correctly, but this distinctive character notwithstanding, they nonetheless attach great importance to and appreciate teamwork. This is even more decisive as R&D professionals have to perform in teams. Valuable synergies can only be achieved if people do their work together. This is also the most effective and efficient way to spread knowledge across the firm. Engineers in fact have no other choice than to adopt an attitude that favours teamwork and interaction with other colleagues. Otherwise, there is little hope of building up or maintaining a successful R&D organisation. However, such lack of interpersonal skills can easily be compensated with regular training of the people involved and, above all, by drawing attention to the problem.

2.2.2.4 ...As managers

A company’s success depends very much on the achievements of its researchers. But despite their eminent function, often they do not enjoy the same esteem and privileges as their counterparts the managers. And “even when technical positions are put on the same level as managerial positions in terms of prestige, salary and status, the former lacks the vital ingredient of power.” As a matter of fact, research, development and engineering still have a somewhat inferior image, especially among businessmen. Engineers then see themselves forced to live in such a hostile environment in which they have no say and find themselves in a situation where they have to report to people who might not always understand their interests. A study in 1999 revealed that researchers have the feeling that their work was being more and more confined by the needs of management (i.e. commercial needs), whereas, formerly, the science itself used to be the main driving force. Now they have to operate in a context dominated by fiscal objectives, a context that emphasises greater accountability and the realisation of short-term goals. This, in turn, can give birth to major tensions, which can jeopardise

272 Stephenson (1997), p. 52
273 Petroni (2000b), p. 53
the existence of the whole organisation. This problem of “increasing managerialism”\(^{274}\) is then often compensated by promoting scientists to (top) management positions, with the hope that they will be more thoughtful and restore the balance.

Such a transition, however, is regularly connected with difficulties, as the management job goes, at least to a certain extent, against the researcher’s nature. Despite special schemes such as job rotation or the so-called dual-ladder system, which are designed to ease conversion from one function to the other, there remain many stumbling blocks for this kind of career path. The fundamental conflict between the researcher and the organisation (represented by the manager) was pointed out earlier and it has already been noted that R&D professionals dearly appreciate autonomy. It would therefore be very ill-advised to do to colleagues what they would not like. Moreover, they are generally not too impressed by authority,\(^{275}\) possibly thinking of management as some kind of second-class discipline, by no means as a science equivalent to their own. This stance is reflected in some disrespect for white-collar issues. For instance, mentioning terms such as “mission statements” regularly triggers hilarity among R&D professionals.\(^{276}\)

Still, some researchers break the pattern and have the courage to make the step into management. But what are the motives for such a move? According to a survey by Johnson and Sargeant, the prime motivations for this kind of transition are personal career advancement, money, a chance to influence the R&D process, increased status, and the expectation of gaining a greater understanding of the business. Other reasons, such as hoping to enjoy managerial tasks, fear of a restricted career path or believing in one’s ability to do the job better than others played a minor role, while arguments such as power, family pressure, access to a company car, or the feeling of being technically obsolete were almost insignificant. Finally, nearly half of the respondents considered that engagement in management was a natural process.\(^{277}\)

\(^{274}\) Cohen / Duberley / McAuley (1999), p. 473-477  
\(^{275}\) O’Leary (1999), p. 246  
\(^{276}\) Cohen / Duberley / McAuley (1999), p. 486  
\(^{277}\) Johnson / Sargeant (1998), p. 46
Once they are managers, ex-researchers face certain troubles. An earlier section revealed that scientists generally had a lack of communication, presentation and interpersonal skills, which are all indispensable for leaders and supervisors. In fact, researchers are more trained to operate machines and scientific concepts, than to deal with people. The role of R&D specialists is purely technical and is performed in an environment of precision and predictability of physical problems. On the other end of the spectrum, the role of the manager is dominated by non-technical elements and the environment is one of uncertainty and rapid change. His purpose is to plan, organise, direct and control the resources of the firm. Such tasks necessitate a much broader approach and above all the readiness to search for various alternatives and options and to select the most appropriate solution.\textsuperscript{278} This constitutes quite a drastic change for somebody who is used to applying more mechanistic methods.

Nevertheless, it would be absolute nonsense to claim that scientists and engineers make bad managers as a general rule. After all, general management is about solving problems. And since researchers are trained to become problem solvers, who else would be more appropriate for the job? In many countries, people with a scientific background are preferred when top management positions need to be filled. This is the case in France in particular where a majority of CEOs are alumni of the Ecole Polytechnique or the Ecole Centrale, the country’s leading engineering schools.

2.2.3 Integrating both dimensions

The last two sections focused on the national and the professional cultures of multicultural R&D teams’ participants. As mentioned earlier, people are influenced by several cultural spheres. The purpose of this chapter is to integrate the previous two and to show how one culture can have some bearing on the other. The areas alluded to in this issue are R&D management and multicultural management (figure 2.13). The first part of the investigation will show how national culture can affect a society’s approach about technology. The findings are then applied in a second part, which will characterise the researchers from four countries in particular.

\textsuperscript{278} Harrison (1989), pp. 329-331
2.2.3.1 Variations in technological orientations

The esteem granted to specific functions in corporations depends to a certain extent on national culture. For instance, the British lay a great emphasis on finance, while the German give an important significance to R&D, as manifested in their concern with Technik. In turn, the legacy of Holland’s trading tradition may justify the high regard on which the Dutch hold sales people. Consequently, the status accorded to scientists and engineers will also depend on the national culture, which suggests that interaction does not only take place between functional and national, but also between professional and national culture.

Technological and scientific advances can be explained by looking at a number of country specific factors, such as the amount of R&D spending, the protection of intellectual property, the availability of qualified personnel, the infrastructure, the existence of state sponsored incentives, the size of the markets, etc. In turn, these elements depend on countries’ common perspective of science in general. Such views are not limited to issues like religious beliefs about the desirability of progress, the social acceptance of certain types of technologies, the risk aversion of local companies, or

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279 Schneider / Barsoux (1997), p. 61
280 Herbig (1994), pp. 56-58
the like. Rather, the discussion pertains more to how national culture can incite its members to be creative and innovative, for such values are located deep in societies’ mental programming and cannot be explained by government policies or by financial motivators. They are due to the orientations induced by people’s national culture, orientations that affect the way in which people reason and solve problems. For example, the way people from Western civilisations think about problems and design solutions is said to owe much to early Greek philosophers, such as Plato and Socrates.

Cultural values are transmitted from generation to generation and are amplified by the country’s educational system. Therefore, scientists and engineers from different nationalities can sometimes use completely opposite approaches when tackling the same scientific question. More generally, culture has been shown to “effect a profound influence on the innovative capacity of a society, its innate ability to create innovations.”

Indeed, authors have demonstrated that certain cultural traits either encourage or obstruct technological development, and shape the way nations generate innovation. For instance, those countries that praise creativity are presumed to realise a greater quantity and quality of innovations, while nationalities that emphasise technical ability and higher education will be successful at ameliorating innovations. Likewise, innovative achievement is proportional to the support and status granted to entrepreneurial efforts within a society. Also, among the other cultural values believed to foster innovation are the willingness to face uncertainties and take balanced risks, urgency and timeliness, readiness to accept change, as well as a dynamic long-term orientation.

2.2.3.2 Culture’s consequences on scientific approaches

It appears that each country has advantages in certain types of innovation: For example, it seems that the Japanese excel at incremental innovations (e.g. making television sets smaller and smaller), whereas the Americans have a reputation for producing scientific breakthroughs (judging by the number of Nobel prize laureates). Such

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282 O’Connor (1994), p. 59
283 Dunphy / Herbig / Palumbo (1997), p. 195
284 Herbig (1994), pp. 51-52
285 Hilb (2000), p. 43
observations have bred many other preconceptions about the behaviour and methods of researchers from different countries. Table 2.9 offers a few of them for French, German, Japanese and U.S. engineers and scientists.

While those stereotypes are rather worthless, some of the cultural dimensions plotted in section 2.2.1 can be used to explain differences in national technology approaches. For instance, Hofstede’s dimensions are said to have significant effects on innovation.\textsuperscript{286-287,288}

- **Power distance**: Obviously, bureaucracy and centralised structures characteristic of high power distance societies are not as beneficial to innovation as decentralised and egalitarian hierarchies. Indeed, imagination is deterred by the control systems, rules, and procedures that exist in hierarchical cultures. High power distance also involves a certain fatalism, which deters people from taking on the effort without which innovation is not possible. Similarly, as hierarchies inhibit change and given that innovation is change, the former are likely to obstruct the latter. Hence, the capacity for innovation, especially for radical innovation, tends to decrease with the power distance.

- **Uncertainty avoidance**: The negative influence of uncertainty avoidance on inventiveness is even more apparent. In effect, cultures with weak uncertainty avoidance are inclined to take risks, and pass for being more tolerant towards deviant behaviour and opinions. Accordingly, they will be quite open to novel ideas and to technological breakthrough, bringing about more radical innovations and inventions. In opposition, the formalisation, standardisation, ritualisation, precision, etc. that are inherent to societies with high uncertainty avoidance, hamper the invention mechanism. This is not to say that such cultures do not innovate at all, but their innovations will have a more incremental character.

\textsuperscript{286} Herbig (1994), pp. 52-53, 91-97
\textsuperscript{287} Dunphy / Herbig / Palumbo (1997), p. 196
\textsuperscript{288} Herbig (1995), p. 200
<table>
<thead>
<tr>
<th>Nationality</th>
<th>Traits of local researchers</th>
</tr>
</thead>
</table>
| French     | • Are known for coming up with bright ideas  
             • Are inventive, creative and technically sophisticated  
             • Emphasise rational and theoretical education  
             • Like great intellectual and abstract theories  
             • Ascribe to superiority of theory over practical matters  
             • See technology as a means, not as the goal  
             • Prefer holistic and analytical approaches  
             • Have a passion for theory and pure science  
             • Love to solve knotty technical problems, and care less about immediate marketability |
| German     | • Are known for their superior technical and professional training  
             • Have a reputation for high quality and reliability  
             • Are pragmatic  
             • Are good at structuring problems  
             • Appreciate technical purity  
             • Consider the supremacy of theoretical conceptualisation as detrimental to action |
| Japanese   | • Excel at incremental innovations and process engineering  
             • Imitate rather than innovate  
             • Are known for their effective R&D teams  
             • Apply deductive reasoning  
             • Are good at correlational logic and combinative thinking |
| U.S.       | • Are pragmatic  
             • Focus on the commercial applicability of innovations  
             • Apply inductive reasoning |

Table 2.9: Stereotypes about researchers from selected national cultures

289 Or as a famous Japanese joke says: “A Western engineer is better than a Japanese, but ten Japanese engineers are better than ten Westerners” (Ernst / Wiesner (1994), p. 160)
• **Individualism**: As individualism stands for the emphasis on freedom – an essential ingredient for creativity – individualistic cultures are predisposed in favour of a larger innovative ability than collectivistic ones. As a matter of fact, “the greater the freedom of the individual to explore and express opinions, the greater the likelihood of new ideas coming into being.”\(^\text{290}\) In addition, individualism nurtures independence, achievements, and non-conformity, i.e. values known for promoting fundamental innovations. People from collectivist cultures, on the other hand, are usually not willing to differentiate themselves by stating new ideas. Moreover, the acceptance of geniuses and entrepreneurs and the ability to be and think different, which is a basic catalyst in the pursuit of innovations and radical inventions, are lacking in such societies.

• **Masculinity**: It appears that the drive for achievement is felt to be a characteristic of masculinity. So masculinity is expected to have positive effects on radical innovations. Besides, while masculine societies place great emphasis on output and performance, feminine ones seem to favour processes and aesthetics. Consequently, the orientation on this dimension not only shapes the way cultures perform scientific research, but also determines product innovation expertise.

2.2.3.3 *When cultures collide*

National and professional cultures have many aspects in common. Both the nationality and the occupation involve learning a language to express oneself together with the adaptation of specific codes. This type of knowledge is essential to understand and to be accepted by the other members of the respective culture. The exercise of any type of job necessarily leads to the adoption of a culture, which is characterised by a complex set of know-how, knowledge, and specialised terms. Sharing the same professional culture facilitates the realisation of common projects, and concurrently, such joint projects help to develop that culture. The profession therefore eases the (national) cultural integration of people, and at the same time, the practice of the same job fortifies the common bases and the professional culture. Moreover, the original expertise mentioned above, which is the exclusive prerogative of the professional community,

\(^{290}\) Herbig (1994), p. 95
bestows an identity on those who hold it. Such professionals thus surmount (national) cultural barriers. In other words, technical cultures seem to be transnational, at least to a certain extent. Hence, the professional culture may play an integrating role by gathering all members around a hard core of shared knowledge, *savoir-faire*, and abilities.

So the professional culture of researchers proves to be a facilitator for cross-cultural co-operation, acting as a catalyst for intercultural communication, by providing conditions that are favourable to the sharing of knowledge:

- **A content**: Interaction with other professionals and the exchange that comes with it, are regarded as a personal enrichment;

- **A medium to express it**: Technical issues are associated with a specific terminology which is understood by all members of the professional community;

- **An auspicious environment** for the development of interpersonal relationships, based on the mutual recognition of skills.

However, the previous section showed that each researcher orients himself to the references his national culture provides him with. Therefore, the intercultural scientist or engineer is an extremely rare specimen. The sole points that members of multicultural R&D teams have in common are usually the shared technical scope of their profession and the same scientific objective.²⁹¹

### 2.3 The purpose (what?)

This chapter will show what multicultural R&D teams do exactly and what their precise functions and purpose in the business are. The argument will revolve around those points that are specific to the role of researchers in companies. Scientists and engineers are basically paid for carrying out two types of operations: the generation of technology (to be regarded as the result of purposeful research and development activities) and knowledge creation. Both pursuits have the eventual aim of generating new products or more efficient processes, but the theoretical level of abstraction of both activities are not the same. While technology is a rather mechanical and substantial notion, knowledge creation is more intangible and abstract. Yet both concepts are closely
related to each other, and should be considered as an integrated whole. However, the analysis will be carried out in such a way that the differences between the two processes are made apparent.

2.3.1 The technology time path

The following part shows what technology is, and how it is generated. Research and development activities will be at the centre of the debate. The sketch of the processes still remains very general, since the objective is to give an overview of their function for the company. This approach is expected to reveal exactly those points in which R&D is different from other functions. The discussion will demonstrate why teams of R&D professionals should not be analysed in the same way as teams of managers or diplomats, who tend to focus on procedures like negotiation (as opposed to combined partnership). Hence, the theoretical area concerned by this subject matter is mainly R&D management (figure 2.14).

![Figure 2.14: Classification of technology generation](image)

For companies, research and development is mostly conceived as a means of creating and sustaining competitive advantage in the marketplace, though R&D and technology in general can also be considered as main factors for progress and welfare. Along with other items such as labour, capital investment, natural resources and management

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291 Chevrier (1996), pp. 6-7
skills, technology is the major ingredient for long-term economic development, since it either boosts productivity or leads to new products and processes.\footnote{Jain / Triandis (1990), pp. 229-230} The impact of technology on the economy has been the object of many theoretical models, all showing that economic activity was spurred by technological advance.\footnote{Vahs / Burmester (1999), pp. 5-8} According to a logic that can be traced back to Francis Bacon, the 17\textsuperscript{th} century philosopher, basic research itself is a vital ingredient for growth and social welfare, as it directly influences economic output. Indeed, there seems to be a positive correlation between R&D investment and gross domestic product growth. In particular, technological breakthroughs are often the origin of cyclical upturns, triggering expansionary waves. For instance, the development of riverboats and canals is acknowledged as the prime motor for the expansion of American commerce in the early 1800s (first wave), as are railroads for the second wave (1860s). Likewise, the third wave (1920s) was propelled by radical novelties in the automotive and oil industries. Furthermore, chemistry, physics, and transportation have been identified as the driving technology of the fourth wave (after 1945).\footnote{Herbig (1994), p. 36} Finally, many observers believe that the recent improvements in information and communication technologies have placed the world on the brink of a new such expansionary wave.

As already mentioned, R&D activities underlie technological advance. As purposeful operations, research and development are always carried out with the prospect of solving some problems, discovering new facts, and creating new knowledge about the research area. Therefore, R&D constitutes a sort of pivot in the loop system depicted in figure 2.15. The so-called “applied research loop”, which focuses on human needs, is moved by socio-economic forces and supposes that research uncovers knowledge, which leads ultimately to useful products and processes. The main forces behind the second loop (the “basic research loop”) are science and technology themselves, while human curiosity acts as the principal motivator.\footnote{Dror (1990), p. 46}
While very accurate, this model is still somewhat misleading. In fact, the relationship between basic and applied research is usually thought of as a chronological (though seamless) sequence. This continuous knowledge flow starts with the exploration of fundamental science and ends with the commercial diffusion of manufactured goods or services. It is illustrated in figure 2.16 and is elucidated in the next section.

2.3.1.1 From research through development...

In the words of Maximilian von Zedtwitz, “industrial R&D is about making profits […] with products created by development (D) based on knowledge provided by research (R).”\textsuperscript{296} This definition is extremely general, but demonstrates in a very few words what the relationship between both disciplines is all about. Mutually supportive, the one cannot do without the other: Basic research provides the fundamental understanding of problems and facts. This insight is used to derive certain scientific properties to be embedded in concrete products (development). In turn, some of the proceeds of their sale are funnelled back into basic research.

\textsuperscript{296} von Zedtwitz (1999), p. 1
Basic research is not only relevant from a macro-economic perspective. Rather, it is a crucial stage in the technology time path. It may have a huge scientific and technological impact and therefore ought not to be neglected. The main characteristic of basic research is that “it is not primarily directed towards any specific practical aim or application. Instead, it “focuses on the generality of the solution or the concept.” Such broad focus notwithstanding, the characterisation of basic research does not necessarily imply that it should not be directed towards specific fields of interest. Actually, oriented (as opposed to pure) basic research “is carried out with the expec-

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tation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future problems or possibilities.\textsuperscript{298}

According to OECD, “basic research analyses properties, structures, and relationships with a view to formulating and testing hypotheses, theories or laws.”\textsuperscript{299} Such discoveries must be published in professional journals or at least circulated to the scientific community to be valuable. In economic terms, it is not so much the breakthrough itself as its application that is the cornerstone of technological and social advancement. While discovery is a critical step, its usefulness may vanish if no action is taken to utilise it.\textsuperscript{300} This process of breathing life into a discovery is the object of applied research, a discipline that relies on the results of basic research and aims at finding possible practical applications of the latter. Furthermore,

\begin{quote}
“Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and predetermined objectives. It involves considering the available knowledge and its extension in order to solve particular problems. […] The results of applied research are intended primarily to be valid for a single or limited number of products, operations, methods, or systems. Applied research develops ideas into operational form.”\textsuperscript{301}
\end{quote}

Thus, practicability and immediate utility are notions that lie at the heart of applied research. But once the technical feasibility has been established, the ultimate goal is to turn this knowledge into marketable products. This procedure, experimental development, focusses on the creation of new or substantially enhanced materials, devices, systems or methods and also includes design and the working out of prototypes.\textsuperscript{302}

The development step is finalised in an executive decision to implement the outcome commercially, i.e. to manufacture it industrially. At this stage, the activities do not concern R&D anymore, but innovation, a field to be looked at in the next section.

\begin{footnotes}
\item[298] OECD (1994), p. 69
\item[299] OECD (1994), p. 68
\item[300] Herbig (1994), p. 5
\item[301] OECD (1994), p. 69
\item[302] Jain / Triandis (1990), p. 7
\end{footnotes}
Before, other main differences between basic research and experimental development are recapitulated in table 2.10.

2.3.1.2 ...To innovation

„Invention is a flower, innovation is a weed“\(^{303}\), says Bob Metcalfe, the inventor of Ethernet and founder of 3Com, pinpointing in a very lyrical manner the key difference between the two types of technological evolution. Indeed, invention is commonly referred to as the outcome of research, while innovation is represented as the result of development. In accordance with this reasoning, invention is a prerequisite for innovation, i.e. only the commercial relevance (or at least the social use) of an invention converts it into an innovation.\(^{304,305}\) In other words,

\[
\text{“Innovation is the first practical commercial demonstration of the invention. […]}
\]

\[
\text{Innovation is the conversion of that invention into a business or other useful application. […] If no market (or use) exists for a product, innovation will not occur. […] In simplest terms, Innovation = Invention + Exploitation.”}\(^{306}\)
\]

For the company, this means that invention is the compulsory, whereas innovation is the voluntary exercise.

Although acceptable for most issues related to innovation and technological management, this distinction fails to capture how R&D and innovation relate to each other. In fact, innovation implies a series of scientific and technological undertakings. In this connection, R&D is merely one of these activities and acts not only as a basic form of problem-solving, but also constitutes the true and original foundation for inventive ideas.\(^{307}\) Therefore, another main distinguishing feature between innovation and invention is the way they occur: While invention has a rather serendipitous character, innovation seems to be the result of a methodical planning process.

There are several forms of technological innovations, depending on aspects such as the object, the degree of novelty, or the level of autonomy of the innovations (table 2.11).

\(^{303}\) Metcalfe (1999), p. 54
\(^{304}\) Bleicher (1990), p. 4
\(^{305}\) Martin (1984), p. 2
\(^{306}\) Herbig (1994), p. 6
\(^{307}\) OECD (1994), pp. 19-20
<table>
<thead>
<tr>
<th><strong>Criterion</strong></th>
<th><strong>(Basic) Research</strong></th>
<th><strong>(Experimental) Development</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mission</strong></td>
<td>Creation of new things and finding new phenomena</td>
<td>Development of several ideas in product concepts quickly</td>
</tr>
<tr>
<td><strong>Scientific scope</strong></td>
<td>Broadly defined</td>
<td>Narrowly defined</td>
</tr>
<tr>
<td><strong>Type of knowledge generated</strong></td>
<td>Relatively unfocused</td>
<td>Relatively focused</td>
</tr>
<tr>
<td><strong>Scientific goals</strong></td>
<td>Diffuse</td>
<td>Precise</td>
</tr>
<tr>
<td><strong>Motivation</strong></td>
<td>Knowledge-driven</td>
<td>Profit-driven</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>Know-how, know-what, rights</td>
<td>Plans, prototypes</td>
</tr>
<tr>
<td><strong>Presence of commercial objectives</strong></td>
<td>Low</td>
<td>Medium / High</td>
</tr>
<tr>
<td><strong>Probability of reaching the scientific objective</strong></td>
<td>50%</td>
<td>85-95%</td>
</tr>
<tr>
<td><strong>Property</strong></td>
<td>Mostly public</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Unstructured: Small projects</td>
<td>Structured: Large projects involving large teams</td>
</tr>
<tr>
<td><strong>Operational time horizon</strong></td>
<td>Long run (up to 25 years)</td>
<td>Short run</td>
</tr>
<tr>
<td><strong>Payback</strong></td>
<td>Long term</td>
<td>Short term</td>
</tr>
<tr>
<td><strong>Timing</strong></td>
<td>Not well defined</td>
<td>Well defined</td>
</tr>
<tr>
<td><strong>Degree of uncertainty</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Barriers to entry</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Exposure to market pressures</strong></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Localisation of facilities</strong></td>
<td>Centralised</td>
<td>Decentralised</td>
</tr>
<tr>
<td><strong>Management focus</strong></td>
<td>People</td>
<td>Processes</td>
</tr>
<tr>
<td><strong>Leadership principle</strong></td>
<td>Management-by-intuition</td>
<td>Management-by-control</td>
</tr>
</tbody>
</table>

**Table 2.10: Main differences between research and development**

### Table 2.11: Types of innovations


Norbert Thom subdivides the innovation process into three phases, the idea generation, the idea acceptation and the idea realisation phase (figure 2.17).

Social and organisational innovations are not listed here because they cannot be considered as technological innovations.
According to his model\textsuperscript{309}, any innovation originates from an idea. Generating an idea starts with the definition of a specific search field to be explored. This procedure facilitates the identification of problems and delimits the area in which new concepts are sought. The key aspects to be tackled are the market needs and the available technological possibilities. Finding the idea itself is probably the most difficult part.\textsuperscript{310} This involves a thorough analysis of existing and potential opportunities. Widespread methods for gathering impressions and triggering inspiration include discussions with people inside and outside the organisation about relevant technological capabilities and recent trends. Observation of changing customer needs, of competitors’ activities, of modifications in legal regulations, etc. also provides some interesting input. Other wellsprings of ideas could be external consultants, exhibitions, symposia, and professional literature.\textsuperscript{311} Idea generation is not only restricted to compiling initiatives and

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\textsuperscript{309} The paradigm presented here represents an ideal archetype, which should not be taken for granted unconditionally. Innovations usually do not follow this predefined pattern, but proceed according to the prevailing circumstances.

\textsuperscript{310} How the idea actually occurs will be discussed in detail in chapter 2.3.2.2

\textsuperscript{311} Siemers (1997), p. 48
producing brainchildren, but also covers the formulation and proposal of concrete thoughts or plans (“proposing ideas”).

As the human, financial, and technical resources of companies are limited, projects have to be selected carefully. This is the object of the second main phase of the innovation process (“Idea Acceptation”), which consists in the evaluation of ideas according to different criteria. The main issue here is to determine whether the technical idea matches a need in the marketplace. After the idea has been tested for technical feasibility and commercial viability, an implementation strategy must be designed, so a final decision about the realisation of the project can be made.

The actual realisation of the idea, i.e. the conversion of the idea into a marketable product or a well operating process, is the first step in the third main phase (“Idea Realisation”). This entails actively managing the project and solving technical problems that have arisen in the course of the undertaking. The outcome is then presented to its addressees (customers, employees, production engineers, and so on) who evaluate it and give feedback. After the general acceptance has been assessed and established, the innovation is ready for launch (on the market or across the company).

2.3.2 Knowledge co-creation

As stated by Merton, “the institutional goal of science is the extension of certified knowledge”\(^\text{314}\). In the last few years, knowledge and its management, or its creation, have evolved into a highly topical issue, embracing subjects as diverse as strategy, organisation, human resource management, or R&D management.

One particular point to be highlighted in this context is that knowledge creation is not a mere sequence of actions, but is very often the result of collaborative group effort. That means that knowledge is mostly derived “from the well managed, dynamic interaction of individuals in groups – not just from the brains of individual ‘creatives’.”\(^\text{315}\)

In view of that, the term “knowledge co-creation” appears much more appropriate. Thus, the main focus of this section is going to be on this kind of knowledge creation

\(^{312}\) Schülin (1995), p. 33

\(^{313}\) Roberts / Fusfeld (1981), p. 311

\(^{314}\) Cited in: Jain / Triandis (1990), p. 59

\(^{315}\) From: http://dor.hbs.edu/fi_redirect.jhtml?facInfo=rez&facEmId=dleonard@hbs.edu
within teams. As those groupings may, under certain conditions, be considered as small-scaled organisations, one of the questions to be tackled is to see if knowledge creation premises that are usually made for organisations are pertinent for teams.

Special attention will have to be drawn on intra-team or inter-individual, rather than inter-team and intra-company relationships and co-operation. Thereby, one of the main purposes of the analysis will be to filter out some findings from the organisational knowledge creation theory, and to apply them to the team level. The theoretical areas concerned here are therefore R&D management and team management (figure 2.18). The discussion will start with an *exposé* of knowledge creation in general (the “macro-perspective”). The second part then concentrates on how knowledge can be generated when people work together in teams (micro-perspective). The section closes with some considerations of how knowledge co-creation can be enabled and promoted on the organisational as well as on the team level.

![Figure 2.18: Classification of knowledge co-creation](image)

**2.3.2.1 Co-creating knowledge: the macro perspective**

Knowledge, commonly defined as “justified true belief”\(^{316}\), has been identified as a critical determinant for firms’ competitiveness.\(^{317}\) The key problem of knowledge mana-

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\(^{316}\) Nonaka / Takeuchi (1995), p. 11

The purpose (what?)

gement in general is that most knowledge resides in a tacit form. This is not only true for individuals, but also for entire organisations and, accordingly, for teams. Explicit knowledge, i.e. knowledge that can be expressed in words, formulas and numbers, and which can therefore be transmitted in systematic language, only makes up the “tip of the iceberg of the entire body of possible knowledge”\(^{318}\). Tacit knowledge, conversely, comprises not only technical skills (know-how, craft, etc.) but also cognitive skills, such as beliefs, intuition or mental models.\(^{319}\) This unconscious or semiconscious knowledge, held in people’s heads and bodies, is not accessible to people other than the individuals or groups originating it,\(^{320}\) a characteristic feature of knowledge Polanyi summarised in his famous phrase “we can know more than we can tell”\(^{321}\).

The bulk of the literature about knowledge management emphasises the aspects relevant for the firm as a whole. Classical questions relate for instance to the question of how knowledge can be located within and transferred across the organisation, as a means to remain competitive and to ensure its long-term survival. However, before knowledge reaches this organisational (in terms of corporate-wide) dimension, it first has to be created, an achievement that can only be accomplished by a single person or a group of people. However, individuals are often not capable of coming up with new products or services, new processes, new insights, etc. on their own. Hence, the team represents the ideal organisational form for knowledge creation. In addition, since the major part of the R&D effort in firms is carried out in groups, the very locus of knowledge is, most of the time, the team. Furthermore, for Ravindranath Madhavan and Rajiv Grover, the team acts as a “vehicle for coordinating the separate cognitive activities of individuals”, and the outcome of such co-ordination depends on “the skill and reliability with which the individual functions are performed.” In their concept of “embedded knowledge”, the authors demonstrate the importance of teamwork for the creation of new knowledge. Defining embedded knowledge as “the potential knowledge resulting from the combination of the individual team members’ stores of tacit knowledge”, they stress their belief that only the team as a whole and the interaction

\(^{318}\) Nonaka / Takeuchi (1995), p. 60
\(^{319}\) Rumizen (1998), p. 78
\(^{320}\) Leonard / Sensiper (1998), p. 113
\(^{321}\) Polanyi (1966), p. 4
among its members can assure the mutation of embedded knowledge into new products (which in turn are the visible outcome of “embodied” knowledge).\textsuperscript{322}

As indicated by Ikujiro Nonaka “knowledge is created through conversion between tacit and explicit knowledge”\textsuperscript{323}. From an organisational perspective, knowledge is created in a spiral process initiated at the individual level and moving up through escalating communities of interaction (figure 2.19).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig2.19.png}
\caption{Spiral of organisational knowledge creation (Source: Nonaka / Takeuchi (1995), p. 73)}
\end{figure}

The four modes of conversion underlying the model are the following.\textsuperscript{324}

1) **Socialisation** is the conversion from tacit knowledge to tacit knowledge. Here, the sharing of experience results in the creation of redundant tacit knowledge (e.g. shared mental models or technical skills). The transfer and absorption take place

\begin{footnotesize}
\textsuperscript{322} Madhavan / Grover (1998, pp. 1-2
\textsuperscript{323} Nonaka (1994), p. 18
\textsuperscript{324} Nonaka / Takeuchi (1995), pp. 62-69
\end{footnotesize}
through active watching and mimicking, and most of the time, without even knowing why.\footnote{Leonard / Sensiper (1998), p. 121}

2) During the **externalisation** process, tacit knowledge is articulated into explicit concepts. Special formulations such as metaphors, analogies, concepts, hypotheses, or models can be used in this endeavour.

3) The process of systemising concepts into a particular knowledge system is called **combination**. This mode of knowledge conversion (from explicit to explicit) calls for individuals to exchange and combine knowledge through media such as documents, meetings, telephone conversations, or electronic communication networks.

4) **Internalisation** is a process in which explicit knowledge is embodied into tacit knowledge. Classical channels for internalisation are learning-by-doing (via simulations or experiments), training, exercises, and so on. With such learning devices, the team member gets access to “the knowledge realm of the group.”\footnote{Nonaka / Konno (1998), p. 45} The “learning-by-doing”-approach is often considered as the best way to achieve this type of knowledge conversion.

Furthermore, Nonaka and Takeuchi outline five discrete steps in the knowledge-creation process: sharing tacit knowledge, creating concepts, justifying concepts, building an archetype, and cross-levelling knowledge. This interactive process, known as cross-levelling knowledge, is an intra- and inter-organisational phenomenon, as it occurs amid people within the same division, between separate divisions, and can even involve external units (customers, distributors, suppliers, affiliated companies, universities).\footnote{Nonaka / Takeuchi (1995), pp. 84-88, von Krogh / Ichijo / Nonaka (2000), pp. 7-8}

1) The knowledge co-creation process starts in an informal and unconscious way, when the team members meet to *share* tacit knowledge (for example about customers’ needs, new technologies, personal skills required to perform complex tasks, etc.). In this way, the rich and unexploited knowledge residing in people can be augmented within the organisation.
2) In the second stage, this tacit knowledge is then converted into a new *concept*, i.e. an explicit type of knowledge. Possible forms of such concepts include the specification of functionalities, an algorithm, the description of a manufacturing process, a drawing, and so on.

3) Thereafter, the newly created concept needs to be *justified* towards internal and external organisational members.

4) Upon passing the scrutiny successfully, the concept is transformed into an *archetype*, i.e. a material manifestation of the team’s knowledge.

5) Finally, the knowledge previously created has to be *dispersed* across and beyond the organisation at large.

Still, it is quite obvious that this construction has been designed for knowledge creation on the organisational level. And despite the fact that this spiralling process between the two types of knowledge (i.e. explicit and tacit) involves individuals as well as organisations as a whole,\(^329\) it is applicable to the team level only to a certain extent. While this interpretation of knowledge creation shows how knowledge can be disseminated across the company (and thus generated), it does not really explain how new knowledge actually crops up. When considering a more narrow definition of knowledge creation, it appears that the true formation of knowledge happens in the second phase of the process described above, namely when it comes to creating the concept.

2.3.2.2 **Co-creating concepts: the micro perspective**

The previous concept described how knowledge could be created on an organisational level by converting knowledge from one form into another. The model to be presented here, conversely, focuses on the radical (as opposed to incremental) learning\(^330\) aspects of knowledge creation. Therefore, knowledge creation shall be interpreted here as “the discovery of particular facts and universal principles from an objective reality”\(^331\). Consequently, knowledge creation is about investigating the unknown and solving

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\(^329\) Sawhney / Prandelli (2000), p. 28

\(^330\) In the sense of Bierly / Chakrabarti (1996), p. 124

\(^331\) Floyd / Wooldridge (1999), p. 126
problems, in opposition to knowledge management, which deals exclusively with the known and where the challenge is to create completeness of the raw data.\textsuperscript{332}

According to Polanyi, “creativity begins with the tacit intuition of a scientist who, immersed in her subject, is flooded with subconscious insight.”\textsuperscript{333} The quote makes it clear that any creation of knowledge starts with an individual action, be it conscious or unconscious. One example for a conscious action is thinking. Thinking can take several forms: finding and solving problems, predicting and anticipating,\textsuperscript{334} cross-pollinating ideas (i.e. linking several pieces of information and combining it to something new)\textsuperscript{335}, designing, sketching or drawing, planning or elaborating, or just trying to remember previously acquired information and skills.

The one crucial component without which all those activities are utterly unthinkable is creativity, which is the “process of developing and expressing novel ideas that are likely to be useful”\textsuperscript{336}. Creative behaviour is the force that sparks off the knowledge generation process by enabling individuals to produce novel, unusual or unique ideas, and to solve problems in an original manner. Taken literally, creativity is nothing more than the ability to create. It is revealed in the capacity to associate available data and experience in a novel ingenious pattern.\textsuperscript{337} Creative power can be expressed artistically, scientifically, intellectually, but is equally important in domains such as management or sports. Creativity requires fantasy and a vivid imagination, but also intuition, memory, resourcefulness, sensitivity, cognitive flexibility of the mind, openness, motivation, or self-assertiveness.\textsuperscript{338} Likewise, the activities involved in concept creation are analysing, reasoning, synthesising, and holistic thinking.\textsuperscript{339}

\textsuperscript{332} Bajaria (2000), pp. 562-563
\textsuperscript{334} Leonard / Sensiper (1998), pp. 114-115
\textsuperscript{335} von Krogh (2000), p. 66
\textsuperscript{336} Leonard / Swap (1999), p. 6
\textsuperscript{337} Bleicher (1990), p. 15
\textsuperscript{338} Adriani / Schwalb / Wetz (1995), pp. 25-26
\textsuperscript{339} Adair (1986), pp. 157-158
Thomas Edison once declared: “Genius is 99 percent perspiration and 1 percent inspiration”\(^3\)\(^{40}\). That means that illumination and serendipity (“the faculty of making happy and unexpected discoveries by accident”\(^3\)\(^{41}\)), while indispensable, is by far not even half of the battle. Rather, discoveries are the result of a long and painstaking effort. So concept creation can (ideally) be interpreted as a process with well-defined phases and events. For instance, Green exemplifies the creative process by means of eight periods:

1) The “problem” faced by the individual arises by the nature of the R&D process. The individual develops at least one preliminary conception of the problem and moves to:

2) Accumulation of data, ideas, concepts through literature reading, discussion, investigation, and experiment.

3) Incubation, when the conscious and nonconscious mind assimilate and digest the information gathered.

4) Intensive thinking occurs next, whereby the individual seeks to solve the problem by weaving ideas in new combinations, but – despite the intense effort – without success. This leads to:

5) Frustration, dissatisfaction, and fatigue, so in the face of this psychological blockage, the individual abandons conscious consideration of the problem, takes some:

6) Relaxations, and “sleeps on it”, leading later to:

7) Illumination, or sudden inspiration, the so-called “flash of genius” or EUREKA, and (in science and engineering anyway) finally:

8) Solution, verification, and embodiment.\(^3\)\(^{42}\)

Groups themselves are never creative. It is always individual members who come up with the initial ideas. Nevertheless, teams offer a context in which creative thinking flourishes particularly well: Atmosphere, communication, leadership, morale are all ingredients contributing to the agreeable climate necessary to set off and fostering

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\(^{341}\) Robinson / Stern (1997), p. 179
investigative reflection of individuals.\textsuperscript{343} In addition, plurality of expertise and skills increases the number of possible combinations and the processing capacities. Then, “unfamiliar” ideas, brought in by the other team members, not only stimulate learning effects, but also incite them to try novel associations.\textsuperscript{344} In this regard, several instruments have been designed to fire up teams’ collective brain and to make use of their potential combined creativity. The most widely used are brainstorming, synectics, lateral thinking, and morphological analysis.\textsuperscript{345}

\subsection*{2.3.2.3 Enabling knowledge co-creation}

As indicated by von Krogh, Ichijo and Nonaka, “the key quality of knowledge workers is their humanness”\textsuperscript{346}. In order to capitalise on the benefits of teamwork, this very trait must be employed, cultivated and nurtured properly. Hence, it is the role of the organisation to provide a sound and agreeable working environment, which should allow for mental freedom while promoting the establishment of tight relationships. This context should be designed in a way that it facilitates group activities and, as a result, knowledge co-creation.

In order to promote the knowledge spiral as described above, five conditions should be fulfilled on the organisational level:\textsuperscript{347}

- Intention, i.e. the organisation’s aspiration to its goals;
- Autonomy, which guarantees the maintenance of a greater flexibility in acquiring, interpreting, and relating information;
- Fluctuation and creative chaos;
- Redundancy of information;
- And requisite variety, which enables the team to cope with contingencies imposed by the environment, and which can be enhanced by providing equal access to

\textsuperscript{343} Adair (1986), pp. 155-156
\textsuperscript{344} Schneider (1990), p. 110
\textsuperscript{345} For ampler details and further methods, cf. Souder / Ziegler (1977), pp. 267-279 or Martin (1984), pp. 150-157
\textsuperscript{346} von Krogh / Ichijo / Nonaka (2000), p. 12
\textsuperscript{347} Nonaka / Takeuchi (1995), pp. 73-83
information throughout the organisation and by combining information differently, flexibly, and quickly.

Nonaka and Konno introduced a notion that describes such optimal structural conditions for the establishment of positive interpersonal relationships, the concept of “ba”. In their definition, “ba can be thought of as a shared space for emerging relationships”, offering “a platform for advancing individual and / or collective knowledge.”

One important feature of the model, however, is that the “space” which ba consists of is not necessarily physical, but can be virtual, mental or a combination of all three.

The main environmental enablers and stumbling blocks for creativity, learning, and knowledge co-creation are enumerated in table 2.12:

<table>
<thead>
<tr>
<th>Enablers</th>
<th>Stumbling blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Open channels of communications</td>
<td>• Centralisation</td>
</tr>
<tr>
<td>• Encouragement of contacts with outside sources</td>
<td>• Authoritarian, tight, or rigid management of the organisation</td>
</tr>
<tr>
<td>• Involvement of non-specialists</td>
<td>• Blame</td>
</tr>
<tr>
<td>• Evaluation of ideas are on their merits rather than on the status of their originator</td>
<td>• Fear</td>
</tr>
<tr>
<td>• Encouragement of experiments with new ideas rather than making “rational” prejudgments</td>
<td>• Belief such as “we can’t outrun this problem”</td>
</tr>
<tr>
<td>• Decentralisation</td>
<td>• Focus on individuals rather than on their actions</td>
</tr>
<tr>
<td>• Great autonomy for professional employees</td>
<td>• Constant attention to outside knowledge while ignoring local insights</td>
</tr>
<tr>
<td>• Openness</td>
<td>• Inflated egos</td>
</tr>
<tr>
<td>• Tolerance for risk-taking</td>
<td>• Poor teaching or mentorship</td>
</tr>
<tr>
<td>• Acceptance that mistakes occur</td>
<td>• Inability to forget (e.g. prevalent perspectives and thinking habits)</td>
</tr>
<tr>
<td>• Participative decision making</td>
<td>• Overemphasis of tradition and security</td>
</tr>
<tr>
<td>• Fun at work</td>
<td>• Risk aversion</td>
</tr>
<tr>
<td>• Frequent feedback (both positive and negative)</td>
<td>• Social pressures</td>
</tr>
<tr>
<td>• Open sharing of knowledge</td>
<td></td>
</tr>
<tr>
<td>• An atmosphere that encourages and rewards learning</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.12: Enablers and stumbling blocks of knowledge co-creation
2.4 The means (how?)

The next chapter will present the means team leaders and, more generally, the company have at their disposal to make their multicultural R&D teams operate effectively. To be more explicit, the analyses will show what it takes to have teams work, how team members co-operate, interact, and communicate. Other issues to be tackled will include the management of diversity and the techniques used to solve conflicts within such teams. At this, social-perspective considerations of management\textsuperscript{349} will lie at the centre of the attention. Accordingly, important emphasis shall be laid on soft matters, such as intergroup relationships, personal contacts, emotions, and so on.

2.4.1 Co-operation

Co-operation is the essence of teams. Similarly, team management lies at the core of studies on co-operation (figure 2.20). Without willing co-operation, a team is not a team. In addition, collaboration has to be voluntary so that one can speak of co-operation. The word co-operation implies not only action (“operation”) by the people involved, but also certain connivance between them (“co-”). Hence, the concept encompasses two main facets: teamwork, representing the structural (“team”) and processual (“work”) components of co-operation on the one hand; and interaction, corresponding to the interpersonal dimension on the other.

2.4.1.1 Teamwork

Taken literally, teamwork is nothing else than the work of teams. Specifically, work can be separated into two elements:

\[
\text{Teamwork} = \text{Team} \ (\text{structure}) + \text{Work} \ (\text{process, activity})
\]

In this connection, the term “team” is associated to the structure of the collaboration. Structure is not limited to the determination of teams’ organisational configuration and arrangement, but also concerns questions such as the roles, functions, and tasks to be represented in teams.

\textsuperscript{348} Nonaka / Konno (1998), p. 40

\textsuperscript{349} Cf. chapter 1.2.4
The size of the team is probably the very first issue to be dealt with. Large groups often prevent their members from presenting their ideas (because of lack of time). Then, the leader will tend to monopolise speech, becoming more and more autocratic. Also, sub-teams are likely to emerge and compete against each other. In contrast, small teams may lack a true leader and clear objectives. Furthermore, an insufficient number of team members reduces the diversity of perspectives, which can lead to groupthink. Therefore, five has been identified as the ideal number for discussion groups. This figure is of course rather arbitrary, and not too much significance shall be given to it. More important is the configuration of teams in terms of the functions that are necessary for their effective operation. Three items can be singled out:

- **The leader** has the greatest responsibilities within the team. He has to set its direction and show the way to the other members. He motivates his co-workers and ought to delegate certain tasks to them;
- **The nucleus** is a cluster of several like-minded people around which the team is built;

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350 Jain / Triandis (1990), p. 53  
• The team itself, in which external relationships play an equally important role as the internal ties among its members.

Moreover, it seems that well-performing teams are composed before concrete tasks can be assigned. Hambrick et al. have observed a recurring appearance of three distinct tasks that should be fulfilled in every team, the creative, the computational, and the co-ordinative task.\footnote{Hambrick / Davison / Snell / Snow (1998), p. 194}

• The object of the \textbf{creative task} is to generate new ideas, and to reach consensus on a solution to be chosen;

• In the \textbf{computational task}, information is gathered and analysed so their different solutions proposed can be assessed and tested for correctness or superiority;

• The \textbf{co-ordinative task} is meant to install an elaborate and well-orchestrated interaction among team partners.

It must be noticed that separation of these tasks does not necessarily require them to be carried out by different team members. Considering the relatively small size of teams (at least as recommended), specialising in one single task would be somewhat unwise. Rather, it should be the duty of all participants to make sure that all three charges are permanently performed. Judging by the comparatively clear objectives prevailing in R&D teams, realising this should be quite an unproblematic matter.

\textit{2.4.1.2 Teamwork}

Work is the second term in the equation established previously. The expression “work” here refers to activities the team members share and execute in common. It implies a certain motion. Teams usually do not reach cruising speed and become truly effective immediately (some never do); rather, they go through a finite development process, a process that has been made explicit by Bruce Tuckman. The author distinguishes four stages in the development of teams.\footnote{Tuckman (1965), pp. 384-399, Adair (1986), p. 29, Lumma (1994), p. 44, Palmer (1998), p. 38}
1) **Forming**: In the forming stage of the team development, tasks are contoured and the team members are oriented about how the team works. This involves finding out the team’s goals, defining sub-goals, discovering the boundaries, acquiring information and resources, developing structures and strategies, learning the rules prevailing and the methods employed within the team, experimenting with ways of approaching the task, etc.

2) **Storming**: The value and feasibility of the task are questioned in the storming phase. Tasks are discussed and eventually assigned. Inevitably, discrepancies are made apparent, and resistance to the assignment of tasks may surface. While this can lead to dysfunctional conflict, it nonetheless gives the partners the opportunity to know each other better. In the process, the role of each team member emerges naturally.

3) **Norming**: The norming stage starts when co-operation on the task begins. Comprehensive structuring and organising take place. Concrete plans are drawn up and procedures determined. This allows the team to set work standards and norms. The collaborators begin to truly co-operate with one another.

4) **Performing**: The performing phase is characterised by the achievement of effective teamwork as the group’s energy is directed at being successful in the area of its shared task. Throughout the development process, the team should have achieved important progress, and at present, fruitful work on the task should go ahead. The solutions developed in common are implemented, and the division of work is refined. And whilst the roles are flexible and functional, there is permanent reflection about how to improve the collaboration ever more.

Although the process levels off in the performing stage, it can happen that the team may experience changes typical for the former three phases, for example, when a new member joins the group or the leadership is reshuffled. Moreover, the general mood in each stage triggers different types of emotions, which will have dissimilar effects on the interaction between members.

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357 Schneider / Knebel (1995), pp. 61-64
2.4 The means (how?)

2.4.1.3 Interaction

The team does not only move as a self-contained unit; its members are also constantly interacting. However, interaction in this context does not mean brain or manual effort, but refers to the result of different perspectives, personalities, and cognitions meeting together.

Interaction in teams is a highly emotional process. Partners’ sentiments evolve over time, depending on the team’s development stage (cf. previous chapter). The relational and behavioural aspects in each phase are specified in table 2.13.

The social structures engendered by such interaction need to be held together. Feelings play an important role in this process, even though the emotional dimension of collaboration encompasses considerable threats and opportunities. To minimise the former and realise the latter, teams have to develop a spectrum of enabling qualities, most of which are closely related to humane values, like respect, trust, sympathy, care, and so on.

First of all, multicultural R&D team members should learn to develop and cultivate good relationships with their collaborators. This starts with a deep respect of others and their thinking styles\(^\text{358}\) and with the effort to understand one another’s approaches to problem solving and innovation, as well as cognitive style preferences (i.e. a preference for facts and experience as opposed to metaphor and speculation).\(^\text{359}\) Then, the good knowledge co-worker will listen to others, react to their ideas, share his feelings, and give feedback. If the group achieves this, helpful relationships will emerge, facilitating the sharing of tacit knowledge and thus the creation of knowledge in general.\(^\text{360}\) Moreover, Osterloh and Frey showed that participation and personal relationships (“team spirit”) encouraged intrinsic motivation by raising the members’ perceived self-determination and originating psychological contracts.\(^\text{361}\)

\(^{358}\) Leonard / Straus (1997), p. 112  
\(^{359}\) Leonard-Barton (1995), pp. 64, 70  
\(^{360}\) von Krogh / Ichijo / Nonaka (2000), p. 45  
\(^{361}\) Osterloh / Frey (2000), p. 545
<table>
<thead>
<tr>
<th>Stage</th>
<th>Relational and behavioural aspects</th>
</tr>
</thead>
</table>
| 1) Forming | • Prevailing anxiety within the team  
• Team members are unsure about each other  
• Reliance on the team leader – looking for guidance  
• Partners learn what kind of behaviour is appropriate  
• Individuals come together with a sense of anticipation and commitment  
• Avoidance of controversy  
• High motivation |
| 2) Storming | • Conflict between sub-teams within the team  
• Members challenge the views of others and express their own  
• Strongly expressed views and poor listening  
• Competition for control  
• Flaring up of emotions and full expression of feelings  
• Challenges to the authority and / or competence of the leader  
• Divergence of opinions  
• Polarisation around interpersonal issues  
• Emotional reactions against the task(s) assigned and their demands  
• Individuals react against efforts of the leader or team to control them  
• Motivation decreases |
| 3) Norming | • Team begins to harmonise  
• Active participation  
• Shared leadership  
• Open exchange of views and ideas  
• The communication of more intimate and personal opinions develops  
• In-group feeling advances after resistance is overcome  
• Collaborators become cohesive, respectively united  
• Norms emerge as conflicts are reconciled and resistance is overcome  
• Mutual support of each other  
• Motivation increases |
| 4) Performing | • Roles are seen in terms functional to the task  
• Openness  
• Acceptance of different views  
• Feelings of warmth toward other members  
• Members have built strong relationships and trust  
• High motivation |

Table 2.13: Relational and behavioural aspects in the team development process

Another substantial element in a genuine team culture is trust. This means not only trust in team orientation or in the technical competence of the colleague, but also absolute trust in the other team member as a human being and friend. According to Nonaka, “mutual trust is an indispensable base for facilitating this type of constructive ‘collaboration’.” As knowledge co-creation is about growing and actualising oneself jointly, trust plays a twofold role: First, trust is the glue that welds the team together and makes it act like one. At the same time, it lubricates the knowledge co-creation process within the group. Then, Miles, Snow, and Miles assert that “with increasing trust comes a growing willingness to expose one’s views without the fear of being exploited and to probe more deeply for new insights and perspectives.” This, in turn, advances the sharing of tacit knowledge significantly. However, before one person accepts help from somebody else, he needs to believe in the helper’s good intentions to support him. So what is needed to build up trust? Above all, time and patience. One cannot impose trust on the team members. Rather, the parties should be involved in cooperation. From this perspective, mutual understanding, frequent interaction, the collective exchange of experience, progressively deepening relationships, the forming of strong personal bonds are the major elements in the development of trust.

2.4.2 Communication

“You can have great ideas, but if you can’t communicate them effectively, they don’t matter.” Communication is the intensive exchange of information. In a corporate context, it implies the transfer of data, news, facts, suggestions, ideas, or experiences relevant for the realisation of the collaborators’ operational functions. The process requires reciprocal and thorough disclosure of solutions and new insights between the players, who need to cultivate open interrelations. As such, communication is an essential factor in R&D and knowledge co-creation. Moreover, culture plays an important role in communication since it significantly influences the way people transmit

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364 Miles / Snow / Miles (2000), p. 304
367 Gregory Thomas (2000), p. 86
messages. Likewise, communication can be considered as the main agent of culture (by means of the language). Therefore, communication and culture are closely intertwined, if not inseparable, concepts. Accordingly, communication is a domain that simultaneously touches upon R&D management, multicultural management and team management (figure 2.21).

![Figure 2.21: Classification of communication](image)

### 2.4.2.1 Language

The communication process can be described through five elementary questions: 1) Who? 2) Says what? 3) By which means? 4) To Whom? 5) With what effect? Correspondingly, five elements are needed to constitute such a transmission:

$$\text{Sender} \rightarrow \text{Message} \rightarrow \text{Channel} \rightarrow \text{Receiver} \rightarrow \text{Effect}$$

Language represents the backbone in this process and is embodied in the third component, the channel. It is the medium with which the message is transferred from the sender to the receiver. As such, language lies in the core of communication. In fact, it is an absolute requisite for communication, because it enables people to divulge their thoughts and to be in touch with each other. Language represents one of the key cha-

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368 Schneider (1996), p. 47
369 Spence (1994), p. 87
characteristics distinguishing human beings from animals. Indeed, humans use metaphors, make speeches, tell stories, i.e. display abilities, which other living species do not have. Furthermore, language is what made people more powerful vis-à-vis their natural rivals, because it allowed them to ask questions and to have dialogues, thus sharing knowledge more effectively and efficiently.

A language is a “living entity”, since it is regularly the object of changes. The terminology evolves, vocabulary is enhanced again and again, new words and phrases being added to the existing pool. Furthermore, jargons and dialects are permanently invented, be it in the form of novel idioms, signs or icons employed by a number of people within a community (cf. the example of the abbreviations used by all the users of short messages on mobile phones).

As the prime vehicle for communication, a language must be recognised by all interlocutors involved. Communication is not only about speaking and hearing. Rather, the messages emitted and received must be understood and interpreted properly. The latter is the difficult part. To be useful, a language therefore must be a code shared and comprehended by each member of the community in which the communication takes place. In that sense, language is no more than a convention agreed about symbols carrying a predefined meaning. Every communication system is built on a certain number of rudimentary constituents, such as vocabulary, syntax, and grammar. Miscommunication, i.e. an unsuccessful transmission, means that the message has been filtered, distorted, blocked, misunderstood or misinterpreted by the receiver. Language plays an imminent role in this regard, and may act both as a facilitator and as an obstacle to the communication flow. Complex terminology, ambiguous codes, inaccurate speed of diffusion, etc. are potential hurdles that turn language into a tool that needs to be handled with great care, at least on those occasions when not everybody can be expected to be familiar with it.

370 Descartes (1646), p. 1256
372 Shanahan (1996), p. 316
373 Hilb (2000), p. 163
374 Shanahan (1996), p. 315
375 Marschan / Welch / Welch (1997), p. 595
Broadly defined, language includes not only written or spoken words, but can also be expressed via other media. The most classical ones in this regard are paralanguage and kinesics:

- **Paralanguage** is the term used when communicating involves not only the employment of words but also the sound of those words. Paralanguage bears a substantial part of the emotions to be uttered by accompanying the spoken word with inflexions, emphases, variations in volume and pace, pitch, interruptions, accent, tone of voice, hesitations, pauses, silence, etc.

- **Kinesics** stands for the process of communicating through certain types of body movements. This “body language” is intended to reinforce the oral message by means of facial expressions (e.g. eye contact, smile, lifting of the eyebrow), gestures (e.g. head tilt, “thumbs-up”, movement of the hands), and stance (e.g. posture while standing or sitting, gait, body orientation, position of the shoulders, hands, and legs).

As will be seen later on, these forms of non-verbal communication are particularly delicate in multicultural settings, because they can lead to serious misunderstandings or confusions.

### 2.4.2.2 Communication in R&D teams

“Communication is the essential process that links a team together.” Hence, verbal interaction is a vital precursor for the constitution of teams, especially R&D teams. The exchange of information, which is best performed via direct communication, allows the members to find out each other’s strengths and weaknesses. This information, in turn, enables the team to understand its comparative advantages and to use them more resourcefully.

In order to get the most out of the team’s potential, communication must happen in such a way that the flow is as free as possible. This calls for a team structure with a

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376 Spence (1994), p. 91  
377 Chaney / Martin (1995), pp. 56, 64  
379 McCann (2002)
low degree of centralisation, short distances between the interlocutors, a multitude of channels, openness, as well as flat, small and flexible hierarchies. In that sense, a team configuration as a network is likely to allow for much superior communication than as a hierarchy (characterised by vertical and one-way communication, a top-down mentality, few but imperative channels, overemphasis of the pecking order, rigid leadership, etc.). On the inter-individual level, the requirements of effective speaking include clarity, conciseness, simplicity, naturalness, vividness, and preparedness. Still, communicating is not only about speaking. Listening is equally as important and requires as much skill. In effect, listening is more than simply hearing, as it should cause the receiver to comprehend the core meaning of his interlocutor’s contribution. That’s why listening should be regarded as a positive, co-operative, and searching activity.

As indicated by Miles, Snow, and Miles, trust can only develop if all the parties get the opportunity to pursue interaction and to deepen their relationships. Conversely, “inaccurate communication can result in misunderstandings that lead to mistrust”. Therefore, communication is the foremost vehicle with which trust can be instilled within the team. But to facilitate the establishment of tight interpersonal relationships, communication should not focus too much on professional issues. Rather, some emphasis should be laid on informal exchanges, such as chats about personal matters, small talk, rumours, jokes, gossips, etc. In addition, such casual contact contributes to the mutual understanding of each other, thereby facilitating the integration into the group of all team members. For these reasons, it is commonly assumed that, under certain circumstances, informal face-to-face communication allows for a more efficient and more flexible transmission of information than formal mechanisms.

380 Lawson / Bourner (1997), p. 161
381 Thunig (1999), pp. 32-33
382 Schneider (1996), p. 48
384 Adair (1986) p. 18
385 Miles / Snow / Miles (2000), p. 304
386 Yeatts / Hyten (1998), p. 82
388 Specht / Beckmann (1996), p. 443
The rapid and intensive exchange of data, experiences, ideas, etc. constitutes the breeding ground for the creative finding of new concepts and the solving of problems. Research needs information, the “essence of scientific activity”, to grasp and formulate the question confronting him.\(^{389}\) As a major stimulus for creativity, information must be shared in order to increase the probability of the association and transfer of ideas.\(^{390}\) Consequently, communication is the keystone in R&D and knowledge co-creation. In addition, the complexity of today’s technological problems and the need to analyse and synthesise relevant information reinforce the importance of personal contacts and verbal communication.\(^{391}\)

During all stages of the knowledge co-creation process, there are precise conditions for successful communication to take place. The sharing of tacit knowledge (step 1) asks for unconventional language or metaphors\(^{392}\). This exigency is even more critical when concepts have to be created (step 2). In this phase, which is marked by the need to externalise knowledge, the team members have to “express shared practices and judgement through language”\(^{393}\). Hence, the richer the language employed, i.e. the more meaning the words uttered transmit, the better. Metaphors and analogies and other figurative formulations have the advantage that they can carry much more content than simple content. Similarly, one helpful thing is to embody and communicate the cooperative experience of current and past teams in stories and narratives.\(^{394}\) Such advice can be found again in von Krogh and Roos’ proposition to “manage conversations” by inventing, developing and spreading new words and phrases across the team or the organisation.\(^{395}\)

However, this endeavour is rendered difficult by the diversity of most R&D teams. In such circumstances however, the problems stem from multinationality and multidisciplinarity. While English is the most widely used tongue in scientific domains, each discipline tends to create its own language. The particularities of technical tasks and

\(^{389}\) Allen (1988), p. 8
\(^{390}\) Bleicher (1990), p. 70
\(^{391}\) Jain / Triandis (1990), p. 29
\(^{392}\) von Krogh (1998), p. 140
\(^{393}\) von Krogh / Ichijo / Nonaka (2000), p. 85
the preciseness of the information to be conveyed make the development of profession-specific terms and idioms indispensable. So when for instance biologists, chemists, and toxicologists get together to form a project team, they might not all speak the same language, although they use English to communicate. The team members will first have to agree on a common jargon (which includes the denomination of objects, properties, units of measure, etc.) before they can start working together.

2.4.2.3 Cultural aspects of communication

Culture and communication have much in common. They are two inseparable concepts, glued together by language. Every language is associated to a culture, resting at its very core. As pointed out above, speech is an essential intermediary for communication. Conversely, each culture tends to develop a common language as a way of integrating its members. Nationalities have a tongue, regions cultivate dialects, but also industries, professions, functions, and corporations, are often provided with their own terminology. And language is made of words. Those words are “the atoms and molecules of expression – and not all languages have the same table of elements”. For example, the Eskimos have twenty-seven different words for snow, each of them expressing a different form or consistence. More often than not, affiliation to the respective culture is an absolute prerequisite to understand that language. New entrants first need to learn the idioms before they are fully assimilated to the community. The issue is slightly less problematic in R&D, as the bulk of scientific and technical terms comes from English and is recognised all over the world. Nevertheless, familiarity with that vocabulary is only a necessary but by far not a sufficient condition for becoming a member of the scientific community.

Earlier in this dissertation, culture was described by means of a number of dimensions (context), which was directly connected with communication. Indeed, the notion of context is commonly used to distinguish national cultures, according to the way individuals converse. The amount of meaning conveyed in a certain message will greatly

396 Schrage (1990), p. 74
397 Marschan / Welch / Welch (1997), p. 597
398 Schrage (1990), p. 75
depend on whether the interlocutors are from low or high context cultures.\textsuperscript{399} For example, extensive informal information networks are very common in high-context societies. In low-context cultures, conversely, informal interference is reduced to the minimum, and is replaced by the use of a succinct and precise language.\textsuperscript{400} A mismatch here can lead to accusations such as “they don’t say what they really mean”, spoiling the trust between the partners and jeopardising the relationship.

Yet, communication does not only function as a vehicle for exchanging information. It always transmits some cultural attributes of the person speaking. Therefore, “language is more than a means of understanding each other. It is a means of understanding the world and a starting point for social actions”\textsuperscript{401}. In this case, communication contributes to becoming aware of and to comprehending other cultures. But when several cultures are involved, the interaction itself may be very challenging. In particular, the simple fact that the interlocutors speak different languages, or that one of them communicates with a tongue that is not his native one, may lead to ambiguity.\textsuperscript{402}

Since words are merely symbols, if their full meaning is not shared, they quickly turn into misunderstandings that disturb or even distort the information flow. Hence, the failure to understand and interpret correctly what a partner is saying, or trying to say, is a potential threat for a successful collaboration. Obviously, this happens quite frequently in multicultural projects. Such cultural noise is almost inevitable, given that all team members handle their information based on a rather incommensurable background.\textsuperscript{403} Unfortunately, interpreters do not automatically attenuate the problem, because they are not likely to capture the full richness of the communication, regardless of their language skill.\textsuperscript{404}

Nevertheless, a common language is not always a guarantee for understanding each other. Even speakers of the same language (e.g. Britons and Americans) may encounter difficulties. As already mentioned in a previous section, language involves more

\begin{footnotesize}
\begin{enumerate}
\item Hall / Hall (1990), p. 6
\item Boutellier / Gassmann / von Zedtwitz (2000), p. 214
\item Krech (1991), p. 100
\item Mead (1992), pp. 123-143
\item Boutellier / Gassmann / von Zedtwitz (2000), p. 208
\item Govindarajan / Gupta (2001), p. 65
\end{enumerate}
\end{footnotesize}
than words and sentences. To get the full picture of a message transmitted across cultures, the translation should preserve more than the word. The meaning has been passed on accurately if five types of equivalence are satisfied: Vocabulary, idiomatic, grammatical-syntactical, experiential, and conceptual equivalence.\textsuperscript{405}

As maintained by Tayeb, “language represents and expresses the culture, the value systems behind it. Not knowing this underlying culture can cause problems”\textsuperscript{406}. Hence, communication is not culture-free. It is influenced by a number of cultural factors. Systemic (e.g. ethnic, religious, moral, social) differences may act like impediments in discussions.\textsuperscript{407} In addition, the use of non-verbal forms of communication (gesture, eye contact, silence, facial expression, voice, stance, etc.) varies across cultures, so that unawareness of such differences can also lead to misapprehension.\textsuperscript{408} The same applies to all sorts of expressions that regularly accompany personal contact, such as humour at work, handshaking, dress code, business lunch, or the exchange of business cards.\textsuperscript{409,410}

The arguments developed here show that communication styles are deeply influenced by culture. Table 2.14 illustrates these findings by offering examples of communication patterns of four national cultures.

\begin{itemize}
\item \textsuperscript{405} Jandt (1995), pp. 109-114
\item \textsuperscript{406} Tayeb (2001), p. 103
\item \textsuperscript{407} Jahnke (1996), p. 83
\item \textsuperscript{408} Gesteland (1999), pp. 65-83
\item \textsuperscript{409} Mead (1992), p. 152-154
\item \textsuperscript{410} Mole (1995), p. 190
\end{itemize}
<table>
<thead>
<tr>
<th>Nationality</th>
<th>Communication patterns</th>
</tr>
</thead>
</table>
| **French**  | • Emphasis of eloquence, style  
               • Use of direct, rational, precise, and clear language  
               • Formality  
               • Unstructured nature of meetings (absence of agenda)  
               • Talkative  
               • Debate considered as a pleasure  
               • Logical argumentation  
               • Importance of personal relationship  
               • Frequent interruptions  
               • Lengthy written communication |
| **German**  | • Great concern with protocol and orderly meetings  
               • Seriousness and formality of business conversation  
               • Discussions based on real facts and sound information  
               • Attentive listeners  
               • Appreciation of precise language  
               • Focus on technical information |
| **Japanese** | • High context  
               • Respect of the interlocutor (in order to create harmony)  
               • Politeness  
               • Formality  
               • Attentive and disciplined listeners  
               • Never interrupt  
               • Careful pondering of answers  
               • Use of silence (as an indication of deep mutual trust) |
| **U.S.**    | • Regular use of humour, slogans, and catch phrases  
               • Use of clear, unambiguous and explicit language  
               • Like to get to the point  
               • Direct  
               • Particularly dislike boring speeches  
               • Tendency for exaggeration  
               • Spontaneous |

*Table 2.14: Communication patterns of selected national cultures*

2.4.3 Mutual understanding

Teamwork and communication are compulsory processes for attaining the team’s goals, but what makes the difference between ordinary and outstanding co-operation is a positive climate within the team. What this means in practice is that there ought to be a certain mutual understanding between the partners. Most important, such solidarity and trust must be voluntary and come straight from the team-mates’ hearts. In other words, the collaborators should respect and like each other, so they are willing to continue working together even after the project has been completed. The establishment of such a relationship of mutual consideration calls for a deep understanding of the team as a whole and of each of its members. Three measures contribute to building comprehension on a team level: leading diversity, controlling conflict and cultivating trust. Logically, these three managerial activities are strongly linked to the areas of team management and multicultural management (figure 2.22).

![Figure 2.22: Classification of mutual understanding](image)
2.4.3.1 Leading diversity

Govindarajan and Gupta found out that

“A broad treatment of the international dimensions of organizational behavior
[...] suggests that, although cross-cultural teams are necessary, the challenge of
managing diversity often renders them ineffective”411.

Conversely, it was shown in a prior section that diversity might well lead to outstanding results. Nevertheless, if team diversity is to be turned into an asset rather than a liability, such multiculturalism needs to be actively managed, since it is “the approach to diversity and not the diversity itself [that] determines the actual positive and negative outcomes”412.

“Unity through diversity”, Indonesia’s national motto,413 is an endeavour that can definitely be applied to multicultural R&D teams. The goal of the exercise, which consists in harmonising “the differences between cultures while preserving national cultural strengths”414, is a true tightrope walk because it requires a solution to the antagonism between social cohesion and cultural disparity. More than just developing a culturally sensitive management415, and being able to cope with different nationalities, the task also involves a targeted constitution of the crew (in terms of the cultures involved) as well as a thorough control of the diversity within the team. In addition, every single member of the group ought to be directed and coached in a professional and understanding manner. Therefore, as Christoph Maier emphasises416, it is much more appropriate to speak of leading rather than simply managing diversity.

As already mentioned, cultural variety leads to different scientific methods, assumptions, priorities, languages, communication patterns, reactions to conflict, team behaviour, and so on. All these topics have to be covered simultaneously. Accordingly, in order to reap the benefits of diverse teams, three imperative tasks need to be executed:

411 Govindarajan / Gupta (2001), p. 71
413 McDermott / Brawley / Waite (1998), p. 120
414 Hurn / Jenkins (2000), p. 129
416 Maier (2002)
comprehending the cultural dynamics that prevail in the team, valuing that diversity, and achieving synergy.

1) Comprehending cultural dynamics:

Being conscious of cultural differences and of the dynamics they generate is the foremost condition when leading diversity.\textsuperscript{417} The team members, the leader, and the people in charge of lining up R&D teams (i.e. those who decide on their constitution), should be aware of the fact that certain combinations of national cultures function better than others.\textsuperscript{418} Consequently, they should be aware of the distinguishing features of the various cultures involved and should identify potential areas of conflict. This does not mean, however, that they ought to be able to find the optimal match of cultures straight away. Still, familiarity with these points can be an effective way to avoid or at least reduce culture shocks induced by multicultural teams.\textsuperscript{419} In order to achieve recognition of differences, Nancy Adler recommends having the team members

“Describe the range of cultures present without initially interpreting or evaluating the nature of any particular culture. Team members should become aware of their stereotypes without allowing them to limit their expectations, understandings, and actions. Once they begin to recognize actual differences (to differentiate their stereotypes from the actual personality and behavior of group members – cultural descriptions), they should attempt to understand why the peoples from other cultures think, feel, and act the way they do (cultural interpretation).”\textsuperscript{420}

2) Valuing diversity:

Only recognising the advantages from diversity is not as valuable as when it is appreciated and promoted. Acknowledging the diversity of a team as a resource is a vital enabler when dealing with the issue.\textsuperscript{421} It involves communal efforts to celebrate, value, welcome, and support the differences among the team members.\textsuperscript{422} Moreover, the reciprocal respect of the uniqueness of every individual, as required by Schomer, is

\textsuperscript{417} Mole (1995), p. 225
\textsuperscript{418} Gassmann (2001), p. 93
\textsuperscript{419} Schreiber (1996), p. 463
\textsuperscript{420} Adler (1991), pp. 139-140
\textsuperscript{421} Prasad / Mills (1997), p. 4
only possible in an atmosphere of mutual tolerance. In the same line of thought, Richard Lewis expresses the necessity to develop empathy (in terms of “accepting differences and building on these in a positive manner”) as the final step towards achieving cultural harmony.

One absolute prerequisite for that is the cultivation of a geocentric attitude within the team and, as far as possible in the whole organisation. Geocentrism is widely considered as the ultimate stage in the evolution of the multinational corporation. It is characterised by a “think global, act local” philosophy accompanied by a great cultural sensibility. Geocentric firms orient themselves towards the entire world (as opposed to their own home-country, to a certain region, or to the host-countries of their affiliates) and respect the cultural similarities as well as the national differences across the corporation. They attempt to find an optimal mix of cultures and look for the best people, regardless of national culture, to solve their problems anywhere in the world. Such a geocentric stance can often be fostered and cemented by an appropriate structure (e.g. a network organisation allowing for active exchange of knowledge, resources, and employees) and strong values shared in every subsidiary on the globe.

3) Achieving synergy:

Recognising and valuing cultural differences is one thing. Being able to utilise them is another. As stated by Shaw and Barrett-Power, “difficulty in forming a cohesive unit will in turn influence the group’s ability to manage conflicts and develop group norms and goals.” Therefore, the main question at this stage is how to harness diversity so that optimal team cohesion can be attained and how to maximise the impact of that

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423 Schomer (2000)
424 Lewis (2000), p. 443
425 Geocentrism is a term that only makes sense when compared to its counterparts, ethnocentrism, polycentrism, and regiocentrism, which represent earlier stages in the evolution of the MNC. The four approaches are compared in Appendix D.
426 Perlmutter (1969), p. 96
428 Hilb (2000), pp. 73, 76, 99
429 Shaw / Barrett-Power (1998), p. 1314
diversity. The achievement of such cultural synergy\textsuperscript{430} is not a simple undertaking, and imposes a whole range of multicultural competences.\textsuperscript{431}

Smith and Berg assert that “multicultural groups must develop patterns of thinking that are the converse of what is typical when group members share the same cultural heritage.” As a result, teams should see to it that they use their differences instead of what they have in common.\textsuperscript{432} In view of that, “the key to gaining this advantage [of diversity] is to make sure that teams know how to capitalize on the resources that all team members bring with them”\textsuperscript{433}. Therefore, recognising and employing each member’s uniqueness is a fundamental factor for the success of diverse teams.\textsuperscript{434}

Cultural synergy, the result of this insight and of the attitude induced by it, thus allows a team to bring into play its best people and their specific cultures. This facilitates the creation of an atmosphere of openness and trust, stimulating exchanges between the single individual and the group. Such permeability, in turn, is necessary to enable them to solve problems creatively.\textsuperscript{435}

2.4.3.2 Controlling conflict

Conflict and diversity are two inseparable concepts. As shown in chapter 2.1.2.3, conflict is a direct cause of diversity. Different educational backgrounds or methods inevitably lead to dissimilar perceptions, perspectives or ideas, which can generate frictions between people. Still, conflict should not be equated with confrontation, nor should it be considered as the “downside” of diversity. Leonard and Swap suggest that dissent and divergent thinking should be encouraged as a way to trigger creativity.\textsuperscript{436} Several other authors agree that conflict is necessary and that it may have quite positive effects.\textsuperscript{437,438,439} Tensions can indeed be turned into positive energy, when handled accu-

\begin{footnotesize}
\textsuperscript{430} Adler (1991), p. 105
\textsuperscript{431} Iles (1995), p. 55
\textsuperscript{432} Smith / Berg (1997), p. 8
\textsuperscript{433} McLeod / Lobel (1996)
\textsuperscript{434} Mink / Mink / Owen (1990), pp. 114-124
\textsuperscript{435} Preston / Armstrong (1991), p. 66
\textsuperscript{436} Leonard / Swap (1999), pp. 62, 146
\textsuperscript{437} Katzenbach / Smith (1993b), p. 110
\textsuperscript{438} O’Connor (1994), p. 32
\textsuperscript{439} Graham (1991), p. 92
\end{footnotesize}
rately.\textsuperscript{440} For this reason, conflict should be encouraged instead of repressed; as long as it does not have ethnocentrism, prejudice\textsuperscript{441}, or discrimination for its object.

The expression of “settling” or “resolving” conflict is somewhat erroneous. Those measures only make sense when the conflict has irreversibly turned into an unconstructive dispute (i.e. dysfunctional conflict). At this stage, the damage has already been done.\textsuperscript{442} Teams are much better off when tensions are recognised early, examined and dealt with effectively.\textsuperscript{443} Therefore, it is much more appropriate to speak of “controlling” conflict\textsuperscript{444}, in terms of monitoring, co-ordinating, regulating,\textsuperscript{445} and integrating\textsuperscript{446} the differences and disagreements between team-mates.

This section explores two measures designed to transform the natural divergences inherent to multicultural R&D team into controlled conflict in order to release the energy within them. These are the reduction of cultural barriers (responsible for dysfunctional conflict) and the development and pursuit of common goals.

1) Reduce barriers:

More often than not, dysfunctional conflict is attributable to communication barriers, such as anxiety, the assumption of similarity instead of difference, ethnocentrism,\textsuperscript{447} or contradictory basic beliefs about religion, ethics, politics, or technology.\textsuperscript{448} In addition, the meaning of and the attitude towards conflict themselves vary across cultures.\textsuperscript{449} Explicitly, a society’s tolerance of dispute is influenced by its score on the power distance and the uncertainty avoidance scales. For instance, large power distance cultures consider latent conflict between ranks as normal, while small power distance indicates a certain appreciation of harmony between the powerful and the powerless.

\textsuperscript{440} Davison (1994), p. 88
\textsuperscript{441} Ethnocentrism indicates “a view of things in which one’s own group as the center of everything and all others are scaled and rated with reference to it. Prejudice denotes “the judging of other groups as inferior to one’s own.” (Adler (1991), p. 140)
\textsuperscript{442} Wahren / Scheyrer (1996), pp. 107-108
\textsuperscript{443} Kaltenborn, interview, 10.04.02
\textsuperscript{444} Kilduff / Angelmar / Mehra (1999), p. 24
\textsuperscript{445} Smith / Berg (1997), p. 11
\textsuperscript{446} Graham (1991), p. 77
\textsuperscript{447} Jandt (1995), pp. 39-43
\textsuperscript{448} Jahnke (1996), pp. 83
\textsuperscript{449} Böning (2000), pp. 239-242
Likewise, societies with high uncertainty avoidance tend to reject organisational conflict as undesirable and show a low readiness to negotiate with opponents. On the other hand, high uncertainty avoidance cultures regard conflict as natural, approve competition between employees, and are characterised by a greater willingness to compromise with rivals.\textsuperscript{450}

Lowering such barriers can be a first step in controlling conflict by easing the contact between the associates and making them focus on the more substantial issues of their co-operation. Starting points for the reduction of conflict potential include the following:\textsuperscript{451}

- Renouncement or avoidance of excessively fierce intra-organisational or intra-team competition;
- Enhancement of the information flow in respect of quantity and quality;
- Improvement of the communication within and between teams;
- Enhancement of the overall communication climate.

2) Setting shared goals:

Imbalance – whatever the form (subgroup dominance, member exclusion, etc.) – always brings about undesirable outcomes.\textsuperscript{452} Conversely, tensions and polarities are crucial for the creative process.\textsuperscript{453} Therefore a balance between harmony and conflict\textsuperscript{454} should be developed so that the team attains enough momentum to realise its purposes. In this regard, goals play a vital role for they provide not only a point at which the team can aim, but constitute an essential catalyst for its integration. Indeed, setting (realistic) objectives instils into the group a win-win orientation and helps its members to focus on what they have in common rather than on what separates them.\textsuperscript{455,456} With shared visions and targets, individuals become conscious that they can only be

\textsuperscript{450} Mead (1994), p. 228
\textsuperscript{451} Wahren / Scheyrer (1996), p. 109
\textsuperscript{452} Snow / Davison (1996)
\textsuperscript{453} Pelz (1967), p. 37
\textsuperscript{454} Pirinen (2000), p. 93
\textsuperscript{455} Jain / Triandis (1990), pp. 144, 147
\textsuperscript{456} Katzenbach / Smith (1993a), p. 114
successful personally when their colleagues are also successful. Like that, they find themselves bound together in their collaborative pursuit, motivated to help their fellows perform effectively.\footnote{Yeatts / Hyten (1998), p. 93}

2.4.3.3 Cultivating trust

The third core building block in the development of mutual understanding in multicultural R&D teams is the cultivation of trust.\footnote{Cf. also section 2.1.2.4}

“Trust is a critical component to the whole concept of teams.”\footnote{Natale / Libertella / Rothschild (1995)}

“Whatever the reasons for project collaboration, high trust levels are a factor that makes collaborative ventures successful and profitable.”\footnote{Herzog (2001), p. 28}

“Building up mutual trust […] is of central importance. Trust is especially significant in development projects, where uncertain information and wild ideas have to be brought in at an early stage.”\footnote{Gassmann (2001), p. 94}

“In exchange relationships, where a party’s outcomes depend on the behavior and intent of the exchange partner, trust is particularly crucial. Without trust, the objectives or outcomes of the exchange are in constant and chronic jeopardy. The incentive for exchange would be absent. Without some level of trust much exchange would not happen.”\footnote{Johnson / Cullen (2002), p. 335}

Although scholars vary in their arguments, their message remains the same: Trust is an essential element for the well functioning of any form of collaboration. Pirinen defines trust as a

“Belief that another person makes efforts to behave according to any explicit or implicit commitment, is honest, and does not take advantage of another person even if the opportunity is at hand. Trusting is believing in the good intentions of

\footnote{Yeatts / Hyten (1998), p. 93}  
\footnote{Cf. also section 2.1.2.4}  
\footnote{Natale / Libertella / Rothschild (1995)}  
\footnote{Herzog (2001), p. 28}  
\footnote{Gassmann (2001), p. 94}  
\footnote{Johnson / Cullen (2002), p. 335}
partners, their competencies and skills, their reliability, and their perceived openness."463

Furthermore, trust is manifested in values such as credibility, benevolence, truthfulness, loyalty, consistency, open communication, mutual supportiveness, tolerance, dignity, clarity, care, fairness, discretion, and so forth.464,465,466,467,468,469 As a result, trust enables a team to work through problems and enhances an organisation’s aptitude to deal with diversity and complexity,470 and to stand firm in adverse times471. Moreover, trust is assumed to make team members focus on their work, and worry less about what their fellows do and think. People who have faith in one another are more likely to ask for help or to let colleagues execute certain tasks.472 Then, reliance may have a conflict preventing effect, because it decreases uncertainty, improves communication, enhances relationships and promotes co-operation.473

For those reasons, it should be a prime undertaking of multicultural R&D teams to build trust as a means of overcoming barriers of geography, language and culture.474 Several hurdles render the process of installing mutual confidence difficult: First of all, trust is definitely not something that people grant easily. Rather, it must be earned.475 So ideally, every “trustee” should first supply proof of his trustworthiness to his “trustors”. However, this is not always possible as every trustee has different attributes, which will probably not please all trustors at the same time. Therefore, developing trust on a collective scale is far more a complicated endeavour than in the case of dyadic relationships.476 Multiculturalism adds an extra dimension to the problem, because

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463 Pirinen (2000), p. 96
466 Harkins (1999), p. 98
467 Jarvenpaa / Knoll / Leidner (1998), p. 31
468 Shaw / Barrett-Power (1998), p. 1310
469 Johnson / Cullen (2002), p. 342
470 Pirinen (2000), p. 97
471 Earley / Gibson (2002), p. 115
472 Yeatts / Hyten (1998), p. 102
473 Stüdlein (1997), p. 355
475 Stüdlein (1997), p. 356
476 Jarvenpaa / Knoll / Leidner (1998), p. 31
every culture varies widely in the ways its representatives establish and cope with trust. Consequently, the issue should be handled with great care. Particular emphasis should be laid on the avoidance of ethnocentric beliefs, such as those determining which kind of behaviour encourages trust and which obstructs it. For example, keeping intense eye contact with one’s interlocutor may be a sign of reliance in some cultures (e.g. Arab cultures), while it is considered as absolutely out of place in others (e.g. Japanese culture). Other “trust killers”, such as the interruption of a person who is speaking (e.g. in the U.S.), are quite normal in other societies (such as the French). Hence, in order to avoid any misunderstandings, trust development measures ought to be kept as universal as possible: Training intercultural skills, frequent face-to-face meetings, fostering inter-personal familiarity, and the display of trust-signalling symbols are classical measures in the establishment of reciprocal faith. Then, according to some authors, one excellent starting point for trust lies in the cultivation of an open and honest communication climate. Other frequently employed approaches to infuse trust in global teams include proactive orientations, optimistic and dynamic demeanour, positive tone, rotating leadership, task goal clarity, intense interaction, role division, and regular feedback.

Likewise, there are various personal and interpersonal attitudes that have been found to play a significant role in the formation of trust between people. These are: respect, commitment, cohesion, team spirit, and empathy.

1) Respect:

Respect prompts trust by stimulating the collaborators. It motivates them to succeed, making them confident of their role in the team. If the leader fails to show his asso-

477 Stüdlein (1997), p. 141
479 Bird (2000)
480 Cf. for example Mink / Mink / Owen (1990), p. 65
481 Stüdlein (1997), p. 355
482 Govindarajan / Gupta (2001), pp. 69-70
484 Herzog (2001), p. 32
485 Jarvenpaa / Leidner (1999), pp. 806-807
486 Jarvenpaa / Knoll / Leidner (1998), pp. 52-57
ciates that he respects them, they are likely to return his disregard and not trust him. If the organisation is to attain its objectives, partners ought to think of their interests as being parallel to those of their boss.\footnote{Humphrey (1987), p. 26} This requirement for reciprocal consideration is not limited to the relationship between the leader and his subordinates; it also concerns the team as a whole. Mutual respect, in particular for other colleagues’ culture and origins, is an important agent for the well functioning of groups, because it helps to reduce barriers such as prejudice, ethnocentrism or discrimination.\footnote{Adler (1991), p. 140} \footnote{Chevrier (1996), p. 9}

2) Commitment:

Commitment has already been mentioned as an integral part of teams\footnote{Cf. section 1.2.1}. As such, it also constitutes a basic ingredient for their productivity. To put it simply, “the act of keeping a commitment builds trust; the act of breaking a commitment reduces trust”\footnote{Harkins (1999), p. 103}. Then, for Katzenbach and Smith, the orientation towards a shared goal (another key element in the definition of teams) gives rise commitment and trust. They argue that teams that have a clear-cut common goal automatically feel responsible for their own performance. Members, both as individuals and as a team, develop a sense of mutual accountability. This experience seems to have an energising and motivating effect on team members.\footnote{Katzenbach / Smith (1993a), p. 116} \footnote{Katzenbach / Smith (1993b), p. 92} Moreover, the same authors assert that commitment has the potential to transcend the team in the sense that each member is profoundly dedicated to his co-workers’ personal growth and success.\footnote{Katzenbach / Smith (1993a), p. 116} \footnote{Katzenbach / Smith (1993b), p. 92}

3) Cohesion:

Cohesion, i.e. the force that causes the team to hold together, has been identified by several authors as a major feature of effective teamwork.\footnote{Moran / Harris / Stripp (1993), p. 69} By creating a certain unity between the partners, and by pulling them together, cohesion affects the people
in such a way that they stay within the team. Yeatts and Hyten distinguish between task-oriented (which stems from a common concern for and focus on the team’s task) and team-oriented cohesiveness (is more founded on the mutual attraction of the teammates themselves). Still, both forms involve fundamental rules and core values that are shared by all members, and which guarantee the consistency required to make the collaborators feel attracted to their team and compelled to stick with it.

4) Team spirit:

Team spirit can be described as a feeling of togetherness and solidarity that emerges in the course of the development of the team. It can only be achieved by its members altogether. Team spirit goes hand-in-hand with cohesion, but it supplements it with an additional side, which is collective identity. Shaping such an identity requires special efforts, but the investment is worth making, as it triggers special emotions that are valuable for co-operation, such as camaraderie or the sentiment of “being all in the same boat”. Such a mind-set leaves people moving together and provides the team with the drive and the energy to attain its targets.

5) Caring:

The significance of solidarity for teams has just been mentioned in the previous paragraph. But solidarity (that is, a unanimous action based on shared concerns) is not enough, as it is purely anchored in a common interest. What is even more worthy is collective care. A caring individual will most of the time be trusted by the person who benefits from this care. So care is an important vehicle for trust. Care goes further than just helping one another at the workplace, or prioritising the team over oneself. Caring is something that is situated much deeper in the mind and the heart. It is

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496 Högl (1998), p. 83
498 Cf. section 2.4.1.3
499 Schneider (1996), p. 107
500 Pirinen (2000), p. 203
503 Högl (1998), pp. 80-81
504 Thompson (1996)
about being intrinsically nice, altruism, sharing, etc.\textsuperscript{505-506} One concept inseparable from care is empathy, the “ability to see the world through other people’s eyes”\textsuperscript{507}. By listening actively, adopting helpful behaviour, being open-minded towards collaborators’ feelings, understanding what they go through, the empathic person sends explicit signals of spiritual kinship, thereby offering a basis for trustworthiness.\textsuperscript{508,509}

These five attitudes (respect, commitment, cohesion, team spirit, caring) are closely intertwined. They represent universal values and stand for righteousness, harmony, and decency. Nonetheless, each of them has its own downsides: For instance, too much cohesion (and consequently too much trust) can lead to groupthink, a rather harmful phenomenon for teamwork.\textsuperscript{510} Therefore their pursuit and application should always be taken with a big pinch of salt.

\textbf{2.5 Implications}

\textbf{2.5.1. Defining the success of multicultural R&D teams}

Before the factors explaining the success of multicultural R&D are to be identified, explored, dissected (empirical part), and related to each other (chapter on the construction of the theoretical model), it is necessary first to explain what “success” of R&D teams really means. For the present purposes, success shall be defined as the simultaneous achievement of high scientific performance on the one hand, and high team performance on the other. Conversely, any teamwork leading to low scientific and team performances can be considered as a failure. R&D teams which are high on scientific performance but have a low score in team performance, must have a collaborating malfunction. Likewise, teams which attain a high score on team performance, but a low one on scientific performance display a certain operating malfunction, since they do not deliver what they are expected to accomplish (figure 2.23).

\textsuperscript{505} Pirinen (2000), p. 287
\textsuperscript{506} von Krogh / Ichijo / Nonaka (2000), pp. 45-49
\textsuperscript{507} Fatehi / De Silva (1996), p. 204
\textsuperscript{508} von Krogh (1998), pp. 137-138
\textsuperscript{509} von Krogh / Ichijo / Nonaka (2000), pp. 50-51
\textsuperscript{510} Högl (1998), pp. 83-84
2.5.1.1 Scientific performance

Appraising the productivity of scientists and engineers is quite a complicated endeavour. Measures such as the R&D intensity, the ratio of R&D spending to sales or the ratio of current annual sales of new products to total annual sales, may provide an idea about the R&D activities of a company. However, they do not show the actual outcomes of R&D teams’ creative or intellectual work. Then again, those ordinary R&D productivity procedures are criticised for their subjectivity, their “bean counting” character, and their deficiency concerning the comparison of different teams or disciplines (such as research and development).

Because of the serendipitous character of invention and knowledge creation, usually only the final outputs of R&D activities can be measured. Such outputs, which are not always material (processes, theories, ideas, scientific proofs, etc.), are made more or less tangible via publications or patents. Yet, such certificates do not really make the evaluation procedure easier, because they fail to attest to the production’s quality.

While the criteria for granting a patent include the evidence of non-triviality (confir-
med by a skilled practitioner of the relevant technology) and usefulness (in terms of commercial value) of the invention, such a licence establishing intellectual property does nothing more than awarding its originator a temporary monopoly for commercial application of an innovative device. Although it provides access to newly created knowledge by making it public and available, the patent itself does not reveal anything about the level of “basicness” or applicability of the discoveries.\textsuperscript{513} Moreover, emphasising patents as the sole measurement of scientific performance presents the following drawbacks:\textsuperscript{514-515,516}

- Given that not all ideas are patented, patent statistics cannot possibly cover all inventive activity;
- The propensity for filing and holding patents differ according to industrial branches and depend on firms’ sizes;
- Many patents are filed and held for strategic purposes only;
- The quality of patents is heterogeneous;
- Patent laws differ among countries;
- Patents merely suggest the promise of commercial success, but do not guarantee it.

Patent citation statistics are much more adequate, given that they indicate how often existing patents have been employed to generate subsequent technological development. So the more a patent is being cited in other patents, the higher its scientific significance and its fundamental character.

Publications in scientific journals are habitually used to evaluate the output of basic research. As a matter of fact, bibliometric analyses, which are founded on the principle that scientific progress is based on the exchange of research findings, and that a scientist’s production is best indicated by the number of papers he has published, are still the most widely utilised technique in the assessment of R&D activities. Therefore, journals are not only the prime channels for formal information exchange within

\textsuperscript{513} Trajtenberg / Henderson / Jaffe (1992), p. 7
\textsuperscript{514} Schmied (1995), p. 11
\textsuperscript{515} Ettlie (2000), p. 135
\textsuperscript{516} Trajtenberg / Henderson / Jaffe (1992), p. 8
scientific communities, but constitute an essential instrument in a scientist’s claim for intellectual property. Accordingly, the more publications he has, the greater his alleged contribution to knowledge and the better his reputation. The same applies to citations in papers, which play an analogous function to patents. In this case, however, the quality, the influence and the importance of the journal represent an additional determinant of the value of a paper and its author.\textsuperscript{517} But, as for patents, these approaches have several shortcomings:\textsuperscript{518,519,520}

- The quantity of publications is not a valid indicator for the quality of the knowledge contained in them;
- Publications vary a lot in the creativity of their contribution and the impact they may have on further research;
- Citation indices typically consider only English-language journals;
- Industrial R&D imposes secrecy, which leads to considerable delays in the publication of newly created knowledge (if published at all);
- Citing a paper does not necessarily imply that the citing author appreciates it positively, as it may be quoted in order to reveal some errors;
- Bibliometric analyses tend to encourage “publicomania”, auto-citations, or citations by friends and colleagues.

Finally, neither patents nor papers provide any indication about how much an invention cost, and how long it took to find it in the first place, i.e. elements which can be extremely important in an industrial context. Similarly, decisive factors of research work, such as the degree of novelty, ecological and social compatibility, intrinsic scientific quality, originality, feasibility, difficulty, usefulness, elegance and economy,\textsuperscript{521} etc. are not displayed by the tools presented here. Therefore, evaluating the scientific performance of individuals, teams, or entire laboratories should always take

\textsuperscript{517} Schmied (1995), pp. 6-7
\textsuperscript{518} Peyraube (2001), p. 37
\textsuperscript{519} Kumm (1995), pp. 193-194
\textsuperscript{520} Schmied (1995), pp. 7-8
\textsuperscript{521} Schmied (1995) pp. 57-62
into account quantitative as well as qualitative aspects, be it for basic research, applied research, or experimental development.

Table 2.15 provides a list of performance measures for different types of research:

<table>
<thead>
<tr>
<th>Type of research</th>
<th>Public</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of measure</td>
<td>Objective</td>
<td>Subjective</td>
</tr>
<tr>
<td>For individuals</td>
<td>- Number of: - Papers - Books - Citations - Professional awards - Powerful positions held - Professorship offers - Collaborators reporting to him - Projects headed</td>
<td>- Prestige ranking by peers - Frequency of positive appraisals expressed by a dense network of relations</td>
</tr>
<tr>
<td>For teams, groups, or companies</td>
<td>- Sum of the output of its members and their prestige - Quantity and value of equipment owned - Wealth of infrastructure owned - Quality and prestige of the leader - Number of graduate students - Number of visitors</td>
<td>- Frequency of positive appraisals expressed by a dense network of relations</td>
</tr>
</tbody>
</table>

*Table 2.15: A classification of performance measures*

(Source: Schmied (1995), p. 54)
2.5.1.2 Team performance

The measurement of team performance is no less problematic. Here, the multicultural dimension plays a much more important role, as the collaboration is exposed to the appraisal of every single team member and possibly also by some external party. Besides, the evaluation of teams and co-operation may itself vary across cultures. Therefore, the definition of team performance needs to be kept as broad as possible. Quite straightforwardly, an effective team is one that simultaneously exhibits high task effectiveness and high relational effectiveness.522,523

- A team is **task effective** when it meets the objectives it has fixed itself, and when it complies with the standards of quality and quantity established by its superintending unit;

- **Relational effectiveness** refers to the ability of a team to accomplish its tasks while maintaining a good relationship between the partners. The attainment of its goals should not happen at the expense of a co-operative and productive climate within the group, nor should it put at stake the prospect of long-term rapports between its members. In other words, a team is relationally effective, if the people are willing to collaborate again with exactly the same squad.

2.5.2 The six C’s for success

This section will single out a limited number of factors, with which the success of multicultural R&D may be explained. Derived from what has been explored and evaluated so far, six such factors emerge as the most promising ones. As they all begin with a “C”, they will be dubbed as the “six C’s”. These are:

- The **composition** of multicultural teams;

- The **connection** between the individual group members;

- The balance between cooperation and competition (i.e. the level of co-opetition524) within the team;

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522 Oetzel / Bolton-Oetzel (1997)
523 Kaltenborn, interview, 10.04.02
524 As coined by Hilb (2002), p. 52
• **Conversation**;

• **Captaining** (in the sense of sensitive leadership);

• And the **chemistry** among the colleagues.

In the following, the six factors will be described and scrutinised. But at this stage there is no intent to establish relationships between those elements or to develop any theoretical model.\(^{525}\) Therefore, the sequence of the points to be analysed has been chosen arbitrarily. Then, all the assertions made here are derived from what has been mentioned so far. No new premises will be made, and no theory added.

### 2.5.2.1 Composition

“Composition” here refers principally to the cultural arrangement of the team, i.e. to the question of the representation of different cultures in the squad. In fact, composition can be considered as a decisive factor for the success of multicultural R&D teams for several reasons. The sections dealing with diversity showed that multiculturalism, if properly managed, may bring about substantial benefits in terms of creativity, innovativeness and efficiency. Differing educational and cultural backgrounds generate dissimilar ideas and perspectives, a variety that can be enriching for teamwork on the whole. Then, societies (or their representatives) seem to have traits and competences that can render them particularly proficient in given tasks. For that reason, the very combination of cultures may have an influence on the overall performance or success of teams. Also, there must be something like an optimal constitution, determined by the level of heterogeneity, the cultural distance between the people involved, the specific comparative advantage of each culture, etc.

Therefore, the discussion revolves around the question of how to mix the cultures in order to maximise the positive effects and minimise the drawbacks of diversity. Answering this question necessitates an analysis of the cultures that are present in the organisation (i.e. those cultures available when composing the team), finding out where the competitive advantages of each nationality lie, determining complementari-

\(^{525}\) This will only be possible after the empirical study, if at all. Indeed, the latter has the purpose to add some substance to the present insights. Nevertheless, these considerations will constitute the foundation of the fieldwork.
ties, etc. Furthermore, other issues related to composition as a success factor include for instance the intentional formation and the dominance of specific cultural clusters.

Although national culture lies at the heart of the debate, it should not be overlooked that professional or functional culture may perhaps play an important role in the composition of high performing multicultural R&D teams as well.

2.5.2.2 Connection

Just like composition, “connection” is a structural issue, since it relates to the general configuration of the team. However, it concerns more topics like roles and relationships within groups than their general line-up. In this context, the word connection implies that there are strong bonds between the partners. These bonds are formed through intense collaboration, which welds the members together, transforming an assembly of individuals into a true team. As repeated throughout the theoretical part, teams require clear common goals to respond to their vocation. Indeed the very definition of a team calls for “a common purpose” and “a common approach”.526 A sound system, stabilising the roles and responsibilities of each partner, can provide both elements by reducing the confusion that may arise because of cultural diversity.

Hence, connection facilitates the correct completion of the assignment by ensuring that all co-workers join forces and by making them feel that they are all in the same boat. And while connection is above all about the correct distribution of tasks within the team, it also embraces questions such as the arrangement of teams (within and between them), hierarchy, the establishment of formal and informal collaboration arenas, communication channels, face-to-face contact, etc. And here again, the objective is to find an optimum degree of connection.

2.5.2.3 Co-opetition

The third factor in line is “co-opetition”. This neologism is made of two rather contradictory elements, co-operation and competition. While there is an obvious inconsistency between these two types of behaviour, they are both necessary for the well functioning of the group. On the one hand, co-operation is the essence of team-

526 Cf. section 1.2.1
work, because it is the act by which several people perform together. It holds an idea of constructive rapports and positive atmosphere between the partners. Competition, on the other hand, denotes a certain rivalry between the contenders, a rivalry that can be valuable or detrimental for the collaboration. The outcome depends on whether that conflict is beneficial or dysfunctional. For example, a conflict is beneficial when it is the result of diverging experiences and perspectives, inducing the participants to exchange their ideas and proposals, which can lead to various solutions.

Co-opetition entails confronting diverging opinions. Ideally, it should not be related to personal relationships at all. Co-opeting researchers help one another, share data, documentation, knowledge, but do not let destructive emotions gain the upper hand. When controlled, conflict can even contribute to coherence in the team. Conversely, an inaccurately struck balance between co-operation and competition can easily destroy relationships and destroy a team by nurturing harmful attitudes such as secrecy, harassment, jealousy or even enmity.

Co-opetition is probably the most crucial element of all, because it gives the collaboration its true shape. As such, it ultimately determines the intensity and the quality of the knowledge co-creation process within multicultural R&D teams, and thus has a decisive impact on their success.

2.5.2.4 Conversation

“Conversation” is an eminently important ingredient for teamwork, especially in R&D. In this regard, the multicultural dimension as such is not a main determinant, as it is in the other five C’s. Indeed, conversing in a multicultural context is obviously more difficult than in a monocultural one, since multiculturalism often goes hand in hand with different languages. Nor is language itself the only problem. Even when using a lingua franca or focussing on technical jargon, people from different countries can encounter difficulties when they speak to one another: Imbalances in language fluency, incompatible talking and listening behaviour, understanding of context, differences in the use of communication channels, and so forth, are only a few examples of possible barriers that can cause serious misunderstandings.
The term “conversation” was chosen over “communication” in order to accentuate the required proactive character of the procedure. In effect, conversation can involve an intense exchange of information and data, but it also implies the revelation of rather intangible contents, such as impressions or feelings. Furthermore, conversation allows participants to impart implicit knowledge, via analogies and metaphors. At one stage in the theoretical part, it was mentioned that knowledge creation necessitates the management of conversation.\textsuperscript{527}

The rationale behind choosing conversation as a main success factor is quite straightforward. Not only does it represent the means by which researchers accomplish their task; it also contributes to bringing them together, hence creating a pleasant and friendly working environment.

2.5.2.5 Captaining

The term “captain” comes from Latin \textit{caput}, i.e. head. In the original sense, the captain is a military or naval chief. With time, the expression has acquired other meanings, including that of a person having authority over others in a sports team. In this context, the captain is less a commander than a \textit{primus inter pares}, orchestrating the group’s actions. He does not give orders, but instils the R&D team its scientific direction. He is the one who stimulates the formation of mutual understanding by leading diversity, controlling conflict, and moulding the group’s common values. Furthermore, he is somebody who is concerned with the well-being of his subordinates, providing them with the necessary conditions for their development. He is somebody who cares for his people and the organisation.\textsuperscript{528}

So “captaining” stands more for affective purposes than simply technical tasks. It reflects all the human aspects of teamwork. But the function does not necessarily need to be concentrated in the hand of one single person. On the contrary, the task should be inherent to the team as a whole, exactly as it is in the case of the other five success factors. Like that, smoothing out disagreements, encouraging participation, nurturing

\textsuperscript{527} Cf. section 2.4.2.2

\textsuperscript{528} In the sense of von Krogh (1998), cf. section 2.4.3.3
teamwork and interaction\textsuperscript{529}, deciding, motivating one another, etc. becomes a collective undertaking. United captaining is fundamental for the accomplishment of multicultural R&D teams, because it simultaneously serves as the controlling entity for the team and embodies the device by which it gets its own drive.

2.5.2.6 Chemistry

“Chemistry” is probably the most intangible of the six factors. It stands for all the ingredients contributing to the cohesion within the team. While connection unifies the “hard” components of the combination process, chemistry encompasses the “soft” ones. It adds a personal touch to the relationships between the partners (whereas connection focuses on purely professional contact) and brings them together by forming strong emotional bonds between them.

As opposed to the other five success factors, chemistry is likely to influence exclusively team performance, but not scientific performance. Actually, it is the main medium for the development and the preservation of relational effectiveness. Sound chemistry in the group generates the common standards and ideals necessary to make collaborators feel that they are a part of it. It inspires the confidence and the willingness to do one’s best. As such, it represents a critical factor because it ensures that team members are committed and loyal. Furthermore, chemistry fosters values such as recognition, respect, compassion, mutual consideration, connivance, team spirit, and so on. In the chapters mentioning the relational aspects of teamwork, these values have over and over again been praised as crucial for collaboration to flourish. Finally, however, to guarantee the success of a team, these principles need to be embodied in the people themselves. Chemistry does exactly that by producing the right mindset.

2.5.2.7 Indicators

The opening of this section introduced the 6 C’s as variables explaining the success of multicultural R&D teams. As such, they entail specific indicators to be exposed and tracked. Table 2.16 catalogues a number of such markers. For each of the six success factors, the indicators have been chosen in a way that they complement one another, so

\textsuperscript{529} As defined and dealt with in section 2.4.1
that they form a cohesive, self-contained unity. The existence or the measure of the different indicators should reveal whether the team complies with the relevant factor.

Nevertheless, the items listed here are not entirely ready-for-use, in the sense that they require further operationalisation to be surveyed. In fact, it is up to the reader to customise them to his needs and to the context in which he wishes to apply them.
<table>
<thead>
<tr>
<th>Success Factor</th>
<th>Indicators</th>
</tr>
</thead>
</table>
| Composition    | • Cultural distance between the team members’ nationalities  
                 • Level of diversity of experience, education, approaches, etc.  
                 • Cultural mix (in terms of cultural combination, compatibility, complementarity, etc.)  
                 • (Non-)existence of cultural clusters within the team |
| Connection     | • Size of the team  
                 • Physical distance between team members  
                 • Efficiency of the co-ordination of tasks  
                 • Clarity and tangibility of objectives  
                 • Frequency of personal contact between team members  
                 • Appropriateness of team structure and hierarchy  
                 • Expediency of decision making process |
| Co-opetition   | • Adequacy of co-operation intensity  
                 • Adequacy of competition intensity  
                 • Stability of roles and responsibility  
                 • Constructiveness, frequency, and quality of debate  
                 • Level of team members’ participation  
                 • Fairness of the appraisal of team members’ contribution  
                 • Quality of information and knowledge flow  
                 • Quality of dispute resolution |
| Conversation   | • Intensity of communication  
                 • Existence of a lingua franca  
                 • Overall language fluency within the team  
                 • Richness of the language within the team  
                 • Compatibility of communication behaviours and channels  
                 • Duality of communication content (technical and emotional) |
| Captaining     | • Fairness of the team leader’s selection process  
                 • Adequacy of conflict control  
                 • Degree of power concentration  
                 • Effectiveness of the co-ordination of team members  
                 • Level of motivation within the team  
                 • Lenience of the team leader |
| Chemistry      | • Mutual respect among team members  
                 • Commitment within the team  
                 • Strength of the team spirit  
                 • Level of cohesion  
                 • Quality of the atmosphere  
                 • Emotionality of relationships  
                 • Richness of the environment within and around the team |

*Table 2.16: Indicators for the 6 C’s*
3 Empirical part

3.1 Objectives

The aim of the empirical part of the dissertation is to explore the six factors identified previously. These determinants are the basis for the fieldwork, which is designed to elucidate and differentiate them. Every single element shall be looked at in detail so that the concept of multicultural R&D teams’ success can be refined. The objective is to iteratively generate new insights, questions and propositions about the sound functioning of such teams. Moreover, the field study aims at establishing relationships between the main factors and sub-factors observed in the process. At the same time, the examination is expected to disclose how successful teams operate, thus offering best practice examples of the matter.

Before the case study is presented, the research approach needs to be outlined briefly. This section justifies why the case study method has been chosen for the empirical part. It also shows which types of case study analysis in particular will be employed. Then follows a presentation of the different parameters (target group, operating conditions). This introductory section closes with a description of how the data necessary for the case study have been retrieved.

Questions to be answered are the following:

- Are the six factors really relevant for the explanation of multicultural R&D teams’ success?
- How do they relate to each other?
- What are the sub-factors acting as catalysts between the major six building blocks?

In these terms, the investigation will be judged successful if it provides additional substance on the factors. Nevertheless, the material has to be concrete enough to be relevant for theoretical and practical purposes. From the theoretical perspective, the data has to enable the researcher to establish relations between the factors and develop a pattern interlinking them in some way. Likewise, the exploration will be deemed a hit,
if the information generated can be transformed into specific, tangible, and workable advice for the management of multicultural R&D teams.

### 3.2 Configuration of the fieldwork

#### 3.2.1 Research strategy

Prior to deciding which empirical research approach to use, one must be aware of the requirements ruling the realisation of such studies. For instance, the academic community has identified a number of criteria intended to establish the appropriateness of the method for the purposes stated. These criteria are the following:\(^{530,531}\)

- **Construct validity**: Does the method establish correct operational measures for the concepts being explored? In other words, does the instrument measure what it is supposed to measure?

- **Internal validity**: Does the established causal relationship between two variables or constructs really result from the believed conditions?\(^{532}\)

- **External validity**: Can the study’s findings be generalised?

- **Reliability**: Can the operations (e.g. data collection) of the study be repeated, and would a later investigation in identical conditions bring about the same results?

Meeting those requirements is made all the more difficult considering the multicultural character of the investigation. Indeed, the fact that people have different cultural backgrounds increases the richness of the context, thus making the analysis much more difficult to carry out. Furthermore, difficulties typically linked to the assessment of cultures or culture related topics include ethnocentrism, language and translation, the matching of the samples, or the consideration of modal and marginal phenomena.\(^{533}\)

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\(^{530}\) Yin (1994), p. 33
\(^{531}\) Black (1999), p. 35
\(^{532}\) This measure is only relevant for explanatory and causal studies. As is going to be revealed in the following, the present research has a rather exploratory character. Therefore, the internal validity test will not be treated further.

\(^{533}\) Hofstede (1980), pp. 31-40
3.2.1.1 Qualitative approach

First, the instrument should capture data about a wide array of items including work environment, strategies, social structures, scientific activities, knowledge creation processes, ways of thinking, events, perspectives, interpersonal relationships, leadership, and so on. Such issues, however, ought to be described in words rather than with figures. Accordingly, the approach is going to be a qualitative (as opposed to quantitative) one. The advantages of this strategy are quite straightforward. First, it is far more appropriate to describe verbally such intangible and complex matters as conflict, teamwork, trust, or cohesion. Then, what need to be described in the present empirical study are mainly the experiences of people involved in multicultural R&D teamwork. Therefore, the purpose of the enquiry is to understand the phenomena listed above from their own perspective rather than that of the investigator. In qualitative enquiries, the research objects get the chance to explain their impressions and concerns. Besides this, several other contextual elements, such as team specific meanings, mechanisms, or stories can only be revealed by qualitative methods. Put differently, such instruments offer a deep insight and enable the investigator to understand how the different elements relate to one another. But qualitative data are not only a source of well-grounded, abundant descriptions and narratives. They may also be used as a means to determine which events have led to which consequences and to derive plausible explanations for them. Finally, they are likely to produce serendipitous findings and new integrations by forcing the researcher to go beyond his preconceptions.\footnote{Miles / Huberman (1994), p. 1}

However, qualitative approaches also have clear limitations. The main weakness of this method is the high probability of researcher bias. As a matter of fact, the investigator is the person who does not only retrieve the data, but who also codes, processes, and interprets it. Depending on the context as well as his personal and cultural background, he might understand and present the information in such a way that it does not correspond to the truth as conceived by the other people involved, which means that the results are likely to reflect his personal perceptions. These human components leave qualitative data prone to serious distortions, which can turn the whole report into
a worthless study. In addition, qualitative research is often said to produce a data overload which is difficult to handle and can be at the origin of inefficiencies.

Nonetheless, notwithstanding these shortcomings, the qualitative approach appears to be the best suitable for the research objectives pursued here.535

3.2.1.2 Case study

Among qualitative research strategies, the case study is the most suitable for the goals pursued here. Indeed, the case study is an instrument recommended when

- “How”, or “why” questions are being posed;
- The investigator has little control over events;
- And the focus is on a contemporary phenomenon within a real-life context.536

All three conditions are fulfilled in the present instance. In addition, those features make case studies outstandingly valuable for inquiries into circumstances where interaction lies at the heart of the interest.537 However, the most relevant argument in favour of the case study in this context is the fact that this method is especially pertinent for exploratory “what” questions, where the purpose is to develop hypotheses or propositions for further probing.538 Since the pioneering examination of success factors of multicultural R&D teams is actually the principal object of the analysis, advocating the case study as the appropriate strategy is a rather clear-cut case. This approach also presents several other advantages. First, cases encourage a greater depth of study and they allow for a clear separation between theory and empirical assessment. Additionally, they are likely to produce integrated paradigms in which a large number of components are taken into consideration. Furthermore, Eisenhardt has praised case studies for

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535 At this stage, it is worth noticing that the approach of the empirical part is not the same as the one used in the chapter dealing with national culture (section 2.2.1). There, a combination of quantitative and qualitative methods was used in order to be able to distinguish cultural patterns. It was argued that such a mix draws a more adequate picture, thus facilitating the interpretation and comparison of different cultures. In the empirical investigation, however, cultures and their variety in R&D teams are merely parameters, not the object of the research itself. Therefore, foregoing the quantitative approach for this point of the analysis should give no cause for concern.

536 Yin (1994), p. 1
537 Black (1999), p. 48
538 Yin (1994), p. 5
their remarkable capacity to generate novel theory. She also argues that theory emerging from cases is very likely to be confirmable and empirically valid.539

On the other hand, case studies have been criticised for giving an oversimplified picture of situations, processes, and relationships, which in reality are much more complex. Consequently, they tend to lead to narrow theory. More generally, the validity of case studies as the basis for theories is often judged as insufficient. Another main concern is that a single case usually passes as not representative enough, providing little basis for scientific generalisation. Then, the six factors underlying the study cannot be isolated, nor analysed separately, which renders the theorising procedure all the more difficult. What is more is the fact that, owing to the human factors involved in the data collection and processing, one may regret the poor reliability of this research instrument. However, a proper design, retrieval, and handling of the data may well make up for these disadvantages and generate representative and rich results.

So, as hinted earlier on, the scientific approach employed here is going to be the exploratory case study. With this method, the investigator seeks to define the questions and hypotheses of (potential) subsequent research. Describing the circumstances of multicultural R&D teams in real-life environments is the most promising strategy when the objective is to gather as much material as possible about a roughly uncharted field. The insights derived from exploratory cases are then used to elucidate the variables and constructs distinguished before, and to craft causal connections between them.540

Also, in order to generate more substance and enhance the external validity of the research, several teams will be investigated. Yet, they will all come from one single organisation. This practice, the so-called embedded single-case design, applies the “sampling” logic, where multiple subjects are studied within one single experiment.541

By analysing a number of subunits of a given entity, the researcher can observe the case study object from different angles, thereby enriching the whole survey. It may also reveal both similarities and differences between those units, which are equally

539 Eisenhardt (1989)
540 Yin (1993), p. 5
541 The “sampling logic” is quite different from “replication” logic, which can only be achieved when using multiple cases. The replication approach aims at repeating specific critical observations in order to reinforce or to confirm certain results. According to this logic, replication is assumed to have taken place if comparable results are obtained from all cases. (Yin (1994), pp. 44-45)
interesting in an exploratory context. By the same token, it compensates for the lack of replication opportunities due to the choice of looking at only one isolated case. Compared to multiple-case strategies, single-case studies have the disadvantage that they yield less compelling results, though the evidence from multiple-cases tends to be regarded as less potent, making the overall study less robust and thus inhibiting theoretical generalisation. Nevertheless, the revelatory purpose of the whole work unquestionably justifies the choice of the single case study.542

3.2.2 Field study parameters

3.2.2.1 Target group

In order to reduce the number of variables and to enhance the reliability of the investigation, the case study object will focus on research teams exclusively. Covering the whole R&D spectrum would augment the enquiry’s external validity, but the scientific objectives pursued here impose a preference for reliability.

Then, the teams under scrutiny must be known as high performers in their respective domains, and it has to be reasonable to think that their exceptional success stems (at least partly) from their multicultural nature. Furthermore, the units of analysis (i.e. the teams, or their members) have to fulfil the following criteria:

- The team members should be drawn from at least 2-3 project teams (which themselves should have at least four members each). This ensures that the high-performing teams observed are not isolated cases in the organisation.

- The time frame of the projects should be at least one month. This is to guarantee a relatively deep personal interaction between the participants (reflected in acquaintance, familiarity, amity, empathy, commitment but also in disagreement, clash and competition).

- The teams must be real (as opposed to virtual); i.e. the members have predominantly face-to-face contact, and the interaction should be as tight as possible.

542 Yin (1994), p. 44
• As many different national cultures as possible should be represented in the teams; the more remote the cultures (in terms of languages, geographic spread, etc.), the better.

3.2.2.2 Operating context

In order to limit the scope of the analysis and to avoid interference with from external factors, the focus of the empirical part shall lie on multicultural R&D teams operating in Switzerland. Like that, the working conditions can be assumed to be similar across the cases. In addition, Switzerland seems to be predestined for effective R&D activity. According to the 2002 World Competitiveness Yearbook, the country belongs to the top three in several major technological indicators, such as the total R&D personnel in business per capita (No. 2), the Nobel Prizes per million population (No. 2), the patent ownership per 100,000 population (No. 2), the quality of the environment for basic research (No. 2), or the protection of intellectual property (No. 1). It even ranks first in the statistics concerning the total as well as the business R&D expenses per capita.543 In addition, it is known as one of the most innovative countries in the world, occupying top spots in the rankings of the scientific and technological articles per million population and the share of firms introducing new or technologically improved products or processes on the market.544 These prosperous conditions have led many foreign multinational companies to establish R&D laboratories in Switzerland. Moreover, given the small size of the country and in view of the R&D intensive industries Switzerland hosts, the local universities cannot provide enough talented researchers. Consequently, local companies are more and more forced to recruit their human resources from abroad. Hence, from a multicultural perspective, Switzerland represents an ideal test bench, as approximately one third of all scientists and a quarter of all university professors are of foreign origin.545

In the last few years however, a shift of focus has occurred. The creation of the Swiss National Research Program and National Priority Program, introduced to meet the perceived needs of the society and the economy, indicates a tendency to move away

543 IMD (2002), pp. 628-638
544 Taylor (2001), p. 32
545 Pletscher (1995b), p. 257
from basic towards applications-oriented research. It should be noted, however, that although these latter programs have siphoned off funds from fundamental research, cooperation between academic and industrial partners remains at the heart of the scientific process, so that no major harm to basic research has been observed yet.\(^{546}\)

**3.2.3 Data collection**

**3.2.3.1 Instruments**

Case studies are mainly about describing environments, events, processes, impressions, etc. Thus, according to Miles and Huberman, “the lion's share of fieldwork consists of taking notes, recording events, (conversation, meetings), and picking up things (documents, products, artefacts)”\(^{547}\). The “field” on which those activities will occur is the working place of researchers, i.e. laboratories, meetings, but also cafeterias, or any other places where relevant information and knowledge may be exchanged or created. In addition, spontaneous conversations between colleagues or informal team meetings play just as important a role for such investigations.

For the purpose of increasing the construct validity of the report and to reach a wide spectrum of data, as many different instruments as possible should be employed. Documents and archive material to be analysed include newsletters, emails, company brochures, annual reports, websites, prospects, training manuals, artefacts, minutes of meetings, protocols, organisational charts, functional project plans, standard operating procedures, structured observations, newspaper articles, memos, speeches, etc.

The main source of evidence, however, is going to be interviews. The optimal degree of structure of the interview (in terms of whether to follow a structured, semi-structured or unstructured arrangement of questions) will depend on the stage of the research: First, during a prospective (pilot) phase, the goal will be to collect some very general information, intended to give a first overview of the situation, to identify precise problems, and to develop accurate questions. In this phase, unstructured interviews are the most effective, since the interviewer remains flexible as to which question to ask. Then, semi-structured interviews are excellent tools to collect data once the exact

\(^{546}\) Pletscher (1995a), pp. 128-129  
\(^{547}\) Miles / Huberman (1994), p. 35
questions have been set up. This structure guarantees that similar questions are asked all interviewees, who are then free to go deeper into those issues that they regard as particularly relevant. The system to be adopted is one of open questioning, in which the interviewees make causal attributions.

3.2.3.2. Execution

The field study was carried out at CERN, the European Organization for Nuclear Research in Geneva. To be more precise, the object of the investigation was one of CERN’s flagship projects, the ATLAS Experiment\textsuperscript{548}, which is structured as a collaboration between CERN (as the host laboratory) and a number of external institutes. It was chosen for five fundamental reasons:

1) The success of the Organization and its R&D teams are absolutely beyond doubt, as it belongs to the most thriving scientific establishments world-wide. Furthermore, a poll carried out among all interviewees\textsuperscript{549} revealed that the physicists and engineers interviewed rated the task effectiveness and relational effectiveness of their respective teams as high.

2) CERN fulfils the requirements of multiculturalism exceptionally well. As will be seen later on, ATLAS employs researchers from dozens of different nationalities and areas of expertise. Indeed, owing to its very purpose and charter, CERN is the multicultural R&D institution \textit{par excellence}. Therefore, it offers an extremely large pool of possible interviewees, who are themselves in contact with multicultural colleagues on a daily basis.

3) Although ATLAS is a project uniting several domains in science, from particle physics through software development to mechanics (figure 3.1), its core endeavour is related to an experiment aiming to explore the fundamental constituents of matter. Therefore, its activities will be assimilated to the \textit{research} discipline. Hence, the study will concentrate on this half of the scientific gamut, fulfilling the requirements stated in the previous chapter.\textsuperscript{,}

\textsuperscript{548} This project is to be described thoroughly in the introductory part of the case study, i.e. in section 3.3.2.

\textsuperscript{549} The questionnaire was the one mentioned in section 3.2.3.2. The results of the survey are displayed in Appendix E.
4) In view of the duration of the project (several years), the fact that the R&D professionals surveyed see each other every day, having permanent face-to-face contact, ensures that their interaction is profound enough and that they have the opportunity to establish personal rapports with one another. Accordingly, every team examined here can be considered as real, not virtual.

5) As a non-profit organisation, CERN and the other institutes participating in the experiment do not have to focus on aspects like sales or earnings, as a conventional corporation would have to. Consequently, the emphasis is clearly laid on research, on scientific matters, which makes the present empirical study much more valuable.

Prior to the actual fieldwork, an introductory session was held on 17 April 2002 with Peter Schmid, ATLAS’ former Resource Co-ordinator. This meeting was to introduce the author of the case study into the scientific and technical aspects of the experiment, a measure which proved very useful because all the interviewees, passionately dedicated to their job, were usually tempted to talk about their daily occupation, using a quite technical terminology – in spite of the rather “soft” topic of the discussion, namely their perception of multicultural R&D teams. Thus, any analysis of the content of the discussions and meetings would have been much more difficult without such a basic initiation into the ATLAS project. Besides, Peter Schmid was also the person who
arranged the interviews, providing lists of potential people to question, and contacting the sub-teams’ leaders.\textsuperscript{550}

As already stated, most of the information was collected by means of semi-structured interviews. The interview questions were derived from the concepts encountered in the theoretical part, revolving around the six factors as described in section 2.5.2. This material was then supplemented by the results of the pilot study, which was realised with 7 experts drawn from R&D departments of large multinational companies. These professionals were asked to describe and concretise frequent problems related to multicultural R&D teams.\textsuperscript{551} This procedure enabled the author to refine and to add substance to those six points. Based on the insights from both analyses, he was able to develop a catalogue of issues and concepts, to serve as interview guidelines, on which were based the questions to be asked to ATLAS people.\textsuperscript{552}

The interviews were conducted between April and June 2002, at CERN’s Meyrin site in the canton of Geneva. All the conversations took place in an informal, very friendly atmosphere, most of them in the cafeteria in the “Building 40”, CERN’s newest edifice. After a brief description of the project and enumeration of the six factors, the participants were asked whether they thought that these elements played a role in the success or failure of their R&D teams, and to give reasons for their response. Not all questions were posed to all respondents, because the interviewer let the interviewee speak according to his or her own awareness and experience. If the interlocutor did not have anything to say on a given topic, or was unable to answer an open-ended question, then the next area was dealt with. Otherwise, he was free to speak for as long as he was willing. Depending on the course of the dialogue, the enquiries were followed up and deepened by more detailed remarks in the course of the dialogue. On average, the interviews lasted fifty-five minutes. They were all taped with permission and transcribed. The recorder had to be switched off only once because of a delicate statement. Yet, the interviewer never had the impression that information, opinions or sentiments were being held back.

\textsuperscript{550} Appendix F exhibits a cover letter as it was sent to potential case study organisations, including to M. Schmid.

\textsuperscript{551} The interviews carried out for the pilot study are listed in the “Index of interviews (pilot study)”.

\textsuperscript{552} Appendix G presents this list of issues and problems on which were based the interview questions.
3.2 Configuration of the fieldwork

At the end of the conversation, all the respondents were invited to fill out a questionnaire, which was destined to learn about the interviewees’ cultural origins, so that, apart from assessing their scientific specialisation and education, the form also included items related to their nationality, the languages they speak and their international experience.\(^5\) They were also asked to rate the performance (task effectiveness and relational effectiveness) of their own team. This poll made it possible to identify the R&D teams investigated as successful ones, since they all scored outstanding results on both dimensions.

The people asked were chosen independent of their hierarchical and formal rank within CERN. They only requirement was that they had spent enough time on either CERN’s Meyrin or Prévessin site. This constraint was established in order to ensure that the collaborators have regular face-to-face contact as demanded in section 2.1.2.4. Accordingly, the pool of respondents was made of Staff members (that means permanent CERN employees), project Associates who reside in Geneva, Fellows, and one Technical Student.

In total, 23 researchers – 18 men and 5 women – were interviewed.\(^4\) The 5 teams from which the participants were drawn ranged in size from 7 to 20. Regarding their scientific specialisation, no real common denominator could be determined. While most were physicists, the rest of the interviewees had an engineering degree. Surprisingly enough, their expertise (experimental physics, detector physics, high energy physics, exotic physics, computer programming, mechanical engineering, etc.) had practically no influence on their tasks in the project, or on the sub-project they were assigned to. The interviewees were selected so that the sample embraced several national cultures. However, in order to reduce biases caused by isolated cases, the choices were made so that each nationality taken into consideration was represented by two or more individuals. In the end, the 23 participants came from 11 European countries. Furthermore, everyone except two, were declared proficient on speaking at least two

\(^5\) The questionnaire is reproduced in Appendix H.

\(^4\) The names of the interviews are recorded in the “Index of interviews (case study)”.

foreign languages. For most of them, these language skills were acquired during stays abroad (for professional or study purposes).555,556

Interview data was complemented by the observation of team meetings and informal conversations between colleagues. The notes taken during those discussions were added to the case study protocol, which includes the transcripts of all interviews, remarks, explanations, annotations, comments, etc. made throughout the process. Furthermore, desk research, i.e. the analysis of organisational charts, internal newsletters, company brochures, websites (internet and intranet), etc., rounded out the fieldwork. Free access to all meetings, databases, and internal communication was granted. All in all, the several hundred pages of transcripts and internal documentation that could be gathered constituted a vast case study database, which eventually was used to write the report. This material turned out to be very valuable in providing an extensive understanding of the project (including its host, CERN), its organisation, its problems, its culture, and so forth.

3.2.4 Commentary

The research methodology opted for here, the single embedded case study, fits best the requirements imposed by the research questions and the fieldwork’s objectives. Specifically, the exploratory character of the investigation, the impossibility of controlling the events, and the multicultural context itself, made this design necessary.

The main downside of case studies is that they fail to allow any generalisation across contexts. However, some tactics were employed to enhance the quality of the research and to fulfil the criteria defined in the introductory paragraph in section 3.1. They are listed in table 3.1.

555 The international experience of the respondents and of Atlas collaborators in general will be under discussion again in the case study.

556 A tabular characterisation of all interviewees (case study) is provided in Appendix I.
### 3.3 Case study: Multicultural research teams at ATLAS

“Comparing the project to an air trip, ATLAS has just taken off the runway. The plane is new, the crew competent and enthusiastic and there should be enough fuel in the tank. We are confident that we shall reach our planned destination – a host of new discoveries in fundamental physics.”

Peter Schmid wrote this ten years ago. The project has progressed ever since. Some problems have been solved, challenges overcome, and new ones have appeared. While the start of the operations has been postponed by approximately 2 years to 2007, the scientific prospects have remained the same: The experiment is expected to take particle physics to new dimensions.

Because of its huge size, i.e. the large number of laboratories and people involved, the collaboration is particularly difficult to manage. This complexity concerns not only the

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557 Cf. section 3.2.3.2
559 Schmid (1993), p. 15
organisational level (that is the relationships between the institutes), but also the R&D teams themselves. This case study has the objective to show how an undertaking such as ATLAS copes with these difficulties, and in what way its multicultural teams can be regarded as successful. It opens with a presentation of CERN. Then follows an introduction into the technical elements of the experiment, namely particle physics, the Large Hadron Collider, and the ATLAS detector. The core of the report includes a thorough description of ATLAS’ multicultural R&D teams. In presenting this, the six success factors will be used as points of reference.

3.3.1 CERN: The host laboratory

As one of the largest scientific laboratories in the world, CERN represents probably the most shining example of international collaboration in the world today. When it was founded in 1954, the 12 original signatories of the CERN convention agreed to pool their individual resources for the development of high-energy accelerators in order to remain at the forefront of particle and nuclear physics. Although some of the larger countries in Europe could afford to develop, construct and operate such machines, it was unthinkable that any single nation could have the human resources indispensable to run them and to exploit their results scientifically. Hence, the idea was to create an institution supporting “European States in nuclear research of a pure scientific and fundamental character and in research essentially related to thereto”. Specifically, CERN’s final goal was to develop and build state-of-the-art accelerators able to produce the high-energy beams necessary for testing of the underlying structure of matter on the one hand, and the detectors and data-handling facilities to record and analyse those experiments on the other.

Since then, CERN has grown to include 20 European member States and it has entered into several scientific partnerships, joining forces with laboratories from Canada,
China, India, Israel, Japan, Russia, the USA, and many other countries. Thus, despite its European springboard, the scientific collaboration has extended itself to embrace the whole world, gaining immense momentum throughout the global scientific community. Actually, the 6’500 researchers (representing 500 universities and over 80 nationalities) who use CERN’s installations make up no less than half of the world’s particle physicists. Along with its function as a magnet for bright scientists, CERN can boast of being the first European laboratory to overtake American competitors in its field. Indeed, through the years, it has taken the top spot away from U.S. institutes and is now considered as the world’s leading laboratory in particle physics research. So CERN largely contributed to Europe’s gradually recovering a primary role in fundamental physics, a position it had before the Second World War.

CERN is structured in Divisions, themselves grouped into Sectors, which reflect its administrative, scientific, and technical objectives. This organisational design allows flexible operation and ensures that the Laboratory remains responsive to changes in the needs of the scientific community and to the evolution of technology. The group constitutes the basic unit. It performs given tasks in relation to operational duties, such as specific technology (e.g. radio frequency or vacuum systems), specific domains of research and development of accelerator equipment (for example, superconducting magnets), detectors for experiments, or electronics. Divisions, which comprise groups that have tasks in common, are clustered into 3 distinct sectors:

- The *Research* sector is in charge of the implementation of CERN’s scientific policy;

- The *Accelerator* sector is responsible for the construction and operation of the different accelerators as well as for the development of the technologies that go with them;

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564 In less than half a century, numerous CERN scientists have received prestigious awards, including two physics Nobel prizes (Carlo Rubbia and Simon Van der Meer in 1984 for “their decisive contributions to the large project which led to the discovery of the field particles W and Z, communicators of the weak interaction” and Georges Charpak in 1992 for “his invention and development of particle detectors, in particular the multiwire proportional chamber, a breakthrough in the technique for exploring the innermost parts of matter”). Furthermore, the laboratory was able to recruit three other Nobel Prize Laureates (Felix Bloch, Sam Ting, and Jack Steinberger).
• The Technical and Administration sectors provide services needed for the activities in the other sectors.

Moreover, the Management Board, which unites the Director-General (chairman), the Directors and the Division Leaders, contributes to the preparation of new policies and managerial decisions. The Director-General is the Organization’s chief executive officer and legal representative. The Directorate advises him on management decisions and on policy recommendations that are handled by the CERN Council. The latter is the body taking all major decisions affecting the Organization and its activities. This entity is made up of two delegates from each Member State, one representing his government’s administration, the other national scientific interests. Each Member has a single vote, with most decisions necessitating a simple majority – although in practice the Council preferably seeks unanimity.\(^{565}\)

### 3.3.2 Technical aspects of the ATLAS Experiment

#### 3.3.2.1 Particle physics

Particle physics is “a branch of physics dealing with the description and categorization of the basic units of matter and energy”\(^{566,567}\). Stated differently, this discipline explores what matter is made of and what forces hold it together.

For laymen, the first issue can be elucidated in rather simple terms: Matter entails relatively few basic building blocks, the particles. To make it more elaborate: Atoms are composed of electrons orbiting a nucleus, which itself is a sort of berry with protons and neutrons, which, in turn, consist of quarks. The electron, the electron-neutrino\(^{568}\), and one pair of quarks (up-quarks and down-quarks) constitute the elements needed to build all the stable matter in the Universe. However, not all matter in the Universe is stable, in the sense that some particles are short-lived, appearing as a result of high-energy processes occurring naturally in the Universe, or being generated artificially in laboratories (for instance, via high-energy collisions). Short-lived parti-

\(^{565}\) Appendix J depicts CERN’s organisation chart.

\(^{566}\) From: [http://www.pbs.org/faithandreason/physgloss/partphys-body.html](http://www.pbs.org/faithandreason/physgloss/partphys-body.html)

\(^{567}\) A glossary of high-energy physics terms can be found at: [http://atlas.web.cern.ch/Atlas/documentation/EDUC/glossary_index.html](http://atlas.web.cern.ch/Atlas/documentation/EDUC/glossary_index.html)

\(^{568}\) Neutrinos are particles with no electric charge and very little mass.
cles comprise more quarks, more particles like the electrons, and more neutrinos and can be classified into two families – the quarks and the leptons – with six members each. Those twelve particles are covered by the most current paradigm, called the “Standard Model of Fundamental Particles and Interactions”, one of the greatest intellectual achievements of the 20th century.569

The second main aspect of the questions occupying particle physicists’ minds is related to the forces that cause those “building blocks” to stick together. In fact, any force is attributable to the underlying interactions between particles. There are four types of such basic interactions: gravitational, electromagnetic, strong, and weak forces. While the first two kinds should be well known, the remaining two forces have such tiny effects that they cannot be perceived in everyday life. Nevertheless, they are fundamental for the existence of anything the world is made of, and for the decay processes, which cause some types of matter to be unstable. The strong interaction is the force that holds quarks together to form hadrons570; it is transmitted by particles known as “gluons”. Weak interactions are the processes in which a quark can be transformed into another type of quark, or a lepton into another lepton. If all the massive quarks and leptons decay to produce lighter quarks and leptons, it is because of those weak forces. Their carrier particles are the W and Z bosons. The Standard Model contributes to the understanding of mass – one of the most fundamental properties of matter – by suggesting that mass is due to a new field, the Higgs field. According to this theory, particles acquire their masses by interacting with this field, which, like magnetic or gravitational fields, infuses all space. Then, the model predicts that all matter particles and force carriers interact with another particle, called the “Higgs boson”. Hence, it is the strength of the interaction that causes mass: Particles that interact strongly with the Higgs field are heavy, whereas those that interact weakly are light.

The Standard Model currently provides the best paradigm available for describing the world of particles. But although it has passed all experimental tests for more than 20 years, it still leaves many questions unanswered. While it has solved many of the mysteries of the structure and stability of matter by incorporating in it all the known

569 More details about the Standard Model are available in Appendix K.
particles and forces (apart from gravity), there is a common belief that “the Standard Model in its present form cannot be the whole story, for there are still missing pieces and other challenges for future research to solve.”\textsuperscript{571} Some of the most puzzling are the following:

- Why do particles have mass? And is there some pattern to that mass?
- Why are there three types of quarks and leptons of each charge?
- Do neutrinos have mass?
- Are there more types of particles and forces to be discovered?
- Are the quarks and leptons really fundamental, or do they, too, have a sub-structure?
- Which particles form the dark matter in the universe?

Solving these enigmas will certainly call for completing the Standard Model. Various theories have been proposed that go beyond that paradigm, and could elucidate some of the remaining problems. In particular, one of the major breakthroughs in particle physics in the 1960’s was Glashow, Salam, and Wienberg’s “electroweak” theory, which brings together the weak (light and radioactivity) and electromagnetic (electricity and magnetism) interactions. At present, one of theorists’ major objectives is to include the strong force in an extended scheme, i.e. to unify strong, weak, and electromagnetic forces in a “Grand Unified Theory”. The latter, however, would be merely an intermediate stage. Ultimately, the goal is to unify all forces, so that gravity is taken into account as well, and integrated into what is already known as “The Theory of Everything”.

3.3.2.2 The Large Hadron Collider

To verify the models developed by theorists, researchers in particle physics basically require two types of machines: accelerators (including colliders) and detectors. Accelerators are devices that allow physicists to resolve extraordinarily small structures by

\textsuperscript{570} A hadron is “a particle made of strongly-interacting constituents (quarks and / or gluons)” (from: \url{http://atlasexperiment.org/glossary_terms.html})

\textsuperscript{571} From: \url{http://public.web.cern.ch/Public/SCIENCE/ParticlePhysicsToday.html}
producing particles with very high momentum. When they have attained enough kinetic energy, the collision bursts them into a multitude of new particles. In that sense, accelerators can be seen as “particle factories”\textsuperscript{572}. Furthermore, the process of speeding up particles to very high energies and smashing them into targets or making them collide, can expose the forces acting between them. Accelerators consist of four basic components:

1) A source of particles;

2) Cavities (i.e. tools producing an electric field accelerating the particle beams);

3) Magnets (generating the magnetic fields to bend them and to keep them tightly focused);

4) A vacuum chamber (to travel).

When completed, the Large Hadron Collider (LHC) will be the largest and most powerful particle accelerator in the world. It is currently under construction at CERN, and is scheduled to be operational in 2007. By accelerating particles up to 99.99999991\% of the speed of light (300’000 km/s), this machine will produce beams of protons collide at unprecedented energies. Above all, it will lay bare new possibilities for research in physics, for instance in the exploration of interactions between quarks and gluons, which were hidden until now. Moreover, it will help to attain even higher experimental temperatures and to re-create earlier phases in the history of the Universe, to be exact, moments in time at an infinitesimal fraction of a second ($10^{-12}$) after the Big Bang, when the temperature was $10^{16}$ degrees. This will undoubtedly contribute to the establishment of bridges between the science of the very small (particle physics) on the one hand, and the science of the very large (cosmology and astrophysics) on the other. Such advancements surely would not only amaze numerous physicists, but would also bring about important insights in other fields and breed an array of technological spin-offs.\textsuperscript{573}

\textsuperscript{572} Schmid (1993), p. 2

\textsuperscript{573} Spin-offs are “devices and techniques developed to do basic research which turn out to have other uses” (from: \url{http://public.web.cern.ch/Public/bs_3_3.html}). Appendix L lists some example of practical applications of particle accelerators.
The LHC is a circular accelerator\textsuperscript{574} housed in a tunnel\textsuperscript{575} with a circumference of 27 km and situated 100 meters under the ground. The particles, accomplishing more than 11'000 laps in a second, will collide at energies 10 times greater than that produced in any previous machine. Its mode of operation will consist in accelerating each of two counter-rotating beams of protons to 7 TeV per proton. So, in the aggregate, it will collide particles at the unprecedented energy of 14 TeV. For this, it will employ the purest vacuum\textsuperscript{576}, the most sophisticated superconducting magnets\textsuperscript{577} and the most complex accelerator technologies ever used. Then, the LHC will also be the biggest refrigerator of all times, as the magnets need to be cooled by 7’000’000 litres of liquid helium at -271°C, a temperature lower than that of the Universe itself. The operation of the high-temperature superconductors will entail up to 2’300’000 amperes of power, which would be enough to illuminate more than 750’000 regular light bulbs.

3.3.2.3 The ATLAS detector

When the particles have reached a pace close to the speed of light, they are made to crash with other particles. This occurs at certain locations around the ring, called “collision points”. At those places, there are no magnetic fields, and the particles are moving in straight lines. The two beams of protons are brought together into a single vacuum enclosure and made to collide frontally – hence the name “collider”. Collision points are surrounded by large detectors, which record what happens during and immediately after the impact. The detector can be seen as physicists’ electronic eye, as it enables them to observe the fragments set free in the collision.

At CERN, detectors are typically associated with specific experiments. Four such experiments will use the LHC facilities:

- **ATLAS**: A Toroidal LHC Apparatus

\textsuperscript{574} In circular (as opposed to linear) accelerators, magnetic fields whirl the particles round and round in a circle, loading them with ever more energy with each lap. Like that, the particle reach energies that are much higher than would be possible with linear accelerators.

\textsuperscript{575} It is the same tunnel as the one that accommodated CERN’s previous flagship accelerator, the Large Electron Positron Collider (LEP), which was operational for 11 years until it was shut down in November 2000.

\textsuperscript{576} The LHC requires a vacuum of $10^{-10}$ torr, i.e. a medium in which an electron can travel 3 trillion km before meeting a stray molecule of gas.

\textsuperscript{577} Those magnets will create an 8-tesla magnetic field, that is 150’000 times more than that generated by the earth.
3.3 Case study: Multicultural research teams at ATLAS

- CMS: The Compact Muon Solenoid
- ALICE: ALICE Large Ion Collider Experiment
- LHCb: Study of CP violation in B-meson decays at LHC

Of those four machines, ATLAS will by far be the largest. In fact, its 8’000 tonnes, 40-meter length, and 25-meter diameter\(^\text{578}\) will turn it into the most massive detector ever built. Only the materials cost for its construction has been estimated at 475 million Swiss francs (in 1995 prices). But considering the scientific goals of the project, most experts will agree that this price cannot be too high. Indeed, ATLAS is expected to detect the Higgs boson (provided it exists) and explore its properties. Then, in case the Higgs field were not the right answer to the question of mass, the experiment would nevertheless guide particle physicists to the correct solution. So whatever the outcome, it will definitely represent one of the greatest scientific discoveries ever. Thus, the ATLAS project should ring in a new era in the history of particle physics, adding several chapters to the body of knowledge on the field.

ATLAS’ cylindrical shape (figure 3.2) is made necessary by the fact that it deals with colliding-beam (as opposed to fixed-target\(^\text{579}\)) experiments, during which the particles radiate in all directions. Like most modern detectors, it consists of several layers (sub-detectors), each of them measuring different properties of the particles emerging from the collision. Each sub-detector (System) has a different function in tracking and identifying the various particles produced in the collision. Accordingly, the components are assembled in an order so that all particles will go through the different layers sequentially (figure 3.3).

ATLAS itself has four such major components:

- **Inner Detector**: “The Inner Detector measures the directions, momenta, and signs of charge of electrically-charged particles produced in each proton-proton collision. It consists of three different systems of sensors [(the Pixel and

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\(^{578}\) Schmid (1993), p. 4

\(^{579}\) “With a fixed-target experiments, the particles produced generally fly in the forward direction, so detectors are somewhat cone shaped and are placed ‘downstream’ form the collision.” (from: http://atlasexperiment.org/etours_exper/etours_exper03.html)
Strip Detectors, the Transition Radiation Tracker, and the central solenoid] all immersed in a magnetic field parallel to the beam axis.**580

![Figure 3.2: The ATLAS detector](http://public.web.cern.ch/Public/CERNOP/League5.html)

- **Electromagnetic Calorimeter:** “The Electromagnetic Calorimeter absorbs the energies of all electrons and photons traversing it (this constitutes the ‘electromagnetic energy’), and produces signals proportional to those energies. It is finely subdivided so that it can measure the directional dependence of the electromagnetic energy.”**581

- **Hadronic (“Tile”) Calorimeter:** “The hadronic calorimeter surrounds the electromagnetic calorimeter. It absorbs and measures the energies of hadrons, including protons and neutrons, pions and kaons (electrons and photons have been stopped before reaching it). The ATLAS hadronic calorimeters consist of steel absorbers separated by tiles of scintillating plastic. Interactions of high-energy hadrons in the plates transform the incident energy into a ‘hadronic shower’ of many low energy protons and neutrons, and other hadrons. This

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shower, when traversing the scintillating tiles, causes them to emit light in an amount proportional to the incident energy.\textsuperscript{582}

- **Muon System**: “Muons are the only charged particle that can travel through all of the calorimeter material and reach the outer layer. The Muon System determines the signs and momenta of muons with better precision than the inner tracking system does. It is able to measure momenta even at the highest luminosities.”\textsuperscript{583}

![Diagram of detector components](Source: ATLAS-Website)

**Figure 3.3: The interaction of various particles with the different components of a detector**

(Source: ATLAS-Website)

As the collider will generate about a billion collisions events per second, the detector is conceived to record and process a combined data of more than 40 million megabytes in that same period of time. Furthermore, the events physicists are seeking for their studies occur only once in about 10 million such events. Consequently, the computing system will have to be able to select those events with the most promising results, while eliminating the less interesting information. This so-called “triggering” process is based on the analysis of part of the measured data to discard most ordinary (or

\textsuperscript{582} From: http://atlasexperiment.org/etours_exper/etours_exper18.html
\textsuperscript{583} From: http://atlasexperiment.org/etours_exper/etours_exper23.html
“background”) events, and is supplemented by two additional filtering steps intended to realise an overall rejection factor of 10 million to 100 million.

Although ATLAS is designed to explore phenomena that have been predicted theoretically, it must be constructed in a way that allows for surprises. This, however, calls for extraordinary cleverness, cunning, and initiative on the part of the physicists and engineers. Conceiving such a complex device, packed with ultra-precise components and sophisticated electronics, is a grand endeavour.

Nonetheless, the challenges are not only of a scientific and technical nature. Specifically, ATLAS’ melting-pot character – the 2’000 physicists-strong crew, assisted by an even larger number of high-level technicians and engineers, drawn from more than 150 laboratories and universities in 34 countries – may pose difficulties for some researchers. For example, they have to understand that “a line of argument may take on quite different meanings when presented by physicists from different nations, and that working habits and priorities vary markedly from one country to another”⁵⁸⁴. Finally, apart from its sheer size, it is also the duration of the project that is very impressive. As the experiment is designed to last for 30 years, it could be quite a problem to keep the enthusiasm and intellectual stimulation alive for such a long period. All these elements represent yet another test for what has been referred to as “the largest collaborative effort ever attempted in the physical sciences”⁵⁸⁵.

3.3.3 The Constitution of ATLAS

As made out in the previous section,

“ATLAS is a ‘big science’ project which is at the limits

- of science,
- of technical feasibility and
- of international collaboration.”⁵⁸⁶

And like any other large company of this importance, it necessitates an appropriate managerial effort⁵⁸⁷ to function well and to achieve its goals.

⁵⁸⁴ From: http://public.web.cern.ch/Public/CERNOP/League8.html
⁵⁸⁵ From: http://atlasexperiment.org/
The constitution of the ATLAS Collaboration (at least its construction phase) is fixed in the “Memorandum of Understanding for Collaboration in the Construction of the ATLAS detector” (MoU). As this form of agreement implies, the MoU is not legally binding for any of the signatories, which comprise R&D institutions as well as funding agencies. So in spite of the size of the project, the ATLAS Collaboration is not a legal entity. It only subsists as a factual association hosted by an organisation, which itself has a legal status, namely CERN. However, the MoU regulates all crucial items of the alliance. More explicitly, it

“[…] Defines the construction phase of the ATLAS detector. Its purpose is to define the programme of work to be carried out for this phase and the distribution of charges and responsibilities among the Parties for the execution of this work. It sets out organisation, managerial and financial guidelines to be followed by the Collaboration.”

Eleven annexes, holding most of the substance of the partnership, complement the document. They concern four main themes:

1) The inventory of all participants of the collaboration, including the R&D institutions and their representatives, the funding agencies, and the members of the team (Annexes 1-4);

2) The definition of the ATLAS organisation and procedures for admitting, suspending, and excluding institutions (Annexes 5.1-5.8);

3) Details about the organisation of the different sub-detectors and other activities related to ATLAS, in particular the teams involved, the schedule, deadlines, costs, etc. (Annex 6-10);

4) The general conditions for experiments carried out at CERN (Annex 11).

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586 Schmid (1993), p. 15
587 How exactly ATLAS is organised and managed will be described in detail in sections 3.3.41 and 3.3.42.
588 Article 2.1 of the MoU
3.3.4 The six C’s at ATLAS

3.3.4.1 Composition

According to Martha Krebs, the Director of the Energy Research at the U.S. Department of Energy, particle physics has always led the way in the formation of cross-national collaborations. She associates the year of the discovery of the electron (1891) with the moment at which “high-energy physics became truly world-wide and no longer simply international.”\textsuperscript{589} Ever since its foundation, CERN has acknowledged the necessity to gather people from as many countries as possible and to tap the benefits of cultural diversity. And so it is not a surprise that the Organization itself has become one of the most multicultural research institutions worldwide. Along with the representatives from its 20 member States, it takes in technical students, doctoral students, fellows, associates, and users\textsuperscript{590} from several other nations. For CERN is an extremely admired and highly demanded employer among physicists. One knows that the people who enjoy the privilege of working there have access to state-of-the-art facilities and stay in constant touch with the best global research. “Working on the most difficult [scientific] problems in the world”\textsuperscript{591}, researchers are exposed to challenging questions. They gain precious know-how in dealing with a multitude of technical problems and get familiar with the latest concepts and technologies, while learning to operate in a multicultural environment. Even collaborators who are on site for only a limited period of time profit from those advantages, making a stay at CERN a priceless experience.

Thanks to its outstanding reputation, CERN can afford to appoint only top people in the field. In fact, the scientists and engineers working there are truly the cream of Europe’s particle physicists. But the recruitment criteria are not only scientific and technical ones. Rather, candidates for research staff positions are selected “on the basis of competence and qualifications relevant to the job”\textsuperscript{592}. Those include the ability to communicate, defend ideas, find consensus, take decisions, co-ordinate activities, lead

\textsuperscript{589} CERN Staff Association (1998), p. 4
\textsuperscript{590} Users, who represent by far the largest part of the Organization’s personnel, are external physicists, engineers and technicians sent to Geneva by their university or institute. They participate in CERN’s R&D activities in the framework of its experiments, joining the teams as would regular employees. However, users spend only a variable fraction of their time (roughly 40%) on site and are not remunerated by CERN.
\textsuperscript{591} Alexa, interview, 15.05.02
\textsuperscript{592} CERN (2002b), p. 12
people, etc. Thus, the aptitude to work in (multicultural) teams is an important factor in the selection process.

Owing to CERN’s numerous alliances with other laboratories, the majority of the people applying for a permanent post have already worked with CERN teams. This represents a plus for both sides: On the one hand, the candidate gets to know how the Organization, the relevant experiment and how the different groups work; on the other hand, the current team members see if the newcomer is an agreeable colleague, finding out if they would like to collaborate with him on a longer term. Furthermore, this system generates a high turnover of people, which presents advantages as well as disadvantages: While it helps to shake up the company, thus playing a vital role in the procurement up-to-date knowledge, it still deprives the organisation of a certain stability and continuity, which is essential for any scientific pursuit.

According to the Staff Rules and Regulations, the “Director-General shall strive to ensure as fair a distribution as possible of nationals of the Member States”\(^{593}\). This wording is quite fuzzy, but was chosen deliberately as a way to leave enough room for an interpretation in line with the Organization’s performance and scientific interests. Indeed, unlike the rules for other international organisations, this one does not explicitly prescribe that the number of employees from each Member State should automatically be in proportion to the size of its financial contribution.\(^{594}\) Rather, the regulation means that when CERN faces two or more candidates with equal skills and experience, it is forced to recruit the applicant from the country, which is currently underrepresented.\(^{595}\) In practice, this is a hypothetical possibility, so that one can say that CERN is virtually free to select the most qualified candidate, no matter which his nationality or country of origin is. In this way, the Laboratory may rely on obtaining the best suitable researchers for the relevant project.

The same applies to ATLAS, as one of CERN’s most ambitious and expensive experiments. Due to its size, it requires a lot more partners than earlier projects. Consequently, the human resources are drawn from many countries. As mentioned earlier,

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\(^{593}\) CERN (2000d), Article II 1.04  
\(^{594}\) Benincasa, interview, 29.05.02  
\(^{595}\) Fontanet, interview, 19.08.02
the experiment mobilises physicists, engineers, technicians, and craftsmen from more than 30 nations, covering the five continents. Seeing that each institute usually concentrates on one specific sub-detector, the contributions are well spread across the experiment. This particularity engenders all kinds of cultural mixes in the various sub-systems (table 3.2). Those combinations turn ATLAS into a vast melting pot, entailing important coordination and harmonisation efforts.

But, as the complexity increases with the size of the team and the number of cultures, this further diversity brings in additional perspectives and opinions. Actually, the variety of cultures is greatly appreciated by all parties involved. ATLAS researchers welcome this phenomenon, recognising that they can learn from colleagues who had a different education, and who solve problems in a different way. They value the multiplicity of ideas engendered by this gathering of people from varying backgrounds.

In a setting like CERN, where multiculturalism is an integral part of life, one does not really pay any attention to national difference. As a general rule, ATLAS collaborators see multicultural teams as a reality of life. They admit that people may be different, but for them, it simply does not matter, because they acknowledge the fact that they have to co-operate to achieve their objectives. But this diversity-neutral outlook notwithstanding, one can observe behaviour or beliefs common to persons from the same culture, although those recurring patterns observed by physicists and engineers concern professional matters more than “intangible” attitudes such as individualism, risk adversity, masculinity, etc. For instance, the representatives of certain cultures have been identified as being extremely disciplined and dedicated to their tasks. Others are famous for their (in)ability to meet deadlines. Furthermore, several “cultural” factors have been attributed to local educational systems. Some schools privilege logical and academic ways of thinking, whereas others support more pragmatic approaches. But generally, the majority of the items that have been felt as culturally influenced concerned managerial issues (e.g. performance orientation, punctuality, quality control, and so forth), i.e. details that were not directly related to R&D.
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Table 3.2: Countries involved in the construction of the ATLAS detector
Moreover, certain nations appear to dominate in particular fields. For example, Anglo-Saxon countries have always had good people in computer sciences. Likewise, Italy has a reputation for producing brilliant physicists, while the French are known for their remarkable proficiency in particle accelerators. So each culture seems to have a particular domain in which it excels. Nonetheless, these exceptional competences are more a question of history than anything else, as countries have established a scientific expertise over the centuries (or at least decades), striving ahead for traditional motives.

In spite of these differences, there are no major clashes between the collaborators. Admittedly, some misunderstandings crop up from time to time, but they are not caused by prejudices, feelings of superiority, or intolerance. Rather, they arise from language problems. Seeing that most researchers have to speak a language that is not their mother tongue, a message is quickly misread: Someone does not get the point his partner is trying to make – this is the most common difficulty encountered by ATLAS’ associates. The potential for confusion is all the more pronounced when the asymmetry in language proficiency is large, for example when one interlocutor is a native-speaker and the other is not. In that case, the former is more likely to take it for granted that his co-worker has understood his idea, a belief that is regularly the main origin of mistakes.

One major source of problems that is tightly related to diversity is that of cultural clusters within teams. Clearly, such gatherings of people who share a nationality or a mother tongue may have advantages: For instance, they are often considered as faster in their activities, because their communication is much more efficient. Not every ATLAS sub-team has clusters, but those that have present recurring troubles: Teammates outside the band complain that the colleagues in the faction cut themselves off from the rest of the group. They do not take part in common coffee breaks, stay among themselves to chat and have less contact with other team members, thus circumventing important parts of the communication and knowledge sharing process.

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596 The term “domination” does not imply any forceful authority or exercise of power within the team. It just denotes that the researchers from the dominating country have more influence on the domain than the others, and that they enjoy particular respect from their colleagues.

597 The topic of language and communication will be discussed exhaustively in section 3.3.4.4.

598 As is to be seen later on, coffee breaks constitute a vital element in the exchange of opinions and ideas between ATLAS team members.
Then, by omitting to socialise with their associates, they fail to contribute to the richness of the organisation. Additionally, once a hard core of people speaking the same language has developed, it is difficult for outsiders or newcomers, who are not fluent in that language, to integrate into the group and to get accepted by his co-workers. Finally, when a splinter-group does not agree with the bulk of the team, it is not easy to have it change its point of view, because it is harder to persuade a cohesive set of like-minded people than single individuals. However, although such problematic groups do exist in some ATLAS sub-teams, they are definitely not the rule. By and large, the teams are kept very heterogeneous in order to avoid clusters and the irritation that accompanies them.

3.3.4.2 Connection

A far-flung project such as ATLAS necessitates an organisational structure satisfying all the constraints induced by its size. The configuration needs to take into account the fact that the creativity comes from the individual researcher, not from the collaboration itself. Each member is attached to one of the numerous (sub-)teams, so people have to act in small groups embedded in the larger ATLAS framework. Yet, “the fact that all the systems must fit and work together [...] imposes some limits on the creative directions that people can take”\textsuperscript{559}. The absence of a legal liability to hold the Collaboration’s partners together intensifies the problem of uncertainty, rendering the relationships even more complicated. Furthermore, the achievement of trust and commitment between partners is not a simple venture, the disbanded nature of the alliance and the physical distance between the associates adding a supplementary dimension to the complexity of the undertaking.

Considering all these factors, the ATLAS partners chose a structural design that facilitates as far as possible co-ordination between the different institutes involved in the project. One further particularity in this regard is related to the fact that each team taking commitments for deliverables, which makes up the basic managerial unit in the Collaboration, is an element in a two-dimensional structure of hierarchies:

- The national hierarchy of institutes and funding agencies (FA);
• The functional hierarchy of sub-systems and systems constituting the entire detector.

Figure 3.4 illustrates how these teams are embedded in both hierarchies and in the CERN system.

Figure 3.4: ATLAS’ two hierarchies
(Source: Schmid (1993), Figure 2)

From: http://atlasexperiment.org/etours_intro/etours_intro06_soc_q01.html
ATLAS is essentially governed by two main entities, the Collaboration Board and the Executive Board (EB):

- The **Collaboration Board** (CB) is ATLAS’ policy- and decision-making body. It brings together the members of the Executive Board and one representative per institution. The CB decides on the global detector design, is responsible for policy matters (concerning guidelines for the interaction with the LHC Committee and the CERN management, publications, presentations, and so on), administers financial and human resources, organises elections, etc.

- In line with policies set by the CB, the **Executive Board** (EB) directs the execution of the ATLAS project. It manages the communication between the ATLAS Management and the different Systems. It is basically composed of the ATLAS Management (Spokesperson, Deputy Spokesperson, Technical Co-ordinator, Resource Co-ordinator), the System Project Leaders, the Magnet Project Leader, and various technical co-ordination staff. Its goal is to monitor and to ensure satisfactory performance of the project. Its main tools are reporting and reviewing. In view of that, the main tasks of the EB are the setting and review of schedules and milestones, the review of financial and human resources, the co-ordination of the different systems (sub-detector work programmes, test beam activities, and other services), the arrangement of the interfaces, and the co-ordination of hardware and software common to all systems.

The **Resource Review Board** (RBB) is the assembly of the representatives of the national funding agencies, the CERN management, and the ATLAS Management. It is chaired by CERN’s Director of Research as the Collaboration’s highest supervisor. The RBB is the body discussing the different national contributions and the Memorandum of Understanding. During its meetings, the ATLAS resources are approved and monitored.

The work of the CB and the EB is supported by **Institute Boards** (not portrayed in the chart), which are made up of the delegates of the institutes contributing to the various

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600 This is the general rule. In some cases however, institutions may have, up to two representatives.

601 Appendix M offers further details about how the management of the project is organised.
Systems (or, roughly said, sub-detectors). The Institute Boards, each of which is affiliated to one System, take decisions on major technical choices and determine how the resources and responsibilities are to be shared. They base their choices on recommendations issued by their respective Steering Group. Organised according to the System’s activities, the Steering Groups bring together the people leading these efforts, deciding on matters related to the technical execution of the project (e.g. what type of gas should be used in the sub-detector). They are headed by Project Leaders, who are directly and ultimately in charge of the design and construction of the corresponding System. In particular, they have to ensure that these activities are carried out on schedule, within cost, and in a way that guarantees the expected performance and reliability within the ATLAS resource-planning scheme.

Similar organisational relationships exist on the Sub-System level, i.e. the smaller units which each System may be broken up into. That means that each detector sub-system has its own management team. Furthermore, there is a Technical Co-ordination team, who makes sure that the separate sub-detectors fit together without interference, and that the full detector can be assembled.

In summary, the power for political decisions is concentrated in the hands of the Collaboration Board, the Institute Boards, and the Resource Review Board, whereas the technical execution of the project is organised along the System and Sub-System hierarchy (Steering Groups, Project Leaders, Executive Board and ATLAS Management). Frequent communication between each of these structural entities, through their spokespersons, is the best way to guarantee that the policy issues are handled appropriately and that reasonable solutions are found for difficult problems.

The participating institutes share the duties in a proportional way so that the workload taken on by the partners is fair and corresponds to their commitment as agreed in the MoU. As a result of their expert knowledge in a given field, the institutes naturally become responsible for certain jobs. In fact, the partners are often chosen for their special expertise in the first place, everyone adding his individual brick to the whole construct. Then, once the tasks have been distributed, each institute specialises in its own particular function, and has to fulfil it as well as possible, that is, according to the
standards required by ATLAS. In return, institutes enjoy full independence regarding means they wish to bring into play to reach their objectives.

The bulk of physicists’ and engineers’ activity at ATLAS consists in discussing. “We discuss, and discuss, and discuss again. One of the things we do here a lot, is discussing,” says Mar Capeans, from the TRT (Transition Radiation Tracker, an element of the Inner Detector) team. The process is made all the more routine as the people are on the whole very open to dialogue. The issues and motives for such debates are manifold: First of all, the project and its substance are so complex and knowledge-intensive that no single person can hold the entire relevant information. Consequently, when a scientist is stuck and does not know what to do in a given situation, the first thing he does is ask his colleague. Then, ATLAS collaborators gather to discuss specific modules or concepts of a detector component, to present latest results, to pool ideas, to talk about alternatives, etc. In addition, reunions are typically scheduled to iron out technical problems and to solve disagreements about scientific questions. Each member gets the opportunity to defend his opinions or to dispute a point openly.

There are four basic types of meetings at ATLAS:

- The ATLAS Weeks, which take place 4 times a year, draw together all collaborators (physicists, engineers and technicians from all Systems and Sub-Systems) for a whole week. During the conferences and workshops, all project (sub-)groups present their scientific data (e.g. from test beams). When results show that something is not working properly, or that something needs to be changed, the other seminar participants are invited to give comments, contributing to the resolution of the problem. These consultations usually end with a session in which the respective Steering Group focuses on the most important aspects of the System and Sub-System and the progress of the work is examined more in depth. For the majority of ATLAS employees, this week of meetings, which is organised by items (that is, one day on the subject of mechanics, one day about electronics, another one dedicated to calibration, etc.), represents an ideal arena for exhaustive discussions among team-mates. This is particularly true for those who are not always on site and therefore do not have the chance to see their co-workers every day.
• **System or Sub-System specific meetings** (the so-called “Tile Cal.”-, “TRT”-Weeks) are habitually held a few days before the ATLAS Week to discuss procedure. They gather all partners (CERN and externals) who are working on the relevant part of the detector.

• Every System or Sub-System conducts **weekly meetings**, during which issues like quality control or the general acceptance of the module within the overall facility are treated. This type of reunion allows monitoring the progress of the work on a weekly basis.

• Spontaneous **discussions in the cafeteria** play an essential part in the daily life of ATLAS collaborators. It is in this kind of get-together that physicists and researchers share their knowledge, voice their doubts about this or that alternative solution, exchange impressions, etc. Besides providing the chance for shoptalk, those situations are often used to chat about personal matters, an important element for the establishment of strong personal ties between individuals and teams.

All these forms of meetings and steps are necessary if the project is to proceed satisfactorily. Each type of contact has a certain function in the obtainment of feedback, in the generation of ideas and alternative solutions to the technical problems encountered in the design and the construction of the detector.

Generally speaking, the meetings are all kept very casual. The dress code at internal conferences is rather light, hardly any participant wearing a suit or a tie. During presentation, regardless of its official character (for instance, in the case of the ATLAS Week) and the size of the audience, listeners do not hesitate to interrupt the speaker to ask questions or comment on the content. When addressing one another, the co-workers all use first names, or the second person (“tu” in French). This also applies to newcomers and visitors, as well as virtual associates, i.e. those who cannot be permanently in Geneva. The informal nature of the relationships is also made obvious by the ease with which people can talk not only to other team members, but also to people from a different (Sub-)System, or with Project Leaders or even with the head of the

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662 Capeans, interview, 30.05.02
experiment. Academic degrees (Ph.D., professorships, and so forth), titles, ranks, or positions appear to play no role in the everyday work at ATLAS.

Concerning decision making, ATLAS explains on its website how the process works:

“Many of the important decisions involve just one or two of the subsystems [(sic)]. The pros and cons are initially discussed in the subsystem plenary meetings. The term ‘plenary’ here implies that all collaborators working within the specific group (for example the subsystem) can participate in the meeting and make their voices heard. Recommendations are then discussed in the ATLAS Executive Board, and presented in ATLAS plenary meetings which play a primary role in forming a large consensus about issues for which decisions are required. The leadership can only ‘lead’ the collaboration to decisions which are understandable to all, or at least to a large majority. Practical constraints may influence decisions, like costs, schedule, the availability of teams to take responsibilities for the execution... Procedurally there is a clear sequence of steps to formally make decisions, with a hierarchical structure from sub-system to systems, and ultimately with the vote in the Collaboration Board being the final step for very major decisions.”

3.3.4.3 Co-opetition

In order to complete building the ATLAS detector, the associates have no choice but to co-operate. The physicists and engineers there are aware of that, and are consequently very willing to combine forces and work to as a team. The character of the whole partnership, which is not legally binding, induces a “gentlemen’s agreement” way of thinking, where every participant feels morally obliged to do his best for the sake of the project’s advancement. This is accentuated by the fact that ATLAS is an international endeavour, because the people participating in it want to prove that multiculturalism is a viable concept for achieving great scientific success.

This spirit is made visible through the way in which the tasks are apportioned. In fact, the duties and roles are assigned in a quite democratic and fair manner. Generally, the question is solved through solidarity and camaraderie, as everybody knows that there

603 From: http://atlasexperiment.org/etours_intro/etours_intro06_soc_q02.html
is not enough staff to accomplish the work anyway, the project being too big for the number of employees available. On its official website, the Collaboration asserts that:

“One tries to match the interests and resources of the participating teams to the tasks. This can succeed only if everyone is also willing to share the less interesting but necessary tasks. This in turn works because the physicists are motivated by the prospect of the exciting results to be obtained, and know that these depend on having a complete working detector system.”

So the common attitude is that “something needs to be done, so somebody has to do it”: Every colleague carries a part of the total burden by taking on and executing jobs that might be boring, but that need to be done, which means that members concentrate on duties corresponding to their own knowledge or to that of their home institute’s, so that everyone has clearly defined functions and responsibilities within the team.

But more than fulfilling one’s own tasks, co-operation at ATLAS is about sharing knowledge and ideas: There is a general mindset to make every piece of data, every suggestion, every drawing available to the other team members. For this purpose, a public directory, on which documents and comments can be up- and downloaded, has been set up on the experiment’s intranet. When somebody has a specific question or needs a piece of information, he can go to any co-worker and ask that person, no matter in which System or Experiment (ATLAS, CMS, ALICE, etc.) he is involved. Thus, there is no confidentiality or secrecy what so ever between individuals, teams, subteams, institutes, or experiments. Moreover, it is absolutely unproblematic to get advice, input or feedback from anyone, as access to information is made very easy – in some instances, even inspired – by collaborators.

In view of that laissez-faire concerning the exchange of information, one could even get the impression that this behaviour is pushed to the limit. As a matter of fact, one direct consequence of this kind of extreme participatory behaviour is the emergence of endless discussions. This can easily turn into a problem when a decision needs to be made.

604 From: http://atlasexperiment.org/etours_intro/etours_intro06_soc_q07.html
605 Mitsou, interview, 30.05.02
Constructive discussion among researchers does not imply that there is no competition between them: As in any organisation, competition is a normal thing in ATLAS. Nonetheless, physicists and engineers, who are in the middle of that competition, insist that the challenge is not harmful, and has nothing to do with nationalism or cultural diversity. On the contrary, it concerns purely private (professional) matters, such as opinions, beliefs or the way of looking at a problem. Co-operative relationships notwithstanding, one is expected to prove that what he asserts is right. When a researcher is persuaded that his opinion is the right one, because he has been working on the subject for a long time, he wants to verify the correctness of his results or assumptions, demonstrating that his solution is the most accurate. When two competing and convinced brains meet, interesting clashes may surface. And the potential for quarrel is all the more present, because ATLAS brings together bright minds, i.e. individuals who always were the pick of the bunch in their classes, and might not be used to having “intellectual opponents”. In these terms, the ambience in the Collaboration is extremely competitive, because everybody thinks that his own ideas are the best, and wants to defend his own point of view.

Most of the time, such conflicts are sparked off on purpose. The obsession of researchers to discuss was already mentioned above. Indeed, one could even say that the search for inconsistencies is an institutionalised procedure in ATLAS: In order to actively prevent the problem of groupthink, the partners ask one another to persuade them about their assertions. “Look, this is not satisfactory; convince me that it is good, or I will convince you that it isn’t”\textsuperscript{606}, is a frequently heard request by the members of the Tile Calorimeter team. This reciprocal testing obliges them to be very rigorous in every single line of reasoning.

Thus, it seems that conflicts are initiated in meetings and discussions. Not surprisingly, they are also solved in meetings and discussions. Anchored in differing priorities, views, and convictions, the discord develops when the co-workers’ exchange becomes aware of discrepancies. This happened for example, when:

“[…] A person responsible for radiation tests insisted that a radiation test be carried out, and that specific electronic components be installed onto the detector.”
The collaborators who had built those modules maintained that the test had already been done, and that repeating it would not make any sense.\footnote{Schlager, interview, 29.05.02}

Consequently, solving the dispute inevitably leads to reaching an agreement on the question under debate. The conflict resolution process used by most teams is straightforward: First, one group presents its solutions; then, the other participants give feedback and comment on the proposal; after a mutual effort to convince one another, the parties negotiate until a fair arrangement is found. In the case described above, the agreement consisted in having the tests performed, but with a reduced sample of radiation types. This illustration shows that the debates are founded at all times on scientific arguments, so that conflicts never become personal. Of course, trouble can arise when antagonists are particularly stubborn and stick to their position. But in that case, it is more a question of character rather than of cultural diversity.

It is only natural that one should desire to have one’s own ideas recognised in the community. So every participant demands acknowledgement and visibility for his findings, initiatives, or suggestions. The rationale behind such behaviour is rooted in two types of aspirations: First, employees are looking for their work to be exhibited to the other team members and to the outside, so they can build up a reputation; then, in order to maximise their chances for promotion, they expect that what they put forward is taken into account internally. Therefore, an institution like ATLAS has to ensure that all contributors get the credit they deserve. The dilemma with this Experiment is that it is so vast (from the perspectives of human resources and time), that it is almost impossible to track down the contribution of Mr What’s-his-name, and to identify the significant nature of his idea. “The size and composition of a team may be such that individual members find it difficult to emerge and sense that their intellectual contribution is not given proper recognition”, says Giuseppe Mornacchi. “If this happens, strong tensions may be created among team members”\footnote{Mornacchi, interview, 17.05.02}. In order to prevent such trouble arising, the ATLAS management takes care to handle all contributions in a fair way that respects authorship:

\footnote{Miralles, interview, 17.05.02}
\footnote{Schlager, interview, 29.05.02}
\footnote{Mornacchi, interview, 17.05.02}
“Internal publications within the Collaboration, usually with one or a few authors, will document the individual contributions. These can be made known to the whole scientific community. Also, leading contributions are often recognized by asking the person in question to present results at conferences.”

For those publications that do not come under ATLAS’ official publications policy, the issue is solved quite rationally. In several Sub-Teams, the procedure is that all members are mentioned on the document (papers, notes, memoranda, etc.), independent of the form and the extent of their contribution. However, the instigator or the main author is entitled to go to the congress at which the piece is being presented. So he is also the one who stands in front of the audience, giving speeches, answering questions and representing the team. This formula ensures that the person who was most involved in the effort obtains the acclaim and the visibility he merits.

In spite of such precautions, however, arguments arise. The countless cultures involved, the scientific complexity of the subject, the technical challenges raised, etc. are all elements that inexorably trigger disputes between the team members. Then, divergences are more seen like a chance than a threat, provided they are based on objective reasons. Otherwise, when tensions are caused by destructive attitudes, such as prejudice, narrow-mindedness, or intransigence, they rapidly have negative effects on the co-operation. While this is quite a rare occurrence, given the multicultural constitution of CERN and ATLAS, it did happen for instance when collaborators from Eastern European countries joined the team in the mid-1990s. Their cultures were rather new to the existing employees, who were used to working with people from Western nations.

"At the beginning, our co-operation wasn't so good. This was due to our new membership in the project. Our group was very enthusiastic and we brought new ideas how to solve technical problems. Not everybody was pleased about that. Our new partners didn't have experience with people from Eastern Europe and they probably didn't believe in our novel proposals. […] The people here had a precise perception about the [Sub-System], and we had a completely different one. We were new, and we had non-standard ideas and non-standard solutions.

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609 From: http://atlasexperiment.org/etours_intro/etours_intro06_soc_q16.html
The problem was that we were thinking outside the usual concepts, outside the usual technical solutions; and therefore we were strange for them. Ours were not the typical solutions. [...] Discussing with them was difficult, because we had different ideas, different solutions. Our’s is a very sensitive area, which requires time to find a ‘common language’. Sometimes, I felt that they didn't believe that we were able to manage such complex technics and non-standard technical solutions. Discussing with them was sometimes a little bit more difficult than usually.\textsuperscript{610}

The previous is a typical case of the not-invented-here syndrome. Although this episode was an exception and apparently only a short-lived transitory phenomenon\textsuperscript{611}, the example shows that even a multinational organisation like CERN or ATLAS is not free of preconceptions and discrimination.

Habitually, dysfunctional conflicts have their roots in the politicisation of issues. Specifically, clashes arise when some associates wish to impose their own proposals because of the weighty financial contribution of their home institute. As a matter of fact, their political strength (that is, the influence they exercise in the decision making process) often depend to a large extent on their involvement in the project, in terms of money and human resources. So institutes supplying more funds, material or workforce than others can expect to have a greater say in the choice of a particular design, concept, or supplier. Such power struggles represent exactly the situation in which the seeds for severe failure are sown.

3.3.4.4 Conversation

Maintaining effective conversation is one of the main challenges within the Collaboration, because it is a key vehicle for the exchange of knowledge, and thus for scientific advancement. But at the same time, it constitutes the “principal source of technical problems”\textsuperscript{612}. Misapprehensions due to deficient communication can not only lead to technical or procedural errors, which cost money and time, but may also have grave consequences on interpersonal relationships. This occurs for example when comments

\textsuperscript{610} Anonymous, interview

\textsuperscript{611} Indeed, the author of the statement insists that “in the end, all controversial things were solved and today, I'm fully satisfied by our co-operation. Our present results confirm this.” (Anonymous, interview)
are taken personally, although the person who made them intended to remain objective and factual. The potential for confusion is notably manifest when dissimilar cultures are involved. Examples of pitfalls include the following:

- Because of lack of vocabulary, the addressee of a message is unable to capture fully what the issuer wishes to get across.

- Somebody with a strong local (e.g. Scottish) accent might use an intonation pattern or expression that are typical of his region, but which are not understood by the rest of the team.

- A native English speaker overestimates the language skills of his interlocutor, while the latter, not grasping the complete message, prefers for reasons of dignity not to ask the former to repeat what he had just said.

- Researchers from low-context cultures do not receive the “hidden” messages of colleagues from high-context nations.

- Newcomers who do not speak English, French, German or Russian well enough are excluded from the socialising process at ATLAS and CERN.

Apparently, the first main source of difficulties is the language itself. Indeed, communication deficiencies arise mainly when a common language is missing. Still, this is something that can hardly ever be observed. The grounds are manifold: On the whole, a large majority of physicists and engineers working on the ATLAS project and, particularly those sent to Geneva, are more or less fluent in English. Many collaborators are from a generation that learned the language in school or in university. Then, given that English is the lingua franca of physics, this tongue heavily influences the terminology but those who do not speak it can try with French, German, or Russian, other common languages within the Collaboration. If this solution does not work either, the partners can count on compatriots who act as translators. The readiness to lend a hand to fellow nationals (regardless of the team) who have difficulties in understanding and in being understood by their team-mates is exceptionally pronounced in ATLAS. The motive for such wholehearted assistance is quite evident: Everybody who has experienced fal-
tering discussions as a result of an asymmetry in language skills – and those situations do take place quite regularly, as when newly arrived researchers, who learned English by “reading and translating articles”\textsuperscript{613} have to converse for real with their colleagues – knows how painful it is to get stuck in a dispiriting process, and therefore is willing to help by interpreting dialogues.

The menace of communication problems in the course of professional exchanges should not be overestimated. It should be remembered that the terms used at work have a technical or scientific meaning; consequently, they can be considered as universal, so that misunderstandings should remain exceptions. The situation is different, of course, when language is the medium for talking about personal matters. Specifically, non-native speakers’ vocabulary may not be extensive enough to express thoughts, impressions, or emotions. On the words of a Bulgarian summer student, “the language barrier is a problem to socialize sometimes”\textsuperscript{614}. This in turn can become an impediment for the integration into the team.

In order to facilitate assimilation and collaboration, CERN offers training in English and French, both for internal and visiting associates. These “courses are designed to develop oral communication at CERN and in the local environment, with a strong emphasis on the specific needs related to CERN’s scientific and technical activities”\textsuperscript{615}. While the participants of the English lessons are above all new users and established staff of French mother tongue, those learning French include primarily Users as well as recently arrived staff members. Probably as a direct corollary of CERN’s physical location, the Organization chose French as its second official language. That means that all official publications (annual reports, circular letters, brochures, CERN bulletins, etc.) are brought out in French as well as in English. Then, employees working in the canteen, the library, cafeteria, and so forth are ordinarily recruited from the nearby region. Since they are not as exposed to multicultural teamwork as their scientific comrades, there is no immediate need for them to learn English.

\textsuperscript{613} Moraviev, interview, 30.05.02
\textsuperscript{614} CERN (2000a)
\textsuperscript{615} CERN (2002b), p. 21
As a consequence, French is almost as widely spoken at ATLAS as English. In effect, one can hear conversations held in French in many places around the CERN site. Given that leisure is enjoyed and hobbies are practised in a primarily francophone context, chats and dialogues about such activities and experience (weekend, holiday, family, etc.) ordinarily take place in French. But the regular use of that language is not limited to administrative and casual communication. In fact, it seems that French is prevalently used in CERN’s accelerators departments (for example, the Proton Synchrotron Division, the Accelerator Co-ordination Unit, or the Large Hadron Collider Division), while English is predominant in the more research- or physics-oriented units (Experimental Physics Division, Theoretical Physics Division, etc.). This is probably a direct consequence of the influence of French scientists on the former area. As a result, the traditionally high number of Frenchmen in these sections of CERN has reached a critical mass, establishing (if not imposing) their native language as the prevailing medium of communication in the Organization. Other francophone-dominated areas include civil engineering, construction, handling of equipment, monitoring of technical infrastructure, or safety, i.e. domains that require the constant presence of technicians.

Technicians are in some ways also responsible for the widespread employment of French in offices, meeting rooms, workshops, and assembly halls in other divisions. Indeed, this phenomenon can be explained less by the official nature of French at CERN than by the fact that the majority of the technicians (representing more than a third of CERN’s population) comes from Romandy or France. Technicians often either do not speak English or prefer to express themselves in their mother tongue. Accordingly, people who wish to communicate with them “speak French because they [the technicians] cannot speak English”\(^\text{616}\). In other words, physicists and engineers working on site are more or less forced to learn French. This influence of French technicians is also reflected in the existence of French words in technical reports written in English (e.g. *voussoir* instead of “strut”; *palonnier* instead of “lever”; *cavalier* instead of “inner gas seal support bracket”)\(^\text{617,618,619}\). These terms establish

\(^{616}\) Papadopoulos, interview, 17.05.02  
\(^{617}\) ATLAS (1999), p. 7  
\(^{618}\) Andresen, interview, 29.05.02  
\(^{619}\) Dittus, 30.05.02
themselves, because they are so precise and describe the essence of the object so well, that their users give up trying to translate them, and use them in their own language.

Likewise, technicians who are sent to Geneva by their home institute for only a very limited period of time (one week at most) in order to fix a problem on a Sub-System, do not really have to learn English or any other foreign language. As they do not cooperate every day with the rest of ATLAS’ multicultural personnel, focusing on the component or module for which their institute is responsible, they can afford to rely on a translator to accomplish their tasks. In view of that, the necessity to be able to speak one of the Collaboration’s “common” languages (English, French, and to a lesser extent, German or Russian) is less pronounced for technicians.

Consequently, the language spoken within ATLAS is a sort of mixture of broken English and French, a dialect tenderly dubbed “Cernese” by the Organization. The mistakes and (technical and non-technical) vocabulary remain rather standard. Since scientific aspects lie at the centre of conversations, the grammatical correctness of the sentences pronounced does not really matter. “As long as both interlocutors understand the message, the language actually employed is irrelevant,” says Gerolf Schlager from the Tile Calorimeter Team. This very group emerges as particularly fervent and adept at blending English and French in their conversations. In fact, the team presents ideal prerequisites for such multilingual communication, because almost all its members are from Latin cultures and speak French fluently. Thus, they have the tendency to talk French (in terms of the articles, verbs, and phrases used), although the subject, physics, is in principle a field in which English words are prevalent. Independent of the occasion (formal meetings, informal meetings, coffee breaks, dialogues in the corridor, on the phone, etc.), they switch from English to French and vice-versa whenever the terms and sentences come easier in this or that language. Quite amazingly, many participants who are not entirely fluent in French are all able to respond to questions that have been asked to them. Nevertheless, the others usually reciprocate by continuing the discussion in English.

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620 CERN (2002d)
621 Schlager, interview, 29.05.02
Not every communication difficulty can be put down to language. Rather, one major source of problems in ATLAS is its size. The project is so extensive that the physical distance between the people involved (especially between those who are permanently on CERN’s Geneva site and those who are not) prevents them from establishing deep relationships. The efficiency and quality of their communication suffers considerably from this circumstance, the global spread of the Collaboration generating a sort of detachment of the partners that obstructs the interactive flow between them. Scientists from Europe, Russia, USA, Japan, and beyond have to travel long distances to participate in the meetings and discussions. Between such gatherings, exchanges take place via telephone, email, video conferencing, or the like. In this context, the greater part of ATLAS scientists acknowledge that it is very difficult to establish commitment and trust with colleagues who are several thousand kilometres away. This is not to say, however, that those media listed above are not utilised. On the contrary, the bulk of the messages exchanged within ATLAS are conveyed electronically, since not all members of the participating institutes are based at CERN and permanently included in the discussions.622 But normally, the information contained in such notes is very simple, as they are used to confirm dimensions or scenarios, to ask for something very precise (e.g. the name of a publication), to make sure a point discussed earlier on is well understood, and so on. In contrast, people call one another on the telephone, when they want to arrange a meeting, discuss something very briefly (two minutes or less), or fix administrative questions.

Still, despite constant exchange of emails, everyone prefers to talk and work together face-to-face. Among the collaborators who are based in Meyrin, virtually all choose to drop in on somebody else’s office to tell him something or to share an idea, rather than giving a phone call or writing. It is not only considered as more pleasant to see one’s co-worker, but as Calin Alexa asserts, “you cannot really discuss just by email”623. For example, sitting together at a table is an absolute must when engineers wish to design a component or develop a scenario. Moreover, Schlager perceives a clear correlation between the frequency of physical contact and the incidence and the severity of

622 Capeans, interview, 30.05.02
623 Alexa, interview, 15.05.02
dysfunctional conflicts. For him, “the smaller and the more frequent the [face-to-face] meetings, the fewer the disputes”. Hence, personal exchange and physical presence of the partners remain major ingredients in the sharing and creation of knowledge, a fact that the Collaboration itself does not fail to highlight on its website: “Regular human contacts are crucial elements in the communication. Meetings therefore play an important role in the life of ATLAS.”

3.3.4.5 Captaining

Effective leadership is essential for the functioning and the execution of the ATLAS project. The size and spread of the endeavour require important co-ordination efforts. The structural organisation, its organs, and the ways it is led as a whole was described in chapter 3.3.4.2, which, however, did not show how team members are guided on the individual level. The Project Leaders bear the responsibility for overseeing their (Sub-)System and are in charge of its prompt design and construction. However, their mandate, which is defined quite formally, does not say anything about how they shall fulfil their duties. Therefore, it is at their discretion to employ whatever means they choose to ensure that everybody is heading in the same direction. Their appointment is the result of the following process:

“The Project Leader is nominated by the System participants, short-listed by the Steering Group, elected by the System Institute Board, proposed by the spokesperson to the Collaboration Board and approved by it.”

This procedure is quite an official one. It may be affected by the aspiration of individuals as well as political pressures exercised by institutes. Each member of the Collaboration Board has one vote, independent of its size and its involvement in the project. Therefore, some people feel that the result of the ballot is sometimes inadequate, which leads to discontent among the large contributors. Furthermore, there is a feeling among certain collaborators that one can become Project Leader as soon as he is endorsed by a critical number of institutes, even though he has not proven his worth in the project.

624 Schlager, interview, 29.05.02
625 From: http://atlasexperiment.org/etours_intro/etours_intro06_soc_q06.html
But generally, the Project Leader emerges naturally from the team. When a new such leader is sought, the team member who displays managerial talent, scientific competence and other qualities particular to a good captain, has the best chances to get the post. Those are skills that can be acquired with time. Little by little, the community recognises that candidates for such a position have extraordinary abilities in the management of people. “You feel it in the meetings, when they discuss and give opinions”\(^{627}\), is how Ana Henriques describes the aura of this kind of personality. These abilities are very important, because the Project Leader plays an eminent role from a human relations perspective. His position obliges him to cope with many different characters, activities, and cultures. Because of the frequent contact he has with his colleagues, he is greatly exposed to the diverging opinions that prevail in the team. He has to identify, comprehend, and reconcile the various approaches and ideas of his co-workers. In order to have the whole team focus on the task at hand, it is his duty to moderate the discussions taking place among the scientists, and to determine which of the options put forward by the partners should be kept and which of them filtered out.

The Project Leader holds the formal status of a principal. He gives the direction, sets goals, and establishes and states the requirements for the tasks to be carried out. Still, the Project Leader is not always the only person with managerial duties in ATLAS teams and sub-teams. If he is not directly affiliated to (i.e. paid by) CERN, he is normally supported by a special co-ordinator, who organises the assignments that come up for CERN associates. But in this case, while the Project Leader gives the overall direction of the group, the co-ordinator is the one who synchronises the activities by collecting and channelling the information (test results, state of affairs, schedules, next steps, etc.). He also allocates the tasks that need to be executed. This involves regular visits to assembly halls, arranging meetings, and above all instilling intense communication with all team members (physicists, engineers, and technicians) and with people from other Systems and Sub-Systems. The co-ordinator has to be an insider. As a representative of CERN, the Project Leader has to take into consideration that he and his fellows are stuck in two overlapping organisations, CERN and ATLAS. So it is

\(^{626}\) Åkesson (1996), p. A5.6

\(^{627}\) Henriques, interview, 15.05.02
part of his mission to bring together both systems in a way that is fair for all participants, in particular for those who are not from CERN. Consequently, this job calls for a profound understanding of the internal regulations and the hierarchies ruling both institutions, for a strong sense of diplomacy (to square contradicting views), and for a great deal of integrity (in order to be able to avoid and to resist conflicts of interest).

Although the Project Leader and the CERN co-ordinator can be considered as the heads of the team, the group members are entirely autonomous and free in the way they fulfil their assignments. Feedback comes from all group members, and further requirements are revealed, spelled out, and distributed by the team as a whole. So in ATLAS’ teams, leadership is more a collective matter than that of one or two individuals.

Nevertheless, one question that must preoccupy the mind of the leader is the motivation of his partners. ATLAS collaborators are not to be inspired by money. Although the position of becoming a permanent CERN Staff member – which implies prestige, stability and financial advancement – constitutes a highly desirable objective for many associates, their primary interest is in the scientific success of the project. Yet, the complexity of the endeavour and the technical difficulties that go with it can have different motivational effects. On the one hand, scientists feel challenged by the puzzles posed by the design and the construction of the detector. Alternatively, when those problems are too complicated, full of twists and turns, they may grow increasingly frustrated and disillusioned about the possibility of solving the questions they constantly face. However, the process of motivating ATLAS collaborators is definitely facilitated by the existence of clear goals. “Our objective is to build the detector, to make it operate, to make it operate well. This is what we are working towards.”628 With such a precise target, the physicists, engineers, and technicians know exactly what they are making efforts for and what they are heading to. Their foremost incentive is to see the machine function and deliver the results reckoned and anticipated by theorists and one day to be able to say: “I have contributed to this scientific masterpiece.” In addition, the complexity of the undertaking and the clarity of the goals facilitate co-

628 Schlager, interview, 29.05.02
operation in such a way that they cause the partners to abstain from conflicts attributable to cultural diversity:

“When you have a problem, the multicultural issue disappears. You forget about multicultural differences. You have a bunch of specialists in certain domains, and you want to solve that problem. You know that somebody is good at this problem, somebody else at that problem. So you don’t care, you just want to solve this problem. Let’s find out what we have to do, and let’s do it. Multicultural differences don’t exist anymore.”

Thus, a clear-cut purpose triggers an enthusiasm that renders the collaborators prepared and disposed to work long hours, even during the weekend or over holidays. It confers a meaning to every single task, so that the person who has to execute it is willing to do his best, irrespective of the assignment’s tedious or tiresome nature. In other words, motivation takes place through actively interesting the employees by providing them a point of reference to aim at.

Apparently, this fascination is natural, the driving force of ATLAS people coming from the job and the domain of activity, but this intrinsic motivation, in turn, devalues the role of Project Leaders and co-ordinators as guides. Still, their job regains importance when it comes to inspiring people individually. This is necessary for instance when the team has repeatedly abandoned someone’s suggestions. Such an experience is very frustrating for any scientist, and requires much diplomacy from the leader to encourage his colleague to persevere and carry on contributing comments, thoughts, ideas, or proposals. This kind of stimulation takes place through one-on-one conversations and fairness in the distribution of compliments and criticisms. Leaders who are considered as good by their subordinates and peers tend to be very careful and discreet when paying tribute to collaborators. According to Lluis Miralles, “the best way to keep peace in the team is to make sure that everybody has the feeling that his contribution is important.”

As pointed out in the chapter about co-opetition, scientists seek recognition and visibility. That means that they expect their work to get the credit it deserves, within and

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629 Alexa, interview, 15.05.02
630 Miralles, interview, 17.05.02
outside the team and the Collaboration. Examples of public appraisal include the explicit naming of particular individuals in the completion of an outstanding piece of work, or the mentioning of key contributors as main authors of publications, or the chance to present one’s paper at international conferences. On the other hand, when failures occur, leaders appreciated at ATLAS act in a very open but tactful manner:

“When [...] an important deadline or goal has not been reached, the reasons are pointed out in the meeting, and we ask for explanations. The explanation is commented on and accepted, or not. The person or team responsible gets another deadline to recover his or its mistake.”

Fairness, equality, subtlety and compassion are the qualities in a captain demanded by ATLAS employees if they are ready to dedicate themselves to him. As seen earlier on in the chapter, commitment to the project arises more or less naturally. That does not necessarily apply to the leader. To be accepted, he has to demonstrate his social and leading skills, in particular the ability to praise good performances of the team and individual members. For many people, this constitutes a prerequisite for them to follow their Project Leader or co-ordinator. Once the leader has acquired this kind of respect, i.e. when all team members are committed to him and his views, he enjoys full support for his choices. “The team often reflects his leader of the group, that is, the behaviour of the group depends very much on the leader of the group”, asserts Ana Henriques. “If you have a boss who is very reasonable, the group will in general also be reasonable. If you have a boss who is really fighting for something, the whole group will follow him.” This represents a valuable advantage in situations of negotiation with other teams, because the cohesion displayed by the group demonstrates its collective belief in the solution proposed and its willingness to realise it.

3.3.4.6 Chemistry

The gentlemen’s agreement nature of ATLAS creates a situation of mutual dependence between the associates (funding agencies, institutes, individuals). This circumstance increases the requirements regarding trust and reliance. Still more demanding is

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631 Miralles, interview, 17.05.02
632 Henriques, interview, 15.05.02
the fact that, while the teams are more or less thrown together randomly (at least from a cultural perspective), the management’s sphere of action in quest of an optimal arrangement of R&D teams is very restricted. In other words, ATLAS’ leaders are presented with a *fait accompli* as far as the composition of teams is concerned. However, the Collaboration seems to solve the question of diversity quite effectively. According to the people involved, three main elements explain this success:

- The good integration of new colleagues into the existing teams, sub-teams, and into the organisation as a whole.
- CERN as a particular favourable environment for multicultural co-operation.
- The values shared by all ATLAS collaborators, which act as a lubricant for the relationship among associates.

In the present context, two forms of new entrant may be identified:

1) Scientists who become members of personnel of CERN (Staff, Fellows, Students, etc.) and who get assigned to the ATLAS project; and

2) Associates who were previously working remotely from their home institute, and who settle in Geneva in order to be closer to the venture, or to the detector.

Those partners are expected to stay in Meyrin for a longer period of time, so they have much more contact with their collaborators than those colleagues who operate from their home institute. Accordingly, they are more exposed to issues like personal (in terms of face-to-face) arguments or cultural diversity. So in order to facilitate cooperation, they need to be assimilated into the rest of the team, just like any other CERN “freshmen” (first category).

Not surprisingly, every ATLAS team has different schemes for smoothing the process of introducing and integrating new entrants, though certain practices and customs are common to all of them. As already mentioned in the section about connection, the contact between collaborators is very casual, regardless of the hierarchical level separating the interlocutors. So people who have questions, technical or non-technical, can ask practically everybody. One can address any superior, subordinate or colleague and solicit his help, and the latter will lend a hand and solve the problem. This not only
promotes the familiarisation of neophytes with scientific issues, but by the same token reduces the time needed to adapt to the new environment. Language also plays a central role in the acclimatisation of ATLAS novices. English and French classes offer the possibility to get in touch with people who are experiencing the same feeling of being a foreigner in Geneva or a cultural greenhorn in a huge melting pot made of physicists and engineers from all over the world. Furthermore, in the same way as in the point presented above (gracious support whenever a technical question arises), native speakers are typically very cooperative and obliging when a new colleague, who is not yet proficient in French or English, asks his officemate to explain something about the language he is currently learning. Thus, it often turns out that people learn languages from their immediate partners, just by conversing and spending most of their working hours with them.

The valuable role of humour in this regard is worth noticing. Indeed, when discussed at all, the question of multiculturalism in ATLAS teams is ordinarily picked up in a very playful manner. Anecdotes about certain nations or jokes about cultural preconceptions or stereotypes are very common in those communities, and are appreciated by all participants.

Another means to integrate new entrants and to develop a good atmosphere among colleagues is the organisation of common events. Such gatherings can take place at the initiative of ATLAS itself or of individual persons within teams (a captain most of the time). In wintertime, for example, the Collaboration organises an official ATLAS Ski day, to which all partners and their families can participate. Likewise, CERN employees who share the same pastimes (beyond their job) may join specific associations, like the Concerts Club, the English Book Club, the Solar Club, or the Horse Riding Club. Finally, CERN sets up diverse sporting events, in which the sides are predominantly constituted of members from the same System or Sub-System who see and co-operate with each other every day. The meetings or parties are not necessarily arranged to celebrate the accomplishment of a particular deed. Rather, they aim at drawing the co-workers closer by encouraging them to sit together informally, with the objective of making them discover other cultures. One team that really cultivates the holding of such convivial assemblies is the Tile Calorimeter Team. In effect, its asso-
ciates regularly meet to share local culinary specialities for occasions as various as “birthdays, name days, or the acquisition of a new car”\textsuperscript{633}. Those happenings usually last no more than half an hour, but have proved excellent for the ambience and cohesion within the group, according to its representatives.

CERN itself provides an excellent context for multicultural activity. Thanks to its supranational nature, it constitutes a unique place for people from all over the world to tie strong relationships and combine forces. The reasons are manifold. First of all, its location, just outside Geneva, straddling the Franco-Swiss border, indicates the international spirit of the collaboration. It symbolises the wish to overcome national boundaries in the name of science, “to create better relations between nations, and to rid the world of the dangers threatening the existence of the civilisation that fosters [physics]”\textsuperscript{634}. The Organization acknowledges that its polyglot restaurants, its clubs, the common events, etc. could be as important as its accelerators:

> “It is in the restaurants that a visiting scientist discovers the true flavour of CERN, along with the Swiss cooking. At surrounding tables animated discussions about high-flown theories, intricate experiments, or the best places for skiing, are going on in half a dozen languages, with Broken English predominant. Physicists from many lands, dressed informally for hard work, forge friendships over their hurried meals. With experience, one begins to take such things for granted which may be a pity, because there is nothing quite like CERN anywhere else on Earth.”\textsuperscript{635}

Moreover, in a completely multicultural environment like CERN, i.e. where everybody is basically a “foreigner”, there is an intrinsic feeling of equality and tolerance among all collaborators. Wherever one goes, one finds people of different origins. The greater part of workers come from somewhere else than Geneva, so they are all more or less uprooted, and regard themselves as being all in the same boat. And since no one at CERN is really at home there, it is very easy to find individuals who are living the same experience, and thus who have at least one thing in common, namely their sensation of “uprootedness”. What’s more is the fact that many scientists at CERN have

\textsuperscript{633} Emery, interview, 16.05.02

\textsuperscript{634} From: http://public.web.cern.ch/Public/CERNOP/League9.html

\textsuperscript{635} From: http://public.web.cern.ch/Public/CERNOP/League1.html
brought multicultural matters into their private life. Some staff members who have been living in Geneva for a long time found a Swiss or French spouse, their children playing with locals or foreign friends; or generally, their circle of friends is constituted of people from many different countries. Then, “the fact that you don’t know much about other cultures makes you more interested in the others”\textsuperscript{636}, comments Giuseppe Mornacchi. Therefore, there is a sort of mutual curiosity about other cultures, which helps in establishing contact and strengthening ties between colleagues. This interest in foreign cultures, which seems to be common to the vast majority of ATLAS associates, is reflected in a certain open-mindedness that acts a very effective filter for cultural clashes. Moreover, stressing the differences with a monocultural company, Ian Hooton observes that at ATLAS,

“There is no English animosity against [for example] the French, because most people who work here understand the complexities of the system here, and how it should work together. And when you are applying for a position here, you have to be able to understand that you are working in a multicultural environment, as there are collaborators from all over the world working here. So you have to come already with an understanding in your head. Whereas if you are in Britain, you are working for a British company, it is you against the rest of the world. So when you come here, you have a sort of mindset, you understand that you are working for a multicultural system, and you do your best to integrate into the community.”\textsuperscript{637}

Thus, for some collaborators, the identification with ATLAS appears to prevail over the national affiliation. That means that associates tend to focus primarily on the execution of their tasks and the realisation of the project rather than becoming entangled in quarrels involving the scientific superiority of one educational system over the other, or aiming at the maximisation of the benefits for one’s home institute or country. But the empathy, enthusiasm, and loyalty to CERN and the ATLAS project are the not the only strong values the partners share. Indeed, they also have many principles and ideals in common, which make their interests converge, allowing them to

\textsuperscript{636} Mornacchi, interview, 16.05.02
\textsuperscript{637} Hooton, interview, 29.05.02
concentrate on what is essential, the project itself. Consequently, commitment and camaraderie constitute the backbone of every ATLAS team.

Another common quality of ATLAS partners holding together the community is their shared awareness of belonging among the best particle physicists in the world. This elitism generates admiration of one another’s achievements and great mutual respect. Consequently, when somebody wishes to discuss something, the colleagues listen to him and take him seriously, which considerably accelerates the communication flow among the researchers. Nevertheless, it does not prevent them from having and expressing different opinions on technical questions and debating on them. On the contrary, the climate of constant argument always endures, no matter the level of friendship among team-mates and the range of feelings, beliefs and ideals they have in common.

Finally, the affiliation to the guild of researchers and scientists holds a great potential for cohesion, devotion and allegiance. The discipline they are involved in and the prospect of contributing to scientific advance brings so much satisfaction that it appears to eclipse other aspects of life, including nationality, leisure, career advance, and so forth. In fact, it seems that being a physicist, or being married to another physicist, is much more important than having Portuguese nationality or working for an Organization such as ATLAS or CERN. This in turn may justify the quasi-absence of prejudice at work, as remarked on by Maurice Jacob:

“Scientists share a common language and a way of thinking, whatever their mother tongue or culture. This enables them to establish contacts which, though triggered by scientific interests, can lead to exchanges over a much broader spectrum. These links, built up in the framework of fundamental research, are always free and open and are not undermined by political or economic imperatives.”

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638 Jacob (1999), p. 2
4 Implications

4.1 Construction of the theoretical model

The case study exposed the reasons for ATLAS teams’ success. However, it revealed that the six factors identified beforehand do not all have the same potential to explain this success. In fact, some elements seem to play a more important role than others. Moreover, the factors vary much in the way they influence teamwork. For example, some of them affect task effectiveness more while others have an effect on the relational effectiveness of teams. Likewise, the factors may shape the team directly or indirectly, that is via other sub-factors (to be identified here). The result of this is a closely intertwined set of connections between small rather intangible elements.

4.1.1 Discussion and propositions

The following section will discuss the findings of the previous analysis and derive some theoretical conclusions in the form of conjectural propositions. The main objective is to delimit the question of multicultural R&D teams’ success in a much more accurate way than has been so far done, in order to be able to draw a model explaining the problem in the subsequent chapter. Following the same structure as in the case study, the discussion will consecutively focus on each of the 6 C’s.

4.1.1.1 Composition

One key result of the examination is the de facto insignificance of the mix of nationality as a means of clarifying the success of R&D teams. This outcome undermines the importance of teams’ composition as a success factor. However, this is not to say that cultural diversity is irrelevant for the collective knowledge creation process. It just suggests that using the culture of the individual team member, as an explanation of his contribution is quite a fruitless approach. Rather, those personality traits that appear as culture free, i.e. independent of the nationality (assiduity, diligence, openness, etc.) are much more decisive. People at ATLAS tend to systematically exclude national or

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639 Here, it should be kept in mind that everything that is about to be said is drawn from the empirical part, which investigated research teams solely. That means that the suggestions issued here cannot be generalised offhandy and that an arbitrary application to other types of R&D teams should never be taken for granted.
chauvinistic considerations in their judgements about a colleague. What counts at the end is if the collaborator has a good character, makes good comments, or provides good ideas. So the general idea is that what matters is not the passport, but the fact that people have different opinions and therefore provoke discussion. Hence, as the main occupation of the scientist is to tackle technical problems, this job does not really leave too much room for issues such as the colleagues’ culture or nationality.

The reasons for such an abstraction of cultural matters are quite clear-cut. First, cultural diversity is regarded as something normal in the domain of particle physics. It is not only the logical consequence of international co-operation; in view of the complexity and resources needed to realise projects on the field, it has truly become a necessity. Thus, in an environment like CERN, people are generally very open. They do not care about attributes such as nationality. Politics and interests are forgotten in the name of science. Furthermore, in an R&D project like ATLAS, privileging the nationality over excellence would be a very dangerous choice. Everybody knows that it would not be wise to favour an option just because its originators come from a particular, high-profile country, with a great impressive tradition in a particular scientific domain. Although such comparative strengths do exist, and though physicists from dominating nations do indeed enjoy great prestige, decisions made are nevertheless always derived from rational and scientific arguments.

Having said this, the importance of bringing together people with different backgrounds cannot be underestimated. ATLAS, as the project consisting in the design and construction of a highly complex machine, lives off the ingenuity of research teams. And the more different the views that are represented in the group, the better. Here, the benefits of cultural or educational diversity are beyond doubt. On the contrary, multiculturalism itself is a welcome side effect of ATLAS’ principle of recruiting and accommodating researchers from all over the world. Everybody accepts and appreciates meeting and working side-by-side with fellows from other continents. They are well aware of the advantage of sharing thoughts, suggestions, or comments by people with different educational backgrounds and approaches. They learn from each other and from a human standpoint; operating in a multicultural team renders the venture all the more pleasant. But, again, this concerns only the diversity on the whole; the parti-
cular culture of the partner is rather insignificant, although the possibility to ascribe certain types of behaviour or methods is indisputable.

These insights lead to the following set of propositions:

Proposition 1: *Cultural diversity itself (as determined by the number of cultures involved in the team) is a main vehicle for achieving superior task effectiveness in multicultural R&D teams.*

Proposition 2: *The arrangement of personal characters accounts more for multicultural R&D teams’ success than cultural composition, in terms of the combination of nationalities, does.*

4.1.1.2 Connection

In the main, the key problem at ATLAS is to have people from all over the world work together, though the chief hurdle is not their origin, but their huge number. The size of the collaboration, which here refers to the number and the wide dispersion of institutes, actually loosens the connection between the associates. As such, it constitutes the prime source of trouble for multicultural R&D teams. Reconciling the interests and the opinions of the 150 laboratories carrying out the project, let alone finding an agreement, is not an easy undertaking. Before partners can discuss and decide about issues (even technical ones), they have to build up relationships anchored in trust. For several reasons, establishing confidence and mutual reliance in such large communities is quite difficult: First of all, it takes a lot of time to meet everybody, to get to know people and to become acquainted with their approaches, ways, habits, attitudes, etc. Even after this introductory process, the associates only gather together as a whole four times in a year. Admittedly, this lack of frequent contact is specific to ATLAS as an entire project, not to the different sub-systems. The situation is not as grave in the sub-projects, since the number of participants is accordingly smaller. Still, the fact that ATLAS itself is so extensive obliges the management to divide the project into a number of separate, rather independent, units. This, in turn, implies that the researchers focus much more on their own part of the detector than on the machine as a whole. Hence, the individual collaborators tend to get entrenched in their own thing, losing sight of the final goal, i.e. the completion of an experiment involving several sub-
systems. All these structural obstacles have one effect in common: They disconnect the team, impeding an effective advancement of collaboration.

Proposition 3: *More than the cultural multiplicity of teams, it is the size, the geographic magnitude, or other structural aspects that are responsible for organisational difficulties in multicultural R&D projects.*

On top of that, the non-legally binding nature of the Collaboration (implied by the Memorandum of Understanding) turns ATLAS into a very loosely connected establishment. Exacerbating the risk of free riding, this circumstance imposes even higher demands on trust and commitment. However, this dilemma is solved through the application of two clear principles:

1) **Equality** between all contributors in strategic matters (marked by the political process that governs meetings of the Collaboration Board, Institute Boards and the Resource Review Board); and

2) **Subsidiarity** in the technical execution of the project, i.e. the Institutes and Teams taking part in the endeavour are assigned specific tasks for which they bear full responsibility, but in which they also enjoy extensive independence.

Accordingly, the proposition related to this observation may be formulated as follows:

Proposition 4: *Universal qualities, such as democracy or equality act as connectors enabling multicultural R&D teams to overcome the problems of disconnection posed by structural obstacles like size or the physical distance between team members.*

### 4.1.1.3 Co-opetition

Thus, the organisational efforts that are necessary to compensate the barriers to the development of trust may overshadow the nuisance due to multiculturalism as such. Nevertheless, the potential for intra- and inter-group tensions, either due to cultural diversity or to other structural obstacles, should not be overvalued. Damaging struggles between individuals or teams, i.e. dysfunctional conflict, remain an absolute exception within ATLAS, the collaborators being well aware of the condition that there
are no resources to be wasted in ruinous disputes or power games. Still, heated discussions do occur every day, but they are mostly the result of different perspectives and disagreements about how a technical question has to be solved. Moreover, these disputes are highly appreciated by all co-workers. Such arguments, no matter where they take place, during ATLAS-Weeks, regular meetings, or coffee breaks, represent a very effective arena in which to exchange perspectives, beliefs, or ideas, and thus to create knowledge. Such debates are rarely misused to discredit a colleague. Instead, the purpose of criticism is to reveal errors or possibilities to improve quality, all for the sake of the project or of science in general. Nevertheless, this evidence should not provide an erroneous picture of competition among ATLAS employees. As a matter of fact, the Collaboration has great scientific minds in its ranks, so it is normal that such people wish to distinguish themselves. Therefore, one can definitely speak of intense competition. Yet, this battle for “whose opinions will prevail” is being played out with intellectual means and in very noble terms. Doing this, ALTAS exemplifies how to strike the balance between co-operation and competition. What can be learned from this is that the recruitment and staffing of high-class researchers on multicultural R&D projects make sure that the discussions among the team members are constructive and free of cultural oppositions.

Proposition 5: The higher the (intellectual) quality of scientists and engineers in multicultural R&D teams, the more effective the co-opetition within the team.

4.1.1.4 Conversation

The case study unequivocally confirmed the vital character of conversation in R&D projects like ATLAS. Here, multiculturalism was identified as a factor that can create obstacles as well as benefits to effective communication: On the one hand, English is a foreign language for most physicists, engineers, and technicians. Obviously, confusions may arise when at least one interlocutor is not fluent in that language. Such misunderstandings can trigger technical errors as well as interpersonal feuds. On the other hand, language has an integrative function in ATLAS. Again, the fact that English is the mother tongue of only a minority of collaborators, the possible complex felt by
others when using that language is almost insignificant, as everybody probably understands the other team-mates’ broken English and vocabulary. In fact, most sentences are structured in very basic ways, and the words employed are either simple or extremely technical. This special jargon, which is mainly the result of the working context, forces people to stick to the issue and to be factual and accurate in their expression, thus reducing the scope for misinterpretation.

These reflections on language implies a sixth proposition:

Proposition 6: Sharing a common scientific or technical jargon ameliorates the prospects of effective conversation within multicultural R&D teams.

Furthermore, what makes ATLAS and CERN so extraordinary in relation to the question of communication is the widespread use of French in parallel to English. As a significant number of members of CERN staff (technicians for instance) do not speak English well, the teams often switch to French to ensure that everybody in the group understands what is being said. Furthermore, French – which is after all the language of the geographical region where the project is located – dominates in certain units, in given locations on the CERN campus (e.g. the canteen), as well as in particular settings, specifically during informal meetings or reunions. What results from this is “Cernese”, a mélange of English and French, which, depending on the speakers, may also include some elements of other common languages (such as German or Russian). As a collective property of ATLAS, such an internal dialect contributes a lot to the good atmosphere within the organisation. It not only facilitates the forming of cordial relationships just by representing the cultural result of the community’s long-standing co-operation, but it also constitutes a tangible point of reference, with which every single collaborator can identify. Like that, communication problems associated with cultural diversity can be reduced and the efficacy of conversation within teams ameliorated.

Proposition 7: Blending two or more languages into one multicultural vernacular has enriching effects on conversation practices within multicultural R&D teams.
4.1.1.5 Captaining

The leadership approach applied in ATLAS’ teams emphasises a rather organic management of human relationships and diversity. To be more precise, the melting pot generated by the mix of people from different countries is not really managed, in terms of being actively controlled. What is actually done is a co-ordination of team members, i.e. those who operate in Meyrin and those who do not. Several aspects of the ATLAS project turn this form of leadership into a necessity. First of all, the loose connection and the geographic spread of the collaborators make it impossible for any one person alone to direct and supervise the rest of the team. Furthermore, the groups have relatively clear tasks, as their main objective is to solve the scientific and technical puzzles that arise in the construction of the detector. Therefore, once the overall direction has been set (by the Project Leader), ATLAS’ physicists and engineers do not really need anybody to tell them exactly what to do. The problems to be tackled are brought up and discussed within the community, and very often it is the team that works out the issue collectively during meetings or coffee breaks. Nevertheless, these reunions are marked by intense debates, as the participants argue with one another to determine whose proposal is the best. Of course, the variety of ideas, opinions, and methods is all the more substantial if the team is multicultural. Consequently, the role of the captain in an ATLAS team is not so much to give instructions as to motivate his co-workers and to moderate their arguments.

Proposition 8: The captaining of multicultural R&D teams calls more for the presence of a motivator and moderator than for a formal supervisor with orders expressing authority.

Hence, the human aspect of his responsibility is very important in this function. The position calls for special qualities, in particular regarding social skills, such as sensibility, patience, fairness, compassion, diplomacy, etc. Those are personal characteristics that are mostly innate, so the captain is generally a charismatic individual who is highly appreciated and respected by his colleagues a long time before he accedes to this role. Two propositions may be derived from this:
Proposition 9: An effective captain of multicultural R&D teams emerges naturally from the team.

4.1.1.6 Chemistry

In the case study, three aspects were identified, with which the particular atmosphere in ATLAS, partly responsible for the success of the project, can be explained. First, the acclimatisation of new colleagues into the team is facilitated by the great solidarity and helpfulness of the current members or of compatriots from other teams (e.g. when language problems arise). Casual relations, regular informal gatherings, “Cernese” constitute key elements contributing to the effective amalgamation of freshmen. But one such ingredient that needs to be highlighted and taken into special scrutiny is humour. Humour is indeed a common means for ATLAS partners to process the question of multiculturalism. One reason for that could be that jokes related to national stereotypes aerate the working atmosphere and help people to divert their attention away from potential conflicts to more harmless matters. Thus, humour can function as a valve for possible frustrations resulting from diversity.

Proposition 10: Treating the question of cultural diversity with humour improves the chemistry in multicultural R&D teams.

The second crucial element explaining the exceptional chemistry observable in ATLAS is the extremely multicultural context. CERN itself and Geneva as its host city constitute valuable factors for making foreign ATLAS employees forget that they are not at home. Specifically, integration is greatly facilitated by the fact that physicists and engineers coming from Geneva or its surroundings are rare on the different CERN sites. As almost everyone is a foreigner, there is a strong sentiment of solidarity among colleagues. Furthermore, this condition generates a sort of mutual interest in other cultures and in multiculturalism in general. This omnipresent open-mindedness and cosmopolitan attitude offers the advantage that the associates are very tolerant about diverging beliefs and opinions. Those elements turn CERN (and consequently also ATLAS) into a model of international co-operation, marked by life-long friendships, irrespective of national boundaries and trans-ethnic cohesion. Therefore, it seems that
chemistry is much more likely to develop in such an environment. The proposition that stems from this insight reads as follows:

Proposition 11: *Embedding the multicultural R&D team into a multicultural context has beneficial repercussions on the chemistry within the team.*

Finally, the values and interests ATLAS collaborators have in common are apparently a decisive building block in the question of the success of multicultural R&D teams. In fact, the outlining of precise goals and the existence of shared principles (e.g. the necessity to prove one’s statements or the unconditional disclosure of data and information), norms (e.g. recognition and respect of each other’s work and contributions), behaviour (e.g. systematic discussion of results), and artefacts (e.g. a common technical or scientific jargon) fosters the willingness of people to identify with the project in order to do their best for it. Moreover, the Collaboration gives the impression that its members have internalised these values, so that their empathy for their job or their organisation becomes more important than their national or regional provenance. Recognising that these aspects correspond exactly to the constituents in the definition of the concept of “culture”\(^{640}\), one is tempted to presume that the mind-set carried by the chemistry within a profession, function, or company is eclipses that of a national or regional culture.

Proposition 12: *In successful multicultural R&D teams, the chemistry inherent to professional, functional, and corporate cultures tend to dominate that of national and regional ones.*

4.1.2 The model

This chapter combines the insights of the previous section and provides a theoretical model\(^{641}\) linking the six success factors. It intends to explain how these elements interact with each other in order to answer the question of how to manage multicultural R&D teams successfully. The individual factors hardly have direct effects on each

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\(^{640}\) Cf. section 1.2.2

\(^{641}\) The model presented here should be understood as a sketch or a proposal. It can definitely not be considered as a “ready-for-use” pattern. It applies the propositions derived in section 4.1. To be directly applicable, it would require further validation, which is not going to be provided in this dissertation. Therefore, this chapter will remain quite brief in order to limit its weight on the whole work.
other. Their influence comes remotely and obliquely, by means of sub-factors, or catalysts. How the factors and sub-factors interrelate is displayed in figure 4.1.

As mentioned in the prior chapter, the composition of teams does not immediately influence their success. However, through the professional specialisation of their members (e.g. particle physics or, less explicitly, research and development), and thanks to having English as the lingua franca of the domain, the groups develop a common vernacular that facilitates the conversation among them. The gain is all the
more substantial, if yet another language, for example one that is usually employed in more casual or recreational situations (as French in ATLAS teams), is added to this organisation-specific dialect. Indeed an extra language enlarges the pool of possible words to choose among, thereby increasing the chance of mutual understanding.

Similarly, the connection of the team members (imposed by structural conditions such as the size or geographic magnitude of the R&D project) requires certain types of gatherings during which members can meet, talk, and decide. These reunions, i.e. the common platform for communication, which may include personal (in the sense of face-to-face) as well as virtual elements, in turn, determine the forms and the frequency of conversations taking place between collaborators.

Hence, composition and connection together are important determinants for the constructiveness of conversations in multicultural R&D teams. If conducted properly, conversations lead to productive discussions, during which information and opinions are exchanged. Actually, discussions have a twofold function: On the one hand, they are necessary to share intelligence and knowledge, which is essential for the cooperation of scientists and engineers. On the other hand, discussions constitute the pitch on which competition between the employees is being fought out. It is through discussions that their arguments are confronted, giving them the chance to pit their intellectual strength against each other openly. Therefore, co-opetition is truly the process through which knowledge creation and the generation of new concepts is made possible.

Composition also has some bearing on chemistry. This happens through a sub-factor, the context. Context, i.e. the surroundings generated by the location and the host organisation, is a fundamental catalyst in the creation of productive and agreeable relationships in multicultural R&D teams in the sense that it provides the members with an environment in which they find persons in comparable situations and similar backgrounds, interests, mindsets, or skills. Such similarities assist the members in orientating themselves and allow them to gain confidence and security. Specifically, in a multicultural context, newcomers (but also people in general) have less of the sensation of being a “foreigner” than would be the case in a monocultural milieu. Thus, employees feel less stressed in an appropriate context, which reduces the chance of
tensions between collaborators. Consequently, sound chemistry grows and matures through the attenuation of dysfunctional conflict.

And good chemistry, again, fosters trust between colleagues, and commitment towards the organisation, i.e. two attitudes that are absolutely vital to achieve a healthy level of co-opetition. Indeed, trust establishes bonds between co-workers, generating empathy, affinity and respect. Thus, associates are more prepared to enter a relationship of mutual dependence and reliance, while also being eager to discuss and argue with each other, but without jeopardising the project because of personal feuds. Accordingly, the keenness on “co-operating while competing”, i.e. the willingness to co-opete, is much more pronounced in groups in which the relationships are marked by trust.

Likewise, connection indirectly affects the captaining of multicultural R&D teams, via the definition of goals. As a matter of fact, the loose connection between the different teams and the partners calls for clear objectives so that they know what they are heading towards. For R&D teams, the matter is relatively straightforward, as the targets generally have a rather technical or scientific nature, and can therefore be defined in quite precise terms. Furthermore, the fact that researchers work on so-called exact sciences facilitates the process of setting goals all the more. This relieves the captain of many problems, including that of giving formal orders. After all, R&D teams are here to solve problems, and not to find solutions by commanding other people.

Effective captaining remains important if R&D teams are to have an adequate level of co-opetition and the catalyst required to establish the link between the two factors is motivation. One of the captain’s major functions is to transform the clear objectives (as derived in the connection process) into motivating the people and teams who have to achieve these goals. This involves not only pushing them to do their best, but also promoting dialogue and debate within the group. Hence, the captain has to encourage his co-workers to argue, and to question one another’s contributions, so that the knowledge creation process is permanently in motion. Meanwhile, he has to make sure that those who have suffered the disappointment of losing their argument are still motivated to take part in the discussion. In other words, the captain is responsible for
heating-up co-opetition by stimulating, guiding and arbitrating the contest for scientific or intellectual correctness.

Finally, it was shown in the theoretical part\textsuperscript{642} that co-opetition is the true reactor for success, as it converts collaboration into knowledge co-creation, which constitutes the ultimate output of multicultural R&D teams’ effort.

### 4.2 Suggestions for further research

While offering a helpful pattern of how multicultural R&D teams are managed successfully, the model presented above does not cover the subject entirely. As the purpose of the study was to explore the question of managerial success, it does put forward a basic outline, giving a certain number of answers. At the same time, however, it draws attention to additional problems, raising supplementary concerns. Consequently, the purpose of the following section is to make those questions explicit and to formulate propositions on how to dig into these matters. Thus, the suggestions made here look at methodological issues, but also include ideas about theoretical questions to be tackled in future research.

First of all, some supplementary research should be carried out in order to dig deeper into the questions stated previously. Specifically, it could be worth specifying the problems by adding further substance. Moreover, transforming the propositions of the preceding section into hypotheses could well be the object of research papers or doctoral theses. In this regard, no specific research methodology shall be favoured. Although the qualitative way was identified as particularly appropriate for the present study, other approaches are conceivable for any later analysis. For instance, those who would like to prove explicitly or refute the propositions might want to apply quantitative techniques, such as surveys or statistical tests.

Then, also from a methodological point of view, it would be valuable to implement and test the model, in order to obtain further findings, and to achieve a research loop. The results might be used to put in more concrete terms the theory that has been developed here. This in turn may again be implemented and the findings analysed.

\textsuperscript{642} Cf. section 2.5.2.3
This “action” research (as opposed to conventional empirical social science) cycle would not only bring new substance to this dissertation, but also increase the credibility and reliability of its findings. Like that, more reliable measures of the model’s elements (factors and sub-factors) could be identified, thus providing a clearer direction for future research.

In addition, auxiliary questions need to be examined in further detail. The issues that appear especially exciting and challenging concern the different forms of culture. As a reminder, one of the hypotheses of the study was the consideration of several cultural spheres of influence. The present investigation showed that the values shared by collaborators might, under certain circumstances, contribute to a higher efficiency of the whole team. Those principles, ideals, behaviours, make them forget to some extent the assumptions, norms and attitudes that are induced by their nationality. In other words, their professional culture seems to be stronger than their national culture. Although it would be erroneous to speak here in terms of the elimination of one type of culture by the other, there is nevertheless a sort of primacy relationship between the two. Thus, it appears that some spheres of influence have more momentum than others. To keep the imagery: When two such spheres collide, it could be that one sphere is more affected by the impact than the other, seeing itself being shoved aside, just like a billiard ball that has been hit by another.

Taking the speculation one step further, another possibility could be that there is indeed a clear hierarchy of cultural spheres. This means that one might think of those cultures as strata, one cultural layer covering the next weaker or stronger layer, analogously to what Martin Hilb depicts in his work, in which he regards the six cultural spheres as mutually connected (figure 4.2). Demonstrating that the various types of cultures have dissimilar (e.g. increasing or decreasing) effects on the way of thinking and behaviour of individuals could substantiate the fact that the strength of one type of culture instigates people to disregard or overlook other cultural layers. The stronger culture would thus induce individuals to act in accordance with the code it imposes, cancelling the conventions of the other types of cultures.

643 Cf. section 1.2.2
Along these lines, one interesting point would be to determine which of the cultural spheres or layers prevail. Does the functional cultural represent the “core” of all cultures, as implied by Hilb? How does it have an effect on the other ones? Or is it the national culture that dominates? How does the prevailing culture impinge on the others? The starting point from which to answer these questions, and thereby develop an integrated pattern, would be to isolate the different layers by analysing them separately. This is precisely what was implicitly done in examining the professional culture of R&D scientists and engineers. However, the success factors influencing R&D teams do not necessarily pertain to other types of experts, such as marketers, consultants, board members, or soldiers. Indeed, each profession requires skills and ways of thinking that influence the way its representatives handle cultural diversity and the problems it may breed.

Therefore, from an academic point of view, it seems valuable to study some of these professional cultures, just as was done with R&D. Specialists that would deserve research include for instance board members, sportspeople, diplomats, flight crews, or military men. Further enquiries would allow one to identify the typical components
that explain the performance of multicultural teams made of experts in those fields. From there on, one could compare the success factors and see if there are some common aspects. In particular, it would be fascinating to check if the assumption that some of these elements make national differences disappear, as was concluded in the case of R&D specialists, applies to other professions as well.

**4.3 Practical recommendations**

The following section is devoted to the policy implications of what has been said so far. The purpose is to convert these insights into concrete suggestions for scientists, engineers, or managers who are involved with multicultural R&D teams. This time, the central thread will be not constituted of the 6 C’s, but of the three basic elements of vertical integration, itself an inherent part of the “St. Gallen Management Model” utilised to define “general management” at the beginning of the work – that is, structures, activities and behaviour\(^{644}\). Indeed, the actions to be presented here are meant as management levers for identifying and employing the six success factors in such a way that they are turned into task and relational effectiveness, i.e. into team performance (figure 4.3).

The measures proposed in the following constitute an integrated package of “best practice” instruments, which target the individual team member as well as the whole team. It provides a roadmap for people who are confronted with the practical sides of multicultural R&D teams. Therefore, it is imperative to notice that the thoughts developed here are merely suggestions emerging from common sense. Although they are based on the theoretical reflection of the conceptual part, the empirical results of the case study, as well as the logical deductions of the preceding section, they make no claim to academic correctness. It remains at the reader’s discretion to judge these proposals as accurate and to apply them.

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\(^{644}\) Cf. chapter 1.2.4
4.3.1 Activities

4.3.1.1 Common objectives

The setting of goals is what any managerial process, at least on the operational level, always starts with. Those are all the more important for teams, as they constitute lodestars towards which the team members can orient themselves. Thus, objectives create a sense of purpose, cause professionals to focus, and instil in them a certain sense of persistence. But for these functions to be successful, the objectives must be shared and understood. They should be clear and convincing, so that the collaborators know exactly what they should strive to, and why they are subordinating themselves to the team.

In R&D, the task of defining such targets is not as easy an endeavour as it may appear. At first sight, goals are mainly defined in scientific terms and hence turn out rather explicit and tangible for the scientists and engineers working on the assignments. The difficulty, however, is to find a common ground and get the goals aligned among individual team members, since each associate may have his own opinion on the matter. Accordingly, the exercise entails diminishing and (if possible) eliminating the
struggles between dominant groups, by reducing their differences. This, in turn, can be achieved by scrupulously including all collaborators in the process.

In this regard, the duties of the manager of multicultural R&D teams are manifold. First of all, he has to take care that his co-workers recognise and accept the goals he sets. Then, he is responsible for the tracking of the project’s progress, and thus for the measurement of these goals. The establishment of milestones is an adequate way to do. But again, these sub-targets should be stated as clearly and explicitly as possible, in order to ensure that everybody understands them, no matter his culture.

4.3.1.2 Moderating

Setting the team’s common objectives and assignments is only one part of the operational activities. They facilitate the development of cohesion and therefore foster the establishment and cultivation of trust and commitment among the co-workers. However, in order to make the team advance, it also is vital to have points about which the collaborators do not agree and which generate divergence. Thus, it must be ensured that differences in opinions exist and are expressed openly, during informal conversation as well as in formal meetings. And when R&D professionals collaborate or discuss, one does observe heated and intense, though friendly and respectful, clashes of perspectives. Still, the constructive utilisation of controversies calls for the presence of a person who manages the discussion flow and keeps it on the right track. In this case, it is the responsibility of the team captain to take care that discussions are well structured by stating the agenda, meeting minutes, key questions, etc. But at the same time, he has to heat up the debate, so that arguments take place at all. He should induce all team members to analyse and to challenge others’ views, while seeing to it that the criticisms remain objective and productive. So, his job is to encourage divergent thinking, instead of retraining or suppressing dissent. He can achieve that by asking all members to state their opinion on the issue under consideration. Then, he has to keep communication open and fluid. In a multicultural environment, this involves ensuring that the message is well understood by all participants, which may imply reformulating or even translating concepts or comments. In some instances, it is advisable that the
team captain interrupts the discourse to summarise the key points of what has been said or to recapitulate on the different views represented.

On the other hand, when an adversarial fight eventually does arise, the team captain is in charge of settling or resolving the discord. He has the mission to integrate diverging interests. For that, he has to act as a mediator, reconciling the various viewpoints and integrating the best of individuals’ contributions. And finally, once the solution that satisfies the group as a whole has been found, he has to smooth out the differences between intellectual challengers, and make them work together again.

4.3.2 Structures

4.3.2.1 Multicultural R&D team structure

Grasping the team’s goals does not automatically mean that each member understands his functions or roles or those of his colleagues. Thus, the organisational structure of the multicultural team is at least as important as the definition of objectives. Nevertheless, special emphasis needs to be laid on the difference between common goals and individual roles. While the first issue focuses mainly on the question of how to orient the team members towards a given direction, the second one has more to do with their holding together.

First, the person responsible for the team structure should formulate and organise the putting into practice of the collaboration rules within the group. The teams presented in the case study displayed rather organic (as opposed to mechanistic) structures\textsuperscript{645}. That means that the partners were rather free in their intellectual movement and exchange. Relationships were casual, almost familiar, so that the researchers could share their knowledge unreservedly and in very informal ways. This facilitated the reduction of potential barriers between national cultures. Therefore, organic arrangements of multicultural teams are strongly recommended. Formal hierarchies may be used to order the basic principles in teamwork but should not dominate the dealings.

\textsuperscript{645} In organic systems, tasks, duties and authority are continually redefined by a permanent contact among the members participating in a task. Communication and o-ordination take place laterally, bypassing the formal managerial hierarchy. Mechanistic systems, on the contrary, are characterised “by individual task specialization, functional segmentation and hierarchical managerial control. Within this organizational form, technical tasks and duties are precisely defined and engineers pursue their individual specialist tasks as something distinct from the whole.” (Lam (1996), p. 188)
These principles, to be interpreted as “the rules of the game”, should be limited to items such as the definition of schedules, deadlines, meetings, presentation guidelines, etc. It is the duty of the leader, of course, to make sure that those concepts – in particular those related to time and punctuality – are equally understood by every collaborator. But once the details have been acknowledged and comprehended, it is up to the associates to see how they want to divide roles and workload among themselves, and to find the appropriate ways to integrate each member’s contribution into a whole.

Then, the decision making process in multicultural R&D teams is as equally important a topic as their hierarchy. In the teams studied empirically, the democratic character of the procedure was a decisive element for the good atmosphere in the collaboration. Everybody was allowed to criticise, to give his own impressions, to challenge others’ opinions. This input and feedback coming from all sides of the team triggers discussions ensuring that the decisions finally taken have been thoroughly pondered. Concerning the choice itself, consensus should always be the preferred approach, as it is the sole mode of guaranteeing full legitimacy. While compromise\(^{646}\) generates a similar level of acceptance, it is still only a second-best solution, because it leaves at least one party as the losing side. And this feeling of defeat can be quite disturbing in a multicultural context, especially when the support of a collaborator towards a certain faction is determined by his affiliation to a given nationality or to his home institute. For the same reasons, decision by vote should only be opted for in exceptional circumstances. As for arbitrary judgement by a single individual (the leader), it should always be accompanied by a consideration of all the opinions represented in the multicultural team.

\subsection*{4.3.2.2 Configuration}

The term “configuration” refers to the level of diversity in the R&D team. This section therefore deals with issues such as the constitution of the squad.

The question raised here cannot be answered absolutely. Taking it for granted that diversity can generate substantial advantages, especially in R&D, there are some

\[^{646}\text{Compromise, as opposed to consensus (i.e. general agreement) is the settlement of a dispute by concessions on both sides. Accordingly, the concept implies a certain level of dissatisfaction on both sides.}\]
doubts about the belief that one can actively determine the effectiveness of multicultural teams by choosing certain combinations of cultures. In the theoretical part, it was pointed out that a team whose purpose is to create knowledge has better chances in doing this if its members have different competences, interests, cultural backgrounds, experiences, etc. So teams with varied abilities and expertise are more likely to generate truly new ideas. In addition, phenomena such as groupthink or the “not invented here” syndrome are less likely to occur when the team members themselves represent a multifarious mix of people. The wider the cultural distance between the cultures involved, i.e. the less affinity to each other or the broader the gap in the scores on the various cultural dimensions\(^{647}\), the larger the differences in ideas and opinions, and therefore the greater the potential for knowledge creation. In view of that, there must be something like an ideal cultural mix (in terms of an optimal of combination of cultures) that ensures maximum success.

Opponents of this approach claim that each team is unique, and should be considered as such. Among these disbelievers is Sue Davison, who stresses that “high performance cannot be captured in a ready-made formula for how to create synthesis between imaginary French, Japanese, Taiwanese and Russian team members.” For her, high performance is generated through channelling the cultural forces at play. This means that the teams should be shuffled together without trying to find that magic, universal formula of multiculturalism. Rather, “the task is to use the similarities and differences and the dynamics that these can set up and to turn them to the group advantage.”\(^{648}\) The teams of the ATLAS Experiment could implicitly confirm this belief: The squads there are constituted randomly, at least from a diversity perspective. Participants are sent by their respective institutes, which are based in different regions in the world. So collaborators are drawn together by the will of organisations, and without any thought being given to attributes such as culture or nationality.

Consequently, the main managerial actions related to configuration should aim at finding the right combination of roles and skills instead of just focusing on cultures. Indeed, multicultural R&D teams should be designed to encompass all the comple-

\(^{647}\) Cf. chapter 2.2.1.2

\(^{648}\) Davison (1994), pp. 81, 89
mentary skills crucial for the achievement of their scientific objectives. These team capability specifications are the following:  

- **Technical or functional expertise**: More often than not, R&D teams will need the know-how of scientists and engineers, or even marketers, to bring about truly innovative products or concepts.

- **Problem-solving and decision-making skills**: R&D teams ought to be able to perceive difficulties and opportunities, assess the options they have at their disposal, and make the proper decision about how to proceed.

- **Interpersonal skills**: For an R&D team to function well, i.e. for common understanding and purpose to be established and preserved, it is an absolute must that its members communicate and handle conflicts effectively. The interpersonal skills needed by all collaborators, but also by the team as a whole, include objectivity, acknowledgement of others’ interests and accomplishments, mutual encouragement and help, and constructive criticism.

This last issue, the skills and characteristics of team members, shall be treated in further detail in the next chapter.

### 4.3.2.3 Selection and staffing

Determining the accurate mix of people, in terms of the roles to be fulfilled and the skills to be represented in the team, is one thing. Selecting the right scientists and engineers and putting them into the appropriate group is another. Since this dissertation is not focused primarily on human resources management, it is not possible to describe all aspects of the selection process. So what will be done here is to deliver a catalogue of the most critical aptitudes required by collaboration in multicultural R&D teams.

According to Hilb, any employee should display a set of abilities, falling into four distinct categories: personality competence, professional competence, leadership competence, and social competence. As teamwork is mostly associated with the latter, it is on social competence that emphasis shall be laid. In a multicultural R&D context, the

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649 Katzenbach / Smith (1993b), pp. 48-49
prerequisites are more demanding than in a monocultural one, so in addition to the traditional social skills (e.g. ability and readiness to listen, tolerance, openness, etc.), applicants for a job in a multicultural organisation or team obviously have to exhibit two further types of skills: multicultural dexterity and the capacity for teamwork.

Possessing multicultural skills does not necessarily entail being a cultural chameleon, but acquisition of such skills is to a large extent fostered by experience. Indeed, an individual only gets to develop cultural sensitivity if he has the opportunity to deal with people from nationalities other than his own. Therefore, cross-cultural exposure is a necessary, but not sufficient condition. The candidate also ought to present personality traits reflecting a certain flexibility and adaptability to diversity. The same applies to the ability to work in a team. To some extent, one can learn to work together with other people. Subsequently, experience helps to develop the qualities necessary for being a pleasant and useful team-mate. But again, there are some basic personal characteristics that are indispensable in the first place, if one is to have good relations with others. Table 4.1 lists some of the (learnable and innate) social competences required to make an excellent multicultural R&D team player, as well as indicators with which the skills can be identified.

It is fairly clear that only a very few candidates will exhibit all of these characteristics. Moreover, these competences are never acquired absolutely so that regular education is indispensable. However, seeing that diversity is always linked to concrete cases (misunderstandings, conflicts, success stories, etc.), it is a very straightforward issue to grasp with and to introduce to freshmen. In this regard, seminars bringing together newcomers and people who have recently been exposed to multicultural teamwork, are certainly an adequate arena for such training.

The crucial function of the team captain has been mentioned already. The importance of his responsibilities imposes much tougher skill requirements. However, his selection does not necessarily have to be the object of a formal process. The captain may well emerge naturally, rather than being revealed by a ceremonial choice. However, it is undeniable that any leader needs special abilities beyond those of an ordinary member of a multicultural R&D team.
### Multicultural and team skills

<table>
<thead>
<tr>
<th>Multicultural and team skills</th>
<th>Indicators: The team member...</th>
</tr>
</thead>
</table>
| **Cognitive skills**          | • ...Acknowledges the cultural differences between himself and his associates  
                                 | • ...Recognises and accepts the dissimilar character of other cultures |
| **Affective competence**      | • ...Welcomes and values diversity  
                                 | • ...Is able to sympathise with someone who has different values and opinions  
                                 | • ...Refuses to stereotype other individuals  
                                 | • ...Is interested in other societies and their representatives  
                                 | • ...Is committed to the team |
| **Interpersonal skills**      | • ...Avoids casting judgements on people from other cultures  
                                 | • ...Is eager to work in teams  
                                 | • ...Looks for contact with other people  
                                 | • ...Is sensitive to others’ needs  
                                 | • ...Accepts emotions  
                                 | • ...Tries to understand his associates’ feelings  
                                 | • ...Is patient  
                                 | • ...Is helpful |
| **Communicative skills**      | • ...Listens well to what his colleagues are saying or trying to express  
                                 | • ...Uses a clear, unambiguous, non-idiomatic terminology  
                                 | • ...Takes care that his non-verbal language is well understood  
                                 | • ...Actively seeks conversation |
| **Adaptability**              | • ...Adapts his conduct, speech, etc. to the cultural background of his collaborators  
                                 | • ...Is comfortable with people from different societies and disciplines  
                                 | • ...Tolerates ambiguity  
                                 | • ...Is flexible in his views and is open to new ideas  
                                 | • ...Is willing to acquire new patterns of behaviour |

Table 4.1: Multicultural and team skills

Before one can establish the ideal profile of the captain, it is advisable to know what his job exactly consists of. In fact, the team captain is not primarily here to take decisions, although he may sooner or later be forced to do so. As proposed in section 4.1, his role is more that of a moderator and motivator. As a *primus inter pares*, he guides his collaborators, animates discussions, facilitates the establishment of contacts between the different team members, acts as a spokesperson to the outside, etc. In view of that, his distinctive aptitudes ought be action, motivational, and conciliation skills. Table 4.2 offers a tabular catalogue of these essential capabilities.

### 4.3.3 Behaviour

#### 4.3.3.1 Team integration

The importance of the integration of newcomers should not be underestimated. This procedure is necessary to establish powerful relations between partners and to foster mutual esteem and support, which should help to promote commitment within the group, thus increasing its focus. The purpose is to instil and cultivate a common behaviour, a team spirit, while maintaining an atmosphere of constructive criticism. In addition, it generates the sort of trust that is needed to have associates feel more comfortable with challenging questions while respecting others’ ideas. In these terms, integration also encloses the process by which team members (those who join the group as well as those who are already assimilated) learn to work with difference.

Integration starts with the socialisation of newcomers. The latter have to discover intercultural differences and get acquainted with the ways of how to cope with them. Those who lack multicultural competences have to learn tolerance and acceptance, train their communication skills, etc. For this purpose, training seminars should be organised for new entrants, even before they start to work in the project. Then, it has to be seen that the freshman does not feel estranged, in particular if he is the first representative of a given nationality in that team. He has to absorb the corporate values, become familiar with the norms of behaviour in his new organisation, understand the unknown social and task setting, learn the company language, and so forth. Again, this may happen through formal training sessions (classes, discussion groups, tutorials, mentor programmes, etc.) or by the direct observation of colleagues.
### 4.3 Practical recommendations

#### Skills of the multicultural R&D team captain

<table>
<thead>
<tr>
<th><strong>Indicators: The team captain...</strong></th>
<th><strong>Skills of the multicultural R&amp;D team captain</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action skills</strong></td>
<td>• ...Exhibits initiative and resourcefulness</td>
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<tr>
<td></td>
<td>• ...Tries to gain synergy from cultural differences</td>
</tr>
<tr>
<td></td>
<td>• ...Focuses his energy on tasks to accomplish team objectives</td>
</tr>
<tr>
<td></td>
<td>• ...Is prepared for new mind shifts, while eliminating old mindsets</td>
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<tr>
<td></td>
<td>• ...Understands to delegate task</td>
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<tr>
<td></td>
<td>• ...Knows how to co-ordinate assignments and efforts</td>
</tr>
<tr>
<td><strong>Motivational skills</strong></td>
<td>• ... Fosters new ideas and innovation from all disciplines</td>
</tr>
<tr>
<td></td>
<td>• ...Searches out ideas from all team members, independent of their nationality</td>
</tr>
<tr>
<td></td>
<td>• ...Renders explicit the team’s goals and objectives</td>
</tr>
<tr>
<td></td>
<td>• ...Permits others to make their own contributions to the team</td>
</tr>
<tr>
<td></td>
<td>• ...Tailors his feedback and praise to each participant, taking into consideration his specific cultural background</td>
</tr>
<tr>
<td></td>
<td>• ...Encourages group participation</td>
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<tr>
<td></td>
<td>• ...Knows how to exploit the competences of his collaborators</td>
</tr>
<tr>
<td></td>
<td>• ...Is fair when it comes to conferring recognition and visibility of individual team member’s work</td>
</tr>
<tr>
<td><strong>Conciliation skills</strong></td>
<td>• ...Carefully listens to what all associates have to say</td>
</tr>
<tr>
<td></td>
<td>• ...Knows how to achieve and promote consensus</td>
</tr>
<tr>
<td></td>
<td>• ...Does not favour representatives of any national culture</td>
</tr>
<tr>
<td></td>
<td>• ...Strives to create an atmosphere of unity and cooperation</td>
</tr>
<tr>
<td></td>
<td>• ...Is capable of creating a team atmosphere that is informal, cosy, and non-judgemental</td>
</tr>
<tr>
<td></td>
<td>• ...Facilitates the integration of newcomers and foreigners into the team</td>
</tr>
<tr>
<td></td>
<td>• ...Is open to discuss problems</td>
</tr>
<tr>
<td></td>
<td>• ...Is good at convincing other people</td>
</tr>
<tr>
<td></td>
<td>• ...Trusts and is trusted personally</td>
</tr>
</tbody>
</table>

*Table 4.2: Essential skills of the multicultural R&D team captain*


Furthermore, social events, such as an introductory party or a joint lunch, can have very beneficial effects on the integration of new recruits. Such events may be supple-
mented by socialisation practices peculiar to the company, as is done in the army or in student associations, the so-called fraternity hazing. These rituals, which aim at strengthening the identification of the individual with the group, can definitely be transferred to the corporate context. Nevertheless, these techniques often involve actions that are not culture-free. Therefore, their acceptance may vary from one society to another, depending in particular on the level of individualism prevailing in that culture. So care is necessary when using such methods.651

But even as individuals gain familiarity with their work environment, and can afford to invest less energy in their socialisation, the question of integration remains important at all stages of the collaboration with colleagues. Therefore, integration should be seen as a never-ending process, concerning all partners, no matter if they are foreigners or local citizens, or if their have been in the same company for many years.

4.3.3.2 Inspiration

As a matter of fact, the captain bears the responsibility for the success of the team. He has to ensure that the group he in charge of reaches its scientific objectives. As pointed up above, his duties allude to the three aspects of general management. Indeed, the captain controls not only the goal-setting procedure with the team and the management (structures); he also fixes and synchronises efforts within the team, seeing to it that the jobs are properly assigned to the different team members, setting the agenda, arranging and chairing all formal team meetings as well as informal work sessions (activities). But above all, he has to make sure that his collaborators have an accurate attitude towards problems, performance, and co-operation in general (behaviour). He has to actively seek input from other teams and departments in the company, in addition to that from his own fellows. In doing this, he ought to consider the team as a whole as his sphere of influence, but should also deal with every single associate individually. That means that he must acquire ideas from everybody in his professional surroundings, especially from newcomers and people who originate from “exotic” countries or from societies who had not been represented in the team up to then.652 The captain

651 Schneider / Barsoux (1997), p. 135
652 Odenwald (1996), pp. 119-120
performs this function by seeking dialogue with his partners, questioning, listening, challenging, identifying problems, deriving alternative explanations, suggesting different solutions, etc.

Hence, the captain acts in a threefold function: as an initiator, as a facilitator, and as a coach. This last role is particularly critical for teams, because it is closely related to the question of motivation. In fact, it is also the duty of the team captain to sustain the team’s morale and to encourage the participation of all collaborators. However, motivating a multicultural R&D team involves several elements: First, the group has to be instilled with the willingness and readiness to achieve the goals it has been assigned. As mentioned earlier on, this may happen through the setting of clear goals that are shared, understood, and accepted by all team members. Although collective agreement about the target is very important, the team captain has nevertheless an important part to play in communicating those objectives. He is the one who will have to remind the crew over and over again of what it is there for. So it is up to him to find the words with which he wants to stimulate his associates. Yet, the motivation of an entire team is not the same as the inspiration of individual members. The latter have their personal reasons, in addition to the obligation to serve the team and achieve its goals. These driving forces are usually much more complex and delicate than those of a whole community, because they include aspirations related to their own personality, reputation, financial wealth, career, etc. These partners, who, after all, are also company employees, want to maximise their chance to reach these personal goals. Consequently, it is vital that the captain grants all members the recognition they deserve and that their achievements are visible for everybody, that is, for the rest of the team, the organisation, the scientific community, and so forth.
5 General conclusions

This dissertation presents three forms of insights into the management of multicultural R&D teams. First, the theoretical part helped to uncover a certain number of key factors explaining their success. These factors represented the basis for the empirical part, which tested and specified them. The results of the analytical investigation (theoretical part) and the case study (empirical part) were subsequently used to develop 12 theoretical propositions each of them establishing specific links between the success factors. These associations were then aggregated into a model, which unites all factors into one single framework and was later used to make explicit recommendations about how to manage, i.e. how to organise, staff, direct and co-ordinate multicultural R&D teams.

All in all, the exploration can be judged as a relative success. It meets the objectives set, as it provides tangible answers to the (rather broad) research question set at the beginning of the enquiry: By identifying “Composition”, “Connection”, “Co-opetition”, “Conversation”, “Captaining”, “Chemistry” as six success factors of multicultural R&D teams, and by revealing how they interact, the thesis fulfils its stated purpose. The model and the propositions presented here are intended principally as guides for further research. Nevertheless, they may also support practitioners in their work with multicultural R&D teams. The analyses generate implementable recommendations, offering some concrete solutions to the problems encountered when researchers or engineers from different cultures are required to co-operate.

However, the study has some drawbacks as well. In particular, as the empirical part consists of a single-case study, it does not provide enough material to be able to generalise the results on types of professionals other than researchers and engineers (for instance, consultants, sportspeople, soldiers, diplomats, and the like). Then, the six factors are quite difficult to measure, so that the actions suggested in the last chapter are not easily evaluated and assessed. Finally, the organisation scrutinised empirically (the ATLAS Experiment) presents so many particularities, that elements accounting for the success of its teams are not likely to be exactly reproduced. In particular, its setting, namely the European Organization for Nuclear Research and its host city Geneva,
constitutes a unique asset that will not be found in too many places. This is not to say, however, that the model cannot be applied to other companies at all, but it should be remembered that the conditions in this example are so distinctive that it should not be taken for granted that the model can be transferred to other teams, scientific domains, professions, or types of organisations. Nevertheless, one of the landmark results of the study was that under certain circumstances, shared interests, objectives, and values might overcome cultural differences. In that sense, ATLAS offers a fabulous example of international collaboration. It shows that people from all over the world can work together in the name of physics. Thus, it appears that science serves as a link between peoples. Now, in the long term, it would be interesting to see if this correlation is also true for disciplines such as business administration or politics.
Appendices

Appendix A: Fields of science and technology

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: Computer sciences and other allied subjects (software development only; hardware development should be classified with the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics, other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2. ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3 Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy; industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology, other allied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)
3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S&T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences]

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern languages and literatures)

6.3 Other humanities [philosophy (including the history of science and technology), arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic research of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S&T activities relating to the subjects in this group]
**Appendix B: Consequences of differences in national culture**

**Appendix B.1: Low vs. High Power Distance societies**

<table>
<thead>
<tr>
<th>Low Power Distance</th>
<th>High Power Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inequalities among people should be minimised</td>
<td>• Inequalities among people are both expected and desired</td>
</tr>
<tr>
<td>• There should be, and there is to some extent interdependence between less and more powerful people</td>
<td>• Less powerful people should he dependent on the more powerful</td>
</tr>
<tr>
<td>• Parents treat children as equals</td>
<td>• Parents teach children obedience</td>
</tr>
<tr>
<td>• Children treat parents as equals</td>
<td>• Children treat parents with respect</td>
</tr>
<tr>
<td>• Teachers expect initiatives from students in class</td>
<td>• Teachers are expected to take all initiatives in class</td>
</tr>
<tr>
<td>• Teachers are experts who transfer impersonal truths</td>
<td>• Teachers are gurus who transfer personal wisdom</td>
</tr>
<tr>
<td>• Students treat teachers as equals</td>
<td>• Students treat teachers with respect</td>
</tr>
<tr>
<td>• More educated persons hold less authoritarian values than less educated persons</td>
<td>• Both more and less educated persons show almost equally authoritarian values</td>
</tr>
<tr>
<td>• Hierarchy in organisations means an inequality of roles, established for convenience</td>
<td>• Hierarchy in organisations reflects the existential inequality between higher ups and lower-downs</td>
</tr>
<tr>
<td>• Decentralisation is popular</td>
<td>• Centralisation is popular</td>
</tr>
<tr>
<td>• Narrow salary range between top and bottom of organisation</td>
<td>• Wide salary range between top and bottom of organisation</td>
</tr>
<tr>
<td>• Subordinates expect to be consulted</td>
<td>• Subordinates expect to be told what to do</td>
</tr>
<tr>
<td>• The ideal boss is a resourceful democrat</td>
<td>• The ideal boss is a benevolent autocrat or good father</td>
</tr>
<tr>
<td>• Privileges and status symbols are frowned upon</td>
<td>• Privileges and status symbols for managers are both expected and popular</td>
</tr>
<tr>
<td>• The use of power should be legitimate and is subject to criteria of good and evil</td>
<td>• Might prevails over right: Whoever holds the power is right and good</td>
</tr>
<tr>
<td>• Skills, wealth, power, and status need not go together</td>
<td>• Skills, wealth, power, and status should go together</td>
</tr>
<tr>
<td>• The middle class is large</td>
<td>• The middle class is small</td>
</tr>
<tr>
<td>• All should have equal rights</td>
<td>• The powerful have privileges</td>
</tr>
<tr>
<td>• Powerful people try to look less powerful than they are</td>
<td>• Powerful people try to look as impressive as possible</td>
</tr>
<tr>
<td>• Power is based on formal position expertise, and ability to give rewards</td>
<td>• Power is based on family or friends, charisma, and ability to use force</td>
</tr>
<tr>
<td>• The way to change a political system is by changing the rules (evolution)</td>
<td>• The way to change a political system is by changing the people at the top (revolution)</td>
</tr>
<tr>
<td>• The use of violence in domestic politics</td>
<td></td>
</tr>
</tbody>
</table>
is rare
• Pluralist governments based on outcome of majority votes
• Political spectrum shows
• Strong centre and weak right and left wings
• Small income differentials in society, further reduced by the tax system
• Prevailing religions and philosophical systems stress equality
• Prevailing, political ideologies stress and practice power sharing
• Management theories focus on employees

• Domestic political conflicts frequently lead to violence
• Autocratic or oligarchic governments based on cooptation
• Political spectrum, if allowed to be manifested, shows weak centre and strong wings
• Larger income differentials in society, further increased by the tax system
• Prevailing religions and philosophical systems stress hierarchy and stratification
• Prevailing political ideologies stress and practice power struggle
• Management theories focus on managers

Table A.1: Low vs. high power distance societies
Appendix B.2: Weak vs. Strong Uncertainty Avoidance societies

<table>
<thead>
<tr>
<th>Weak Uncertainty Avoidance</th>
<th>Strong Uncertainty Avoidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Uncertainty is a normal feature of life and each day is accepted as it comes</td>
<td>• The uncertainty inherent in life is felt as a continuous threat which must be fought</td>
</tr>
<tr>
<td>• Low stress; subjective feeling of well-being</td>
<td>• High stress; subjective feeling of anxiety</td>
</tr>
<tr>
<td>• Aggression and emotions should not be shown</td>
<td>• Aggression and emotions may at proper times and places be ventilated</td>
</tr>
<tr>
<td>• Comfortable in ambiguous situations and with unfamiliar risks</td>
<td>• Acceptance of familiar risks; fear of ambiguous situations and of unfamiliar risks</td>
</tr>
<tr>
<td>• Lenient rules for children on what is dirty and taboo</td>
<td>• Tight rules for children on what is dirty and taboo</td>
</tr>
<tr>
<td>• What is different, is curious</td>
<td>• What is different, is dangerous</td>
</tr>
<tr>
<td>• Students comfortable with open-ended learning situations and concerned with good discussions</td>
<td>• Students comfortable in structured learning situations and concerned with the right answers</td>
</tr>
<tr>
<td>• Teachers may say ‘I don't know’</td>
<td>• Teachers supposed to have all the answers</td>
</tr>
<tr>
<td>• There should not be more rules than is strictly necessary</td>
<td>• Emotional need for rules, even if these will never work</td>
</tr>
<tr>
<td>• Time is a framework for orientation</td>
<td>• Time is money</td>
</tr>
<tr>
<td>• Comfortable feeling when lay; hard-working only when needed</td>
<td>• Emotional need to be busy; inner urge to work hard</td>
</tr>
<tr>
<td>• Precision and punctuality have to be learned</td>
<td>• Precision and punctuality come naturally</td>
</tr>
<tr>
<td>• Tolerance of deviant and innovative ideas and behaviour</td>
<td>• Suppression of deviant ideas and behaviour; resistance to innovation</td>
</tr>
<tr>
<td>• Motivation by achievement and esteem or belongingness</td>
<td>• Motivation by security and esteem or belongingness</td>
</tr>
<tr>
<td>• Few and general laws and rules</td>
<td>• Many and precise laws and rules</td>
</tr>
<tr>
<td>• If rules cannot be respected, they should he changed</td>
<td>• If rules cannot be respected, we are sinners and should repent</td>
</tr>
<tr>
<td>• Citizen competence versus authorities</td>
<td>• Citizen incompetence versus authorities</td>
</tr>
<tr>
<td>• Citizen protest acceptable</td>
<td>• Citizen protest should he repressed</td>
</tr>
<tr>
<td>• Citizens positive towards institutions</td>
<td>• Citizens negative towards institutions</td>
</tr>
<tr>
<td>• Civil servants positive towards political process</td>
<td>• Civil servants negative towards political process</td>
</tr>
<tr>
<td>• Tolerance, moderation</td>
<td>• Conservatism, extremism, law and order</td>
</tr>
<tr>
<td>• Positive attitudes towards young people</td>
<td>• Negative attitudes towards young people</td>
</tr>
<tr>
<td>• Regionalism, internationalism</td>
<td>• Nationalism xenophobia, repression of</td>
</tr>
<tr>
<td>• Attempts at integration of minorities</td>
<td></td>
</tr>
<tr>
<td>• Belief in generalists and common sense</td>
<td></td>
</tr>
</tbody>
</table>
**Table A.2: Weak vs. strong uncertainty avoidance societies**

### Appendix B.3: Collectivist vs. Individualist Societies

<table>
<thead>
<tr>
<th>Collectivist</th>
<th>Individualist</th>
</tr>
</thead>
<tbody>
<tr>
<td>People are born into extended families which continue to protect them in</td>
<td>Everyone grows up to look after other in-groups him / herself and his / her</td>
</tr>
<tr>
<td>exchange for loyalty</td>
<td>immediate (nuclear) family</td>
</tr>
<tr>
<td>Identity is based in the social network to which one belongs</td>
<td>Identity is based in the Individual</td>
</tr>
<tr>
<td>Children learn to think in terms of ‘we’</td>
<td>Children learn to think in terms of ‘I’</td>
</tr>
<tr>
<td>Harmony should always be maintained and direct confrontations avoided</td>
<td>Speaking one’s mind is a characteristic</td>
</tr>
<tr>
<td>High context communication</td>
<td>of an honest person</td>
</tr>
<tr>
<td>Trespassing leads to shame and loss of face for self and group</td>
<td>Low context communication</td>
</tr>
<tr>
<td>Purpose of education is learning how to do</td>
<td>Trespassing lead to guilt and loss of self-respect</td>
</tr>
<tr>
<td>Diplomas provide entry to higher status groups</td>
<td>Purpose of education is learning how</td>
</tr>
<tr>
<td>Relationship employer-employee is perceived in moral terms, like a family</td>
<td>to learn</td>
</tr>
<tr>
<td>link</td>
<td>Diplomas increase economic worth and / or self-respect</td>
</tr>
<tr>
<td>Hiring and promotion decisions take employees in-group into account</td>
<td>Relationship employer-employee is a contract supposed to be based on</td>
</tr>
<tr>
<td>Management is management of groups</td>
<td>mutual advantage</td>
</tr>
<tr>
<td>Relationship prevails over task</td>
<td>Hiring and promotion decisions are</td>
</tr>
<tr>
<td>Collective interests prevail over individual interests</td>
<td>supposed to be based on skills and rules only</td>
</tr>
<tr>
<td>Private life is invaded by group(s) Opinions are predetermined by group</td>
<td>Management is management of individuals</td>
</tr>
<tr>
<td>membership</td>
<td>Task prevails over relationship</td>
</tr>
<tr>
<td>Laws and rights differ by group</td>
<td>Individual interests prevail over</td>
</tr>
<tr>
<td>Low per capita GNP</td>
<td>collective interests</td>
</tr>
<tr>
<td>Dominant role of the state in the economic system</td>
<td>Everyone has a right to privacy</td>
</tr>
<tr>
<td>Economy based on collective interests</td>
<td>Everyone is expected to have a private</td>
</tr>
<tr>
<td>Political power exercised by voters groups</td>
<td>opinion</td>
</tr>
<tr>
<td>Press controlled by the state</td>
<td>Laws and rights are supposed to be</td>
</tr>
<tr>
<td>Imported economic theories largely irrelevant because unable to deal with</td>
<td>the same for all</td>
</tr>
<tr>
<td>collective and particularist interests</td>
<td>High per capita GNP</td>
</tr>
<tr>
<td>Ideologies of equality prevail over ideologies of individual freedom</td>
<td>Restrainted role of the State in the economic system</td>
</tr>
<tr>
<td>Harmony and consensus in society are ultimate goals</td>
<td>Economy based on individual interests</td>
</tr>
<tr>
<td></td>
<td>Political power exercised by interest</td>
</tr>
<tr>
<td></td>
<td>Press freedom</td>
</tr>
<tr>
<td></td>
<td>Native economic theories based on pursuit of individual self-interest</td>
</tr>
<tr>
<td></td>
<td>Ideologies of individual freedom prevail over ideologies of equality</td>
</tr>
<tr>
<td></td>
<td>Self-actualisation by every individual is an ultimate goal</td>
</tr>
</tbody>
</table>

*Table A.3: Collectivist vs. individualist societies*

Appendix B.4: Feminine vs. Masculine societies

<table>
<thead>
<tr>
<th>Feminine</th>
<th>Masculine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant values in society are caring for others and preservation</td>
<td>Dominant values in society are material success and progress</td>
</tr>
<tr>
<td>People and warm relationships are important</td>
<td>Money and things are important</td>
</tr>
<tr>
<td>Everybody is supposed to be modest</td>
<td>Men are supposed to be assertive, ambitious, and tough</td>
</tr>
<tr>
<td>Both men and women are allowed to be tender and to be concerned with</td>
<td>Women are supposed to be tender and to take care of relationships</td>
</tr>
<tr>
<td>relationships</td>
<td>In the family, fathers deal with facts and mothers with feelings</td>
</tr>
<tr>
<td>In the family, both fathers and mothers deal with facts and feelings</td>
<td>Girls cry, boys don't; boys should fight back when attacked, girls shouldn't fight</td>
</tr>
<tr>
<td>Both boys and girls are allowed to cry but neither should fight</td>
<td>Sympathy for the strong</td>
</tr>
<tr>
<td>Sympathy for the weak</td>
<td>Best student is the norm</td>
</tr>
<tr>
<td>Average student is the norm</td>
<td>Failing in school is a disaster</td>
</tr>
<tr>
<td>Failing in school is a minor accident</td>
<td>Brilliance in teachers appreciated</td>
</tr>
<tr>
<td>Friendliness in teachers appreciated</td>
<td>Boys and girls study different subjects</td>
</tr>
<tr>
<td>Boys and girls study same subjects</td>
<td>Live in order to work</td>
</tr>
<tr>
<td>Work in order to live</td>
<td>Managers expected to be decisive and assertive</td>
</tr>
<tr>
<td>Managers use intuition and strive for consensus</td>
<td>Stress on equity, competition among colleagues, and performance</td>
</tr>
<tr>
<td>Stress on equality, solidarity, and quality of work life</td>
<td>Resolution of conflicts by fighting them out</td>
</tr>
<tr>
<td>Resolution of conflicts by compromise and negotiation</td>
<td>Performance society ideal</td>
</tr>
<tr>
<td>Welfare society ideal</td>
<td>The strong should be supported</td>
</tr>
<tr>
<td>The needy should be helped</td>
<td>Corrective society</td>
</tr>
<tr>
<td>Permissive society</td>
<td>Big and fast are beautiful</td>
</tr>
<tr>
<td>Small and slow are beautiful</td>
<td>Maintenance of economic growth should have highest priority</td>
</tr>
<tr>
<td>Preservation of the environment should have highest priority</td>
<td>Government spends relatively small proportion of budget oil armaments</td>
</tr>
<tr>
<td>Government spends relatively large proportion of budget on development</td>
<td>International conflicts should be resolved by negotiation and compromise</td>
</tr>
<tr>
<td>assistance to poor countries</td>
<td>A relatively small number of women in elected political positions</td>
</tr>
<tr>
<td>Government spends relatively small proportion of budget on armaments</td>
<td>Dominant religions stress the male</td>
</tr>
<tr>
<td>International conflicts should be resolved by negotiation and compromise</td>
<td></td>
</tr>
<tr>
<td>A relatively large number of women in elected political positions</td>
<td></td>
</tr>
<tr>
<td>Dominant religions stress the male</td>
<td></td>
</tr>
</tbody>
</table>
complementarity of the sexes

- Women's liberation means that men and women should take equal shares both at home and at work

<table>
<thead>
<tr>
<th>complementarity of the sexes</th>
<th>prerogative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women's liberation means that men and women should take equal shares both at home and at work</td>
<td>Women's liberation means that women will be admitted to positions hitherto only occupied by men</td>
</tr>
</tbody>
</table>

*Table A.4: Feminine vs. masculine societies*

## Appendix B.5: High- vs. Low-Context societies

<table>
<thead>
<tr>
<th>High-Context</th>
<th>Low-Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Relationships between individuals are relatively long lasting</td>
<td>• Relationships between individuals are relatively shorter in duration, and in general deep personal involvement with others is valued less.</td>
</tr>
<tr>
<td>• Individuals feel deep personal involvement with each other</td>
<td>• Society tends to be more heterogeneous, and prone to greater social and job mobility</td>
</tr>
<tr>
<td>• Communication can be economical, fast, and efficient (because of shared communication code)</td>
<td>• Messages must be made explicit</td>
</tr>
<tr>
<td>• People in authority are personally responsible for the actions of subordinates</td>
<td>• The sender can depend far less on the receiver inferring the message from the context</td>
</tr>
<tr>
<td>• High loyalty to superiors and subordinates</td>
<td>• Member of the culture group are relatively unconditioned in non-verbal communications codes</td>
</tr>
<tr>
<td>• Agreements tend to be spoken rather than written</td>
<td>• Authority is diffused throughout the bureaucratic system and personal responsibility is difficult to pin down</td>
</tr>
<tr>
<td>• Insiders and outsiders (e.g. foreigners, non-members of the family, clan, or organisation) are tightly distinguished</td>
<td>• Agreements tend to be written rather than spoken</td>
</tr>
<tr>
<td>• Cultural patterns are ingrained, and slow to change</td>
<td>• Contracts are treated as final and legally binding</td>
</tr>
<tr>
<td></td>
<td>• Greater reliance on written legal systems is placed to resolve disputes</td>
</tr>
<tr>
<td></td>
<td>• Insiders and outsiders are less closely distinguished</td>
</tr>
<tr>
<td></td>
<td>• Cultural patterns are faster to change</td>
</tr>
</tbody>
</table>

*Table A.5: High- vs. low-context societies*

*(Source: Mead (1994), pp. 57-60)*
Appendix B.6: Monochronic vs. Polychronic societies

<table>
<thead>
<tr>
<th>Monochronic people...</th>
<th>Polychronic people...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do one thing at a time</td>
<td>Do many things at once</td>
</tr>
<tr>
<td>Concentrate on the job</td>
<td>Are highly distractible and subject to interruptions</td>
</tr>
<tr>
<td>Take time commitments (deadlines, schedules) seriously</td>
<td>Consider time commitments an objective to be achieved, if possible</td>
</tr>
<tr>
<td>Are low-context and need information</td>
<td>Are high-context and already have information</td>
</tr>
<tr>
<td>Are committed to the job</td>
<td>Are committed to people and human relationships</td>
</tr>
<tr>
<td>Adhere religiously to plans</td>
<td>Change plans often and easily</td>
</tr>
<tr>
<td>Are concerned about not disturbing others</td>
<td>Are more concerned with those who are closely related (family, friends, close business associates) than with privacy</td>
</tr>
<tr>
<td>Follow rules of privacy and consideration</td>
<td>Borrow and lend things often and easily</td>
</tr>
<tr>
<td>Show great respect for private property</td>
<td>Base promptness on the relationship</td>
</tr>
<tr>
<td>Seldom borrow or lend</td>
<td>Have strong tendency to build lifetime relationships</td>
</tr>
<tr>
<td>Emphasise promptness</td>
<td></td>
</tr>
<tr>
<td>Are accustomed to short-term relationships</td>
<td></td>
</tr>
</tbody>
</table>

Table A.6: Monochronic vs. polychronic societies

(Source: Hall / Hall (1990), p. 15)
### Appendix C: Hofstede index values and rank of fifty countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Abbreviation</th>
<th>Power Distance Index (PDI) Rank</th>
<th>Uncertainty Avoidance Index (UAI) Rank</th>
<th>Individualism Index (IDV) Rank</th>
<th>Masculinity Index (MAS) Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>ARG</td>
<td>49</td>
<td>86</td>
<td>46</td>
<td>56</td>
</tr>
<tr>
<td>Australia</td>
<td>AUL</td>
<td>36</td>
<td>51</td>
<td>90</td>
<td>2</td>
</tr>
<tr>
<td>Austria</td>
<td>AUT</td>
<td>11</td>
<td>70</td>
<td>55</td>
<td>18</td>
</tr>
<tr>
<td>Belgium</td>
<td>BEL</td>
<td>65</td>
<td>94</td>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>Brazil</td>
<td>BRA</td>
<td>69</td>
<td>76</td>
<td>38</td>
<td>26</td>
</tr>
<tr>
<td>Canada</td>
<td>CAN</td>
<td>39</td>
<td>48</td>
<td>80</td>
<td>23</td>
</tr>
<tr>
<td>Chile</td>
<td>CHL</td>
<td>63</td>
<td>86</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>Colombia</td>
<td>COL</td>
<td>67</td>
<td>so</td>
<td>13</td>
<td>46</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>COS</td>
<td>35</td>
<td>86</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>Denmark</td>
<td>DEN</td>
<td>18</td>
<td>23</td>
<td>74</td>
<td>9</td>
</tr>
<tr>
<td>Ecuador</td>
<td>EQA</td>
<td>78</td>
<td>67</td>
<td>8</td>
<td>49</td>
</tr>
<tr>
<td>Finland</td>
<td>FIN</td>
<td>33</td>
<td>59</td>
<td>63</td>
<td>17</td>
</tr>
<tr>
<td>France</td>
<td>FRA</td>
<td>68</td>
<td>86</td>
<td>71</td>
<td>10-11</td>
</tr>
<tr>
<td>Germany (FR.)</td>
<td>GER</td>
<td>35</td>
<td>35</td>
<td>89</td>
<td>3</td>
</tr>
<tr>
<td>Greece</td>
<td>GRE</td>
<td>60</td>
<td>112</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td>Guatemala</td>
<td>GUA</td>
<td>95</td>
<td>101</td>
<td>46</td>
<td>95</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>HOK</td>
<td>68</td>
<td>29</td>
<td>25</td>
<td>57</td>
</tr>
<tr>
<td>Indonesia</td>
<td>IDO</td>
<td>78</td>
<td>48</td>
<td>14</td>
<td>44</td>
</tr>
<tr>
<td>India</td>
<td>IND</td>
<td>77</td>
<td>40</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>Iran</td>
<td>IRA</td>
<td>58</td>
<td>59</td>
<td>41</td>
<td>24</td>
</tr>
<tr>
<td>Ireland</td>
<td>IRE</td>
<td>28</td>
<td>35</td>
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(Source: Hofstede (1980), p. 315)
Appendix D: General attitudes of multinational companies

Appendix D.1: Stages in the evolution of multicultural HRM

Figure A.1: Stages in the evolution of multicultural HRM
(Source: Hilb (2000), p. 73)
Appendix D.2: Comparison of ethno-, poly-, regio- and geocentric attitudes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ethnocentrism</th>
<th>Polycentrism</th>
<th>Regiocentrism</th>
<th>Geocentrism</th>
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</thead>
<tbody>
<tr>
<td>General mind-set</td>
<td>Colonial</td>
<td>Federalist</td>
<td>Regional</td>
<td>Glocal (=global + local)</td>
</tr>
<tr>
<td>Prevailing Orientation</td>
<td>Home-country orientation</td>
<td>Host-country orientation</td>
<td>Regional orientation</td>
<td>World-orientation</td>
</tr>
<tr>
<td>Cultural co-ordination</td>
<td>World-wide domination of home-country culture</td>
<td>Domination of host-country culture</td>
<td>Mix of the host-region’s cultural influences</td>
<td>Pursuit of an optimal mix of all cultures</td>
</tr>
<tr>
<td>Identification</td>
<td>Nationality of the owner / home-country</td>
<td>Nationality of host country</td>
<td>(Supra-) nationality of the host-region</td>
<td>Truly multinational</td>
</tr>
<tr>
<td>Perpetuation (recruiting, staffing, development)</td>
<td>Recruitment and development of home-country nationals for everywhere in the world</td>
<td>Recruitment and development of host-country locals for positions in their own country</td>
<td>Recruitment and development of host-region locals for positions everywhere in the world</td>
<td>Recruitment and development of the best people world-wide for positions everywhere in the world</td>
</tr>
<tr>
<td>Cultural sensibility of management</td>
<td>Weak</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Multicultural skills of management</td>
<td>Inexistent</td>
<td>Poor</td>
<td>Sufficient</td>
<td>Excellent</td>
</tr>
<tr>
<td>Slogan</td>
<td>“We’re all alike”</td>
<td>“We’re all different”</td>
<td>N.M.</td>
<td>“Thank God we’re not all alike”</td>
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</table>

Table A.7: Comparison of ethno-, poly-, regio- and geocentric attitudes
**Appendix E: The performance of selected ATLAS teams**

<table>
<thead>
<tr>
<th>System</th>
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<th>Members in total</th>
<th>Task effectiveness</th>
<th>Relational effectiveness</th>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Objeccives</td>
<td>Standards</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Climate</td>
<td>Relationships</td>
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<tr>
<td>TRT</td>
<td>5</td>
<td>9</td>
<td>4</td>
<td>3,9</td>
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<tr>
<td>ATI</td>
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<td>4,3</td>
<td>4,5</td>
</tr>
<tr>
<td>Tile Cal.</td>
<td>8</td>
<td>11</td>
<td>4,36</td>
<td>4,8</td>
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</table>

**Table A.8: Self-evaluation of team performance**

(Source: ATLAS personnel list)

654 The ratings range from 1 (very poor) to 5 (very good).
Appendix F: Cover letter

Email:

<table>
<thead>
<tr>
<th>To:</th>
<th>&lt;Peter Schmid&gt; <a href="mailto:peter.schmid@cern.ch">peter.schmid@cern.ch</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>From:</td>
<td>&lt;Olivier Maugain&gt; <a href="mailto:olivier.maugain@unisg.ch">olivier.maugain@unisg.ch</a></td>
</tr>
<tr>
<td>Date:</td>
<td>18.03.02 16:30</td>
</tr>
<tr>
<td>Subject:</td>
<td>Gesuch um die Durchführung einer Feldstudie beim CERN (HSG-Dissertation)</td>
</tr>
</tbody>
</table>

Sehr geehrter Herr Schmid,

Wie am heute Nachmittag telefonisch vereinbart, reiche ich Ihnen per Email mein Gesuch um die Durchführung einer Feldstudie in Ihrem Hause.


Um Ihnen einen Einblick in meine Arbeit zu gewähren, schicke ich Ihnen eine Kurzdarstellung meines Dissertationsprojektes. Ich habe es in Englisch verfasst, zumal auch meine Doktorarbeit in dieser Sprache sein wird.


Für Ihre Bemühungen danke ich Ihnen im voraus. Falls Sie zusätzliche Fragen haben sollten, stehe ich Ihnen jederzeit gerne zur Verfügung. Falls Sie es wünschen, lasse ich Ihnen auch gerne die (vorläufige) Struktur meiner Arbeit zukommen. In Hoffnung auf eine positive Nachricht Ihrerseits, verbleibe ich

mit freundlichen Grüssen,

Olivier Maugain
Appendix G: Interview guidelines

Possible problems or conflicts related to multicultural R&D teams

- “What are the elements that hamper / promote teamwork. Do you think they have a cultural origin?”

**Six C’s:**

- Composition
  - Heterogeneity
  - National or cultural clusters
  - Dominance of clusters or individuals from certain cultures
  - Complementarity
  - Different attitudes to risk
  - Disagreements of which you believe they are due to culture, education, etc.
    - Performance orientation
    - Time (punctuality, deadlines, future orientation, long-term vs. short-term orientation)
    - Work, labour
    - Quality
    - Scientific approaches
  - Social background:
    - There are individuals (as opposed to cultures) who just cannot accept other cultures (just as the are people who cannot work in teams)

- Connection
  - Members being left alone, outcast
  - Insufficient integration of new team members
  - Roles
  - Relationships
  - Responsibilities
  - Tasks and their distribution
  - Goals
  - Attribution of errors
o NIH-Syndrome
o Meetings
o Openness
o Physical distance

• Co-opetition
  o Obstacles / stumbling blocks to collaboration
  o Leadership
  o Sharing
  o Secrecy
  o Rivalry
  o Cultural mobbing, pressuring
  o Pressures to conformity (e.g. not letting the others express themselves)

• Conversation
  o Language
    ▪ Verbal / non-verbal
    ▪ Acronyms
  o Communication
    ▪ Formal / informal
    ▪ Real / virtual
    ▪ High / low context
  o Language barriers
  o Misunderstandings
  o Refusal to communicate via email, or use communication technology
  o Difference in electronic communication habits
  o Asymmetric information
  o Addressing colleagues: First name vs. last name, titles, formalism
  o Imbalance in language fluency
  o Listening habits
  o Redundant discussions
  o Overdiscussing, overanalysing

• Captaining
  o Leadership: Absence, non-acceptance, resistance
<table>
<thead>
<tr>
<th>Appendices</th>
</tr>
</thead>
<tbody>
<tr>
<td>277</td>
</tr>
</tbody>
</table>

- Goals: Agreement vs. disagreement
- Decision making
- Choice of scientific approaches
- Arguments
- Poor active participation, involvement
- Decision making: Consensus, voting, authority
- Cultural clashes
- Failing to come to closure
- Meetings

- Chemistry
  - Preconceptions, stereotypes, prejudices about other members’ culture
  - Trust and trustworthiness
  - Cultural pride, cultural snobbishness
  - Recognition, respect of others contribution, results, etc.
  - Compassion
  - Mutual consideration
  - Comprehension
  - Connivance
Appendix H: Questionnaire regarding the interviewees

General information about the interviewee

- Name: ______________________
- Title of the team / project: _____________________________
- Nationality: ______
- Gender: ___
- Rank: ____________________
- Scientific specialisation: ___________________________
- Education, academic degrees: _______________________
- Languages spoken: ____________________________________
- International experience (countries, duration):  _______________________________
  _______________________________________________________________________
  _______________________________________________________________________
- Rate the performance (1: very poor to 5: very good) of your team according to the following criteria:
  o Task effectiveness:
    - Estimate how far your team has met its objective(s) set: ___
    - Estimate how far your team has complied with the standards of quality and quantity established by its superintending unit: ___
  o Relational effectiveness:
    - Evaluate the general climate within the team: ___
    - Evaluate the relationships between the team members: ___
    - Appraise your own willingness to co-operate again with the same team: ___
## Appendix I: Portrayal of interviewees (case study)

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<th>Last name</th>
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<th>Education</th>
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<tr>
<td>Alexa</td>
<td>Calin</td>
<td>ROM</td>
<td>M</td>
<td>Theoretical physics, particle physics</td>
<td>Ph.D.</td>
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<td>Andresen</td>
<td>Xavier</td>
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<td>Olga</td>
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<td>Aerospace engineer</td>
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<td>Benincasa</td>
<td>Gianpaolo</td>
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<tr>
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<td>Mar</td>
<td>ESP</td>
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<td>Detector physics</td>
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<td>Fridolin</td>
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<td>M</td>
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<tr>
<td>Henriques</td>
<td>Ana</td>
<td>POR</td>
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<tr>
<td>Hooton</td>
<td>Ian</td>
<td>GBR</td>
<td>M</td>
<td>Shielding</td>
<td>B. Eng</td>
<td>ENG, FRA</td>
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<tr>
<td>Inigo-Golfin</td>
<td>Joaquin</td>
<td>ESP</td>
<td>M</td>
<td>Coating and ventilation</td>
<td>M. Eng. (Engineer)</td>
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<tr>
<td>Emery</td>
<td>Emanuel</td>
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<td>M</td>
<td>Technician</td>
<td>Ecole Supérieure</td>
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<td>Joos</td>
<td>Markus</td>
<td>GER</td>
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<td>Software development</td>
<td>Engineer</td>
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<td>M</td>
<td>Computer programming</td>
<td>Physicist</td>
<td>RUS, ENG, FRA</td>
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<tr>
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<td>Katja</td>
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<td>M</td>
<td>Material science</td>
<td>Designer</td>
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<td>Ioannis</td>
<td>GRE</td>
<td>M</td>
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<td>GRE, FRA, ENG</td>
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<td>Schlager</td>
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<td>M</td>
<td>Physics</td>
<td>Student</td>
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Table A.9: Selected characteristics of the interviewees
Appendix J: CERN’s organisation chart

Figure A.2: CERN organisation chart
(Source: CERN (2002b), p. 4)
Appendix K: The Standard Model

The quarks and leptons form two families of particles, which members can be grouped into pairs. Each family has two pairs. The electron and electron neutrino, as well as the up-quark and down-quark of stable matter, form the pairs of particles with the lightest mass. The other pairs fall into the category of the “heavier” generations of their respective family.655

By accounting for the electromagnetic, strong, and weak forces of quarks and leptons, the Standard Model explains the patterns of nuclear binding and decay.

---

655 From: http://public.web.cern.ch/Public/SCIENCE/particleFamilies.html


Appendix L: Examples of accelerators’ spin-offs

<table>
<thead>
<tr>
<th>Domain</th>
<th>Application</th>
</tr>
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</table>
| Medicine and biology    | • Cancer therapy (destruction of deep tumours)  
                          • Sterilisation  
                          • Radiation processing  
                          • Source of synchrotron radiation  
                          • Source of neutrons  
                          • Source of modified biological chemicals (through the production of isotopes) |
| Energy                  | • Incineration of nuclear waste  
                          • Power generation: Energy Amplifier (?) |
| Physics                 | • Non-destructive testing  
                          • Source of synchrotron radiation (for use in condensed matter physics)  
                          • Source of neutrons (for use in condensed matter physics) |
| Industry                | • Sterilisation (food, sewage)  
                          • Food preservation  
                          • Polymerisation of plastics  
                          • Electronics  
                          • Measuring  
                          • Waste treatment  
                          • Destruction of toxic products  
                          • Implantation of atoms on the surfaces of semiconductors  
                          • Superconductivity  
                          • Vacuum |

Table A.10: Practical applications of particle accelerators
(Source: Brianti (1997), p. 4; CERN-Website; Smith (1997); Vitasse (1997b), p. 1)
Appendix M: The Management of ATLAS

Figure A.4: ATLAS organisation chart
(Source: http://atlas.web.cern.ch/Atlas/internal/Organisation.html)
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BADAWY, Michael (1978):

BAILYN, Lotte (1985):
BAJARIA, Hans (2000):

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BIERLY, Paul / Alok CHAKRABARTI (1996):

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BÖNING, Uwe (2000):
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BRECHJE, Albert (1999a):

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BROCKHOFF, Klaus (1999):

BUBSHAIT, Abdulaziz / Gulam FAROOQ (1999):

CANAINN, Aodh (1995):

CARTWRIGHT, Dorwin / Albin ZANDER (1968):

CAUDRON, Shari (1994):

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CHANNEY, Lillian / Jeanette MARTIN (1995):

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JENT, Nils (2002):  

JOHNSON, Jean / John CULLEN (2002):  

JOHNSON, Deborah / Adrian SARGEANT (1998):  

JONES, Oswald (1996).  

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KATZ, Ralph (1988b):  

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MOWERY, David / Nathan ROSENBERG (1989):

NATALE, Samuel / Anthony LIBERTELLA / Brian ROTHSCILID (1995):

NECK, Christopher / Wanda SMITH / Jeffrey GODWIN (1997):

NEFF, Peter (1995):

NONAKA, Ikujiro (1994):

NONAKA, Ikujiro / Noboru KONNO (1998):

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TRAJTENBERG, Manuel / Rebecca HENDERSON / Adam JAFFE (1992):

TRIANDIS, Harry (2002):

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WERNER, Jon (1995):

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YIN, Robert (1993):

YIN, Robert (1994):

ZACHARY, Pascal (1998):
**Index of interviews (pilot study)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Company and position</th>
<th>Date and location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hofmann, Hans</td>
<td>IBM, Zurich Research Laboratory</td>
<td>22.03.02, telephone</td>
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<tr>
<td>Kaltenborn, Uwe</td>
<td>ABB, Corporate Research Center</td>
<td>10.04.02, Dättwil</td>
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<td>ST Microelectronics</td>
<td>26.12.01, Chamrousse</td>
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<td>17.04.02, Meyrin</td>
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<td>26.02.02, telephone</td>
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<td></td>
</tr>
</tbody>
</table>
## Index of interviews (case study)

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Date and location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexa, Calin</td>
<td>Project Associate, Tile Cal.</td>
<td>15.05.02, Meyrin</td>
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<tr>
<td>Andresen, Xavier</td>
<td>Unpaid Associate, Tile Cal.</td>
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<td>Staff, ATI - Mechanical Integration</td>
<td>30.05.02, Meyrin</td>
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<td>29.05.02, Meyrin</td>
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<td>30.05.02, Meyrin</td>
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<td>Schlager, Gerolf</td>
<td>Technical student, Tile Cal.</td>
<td>29.05.02, Meyrin</td>
</tr>
</tbody>
</table>
### Index of meetings (case study)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Participants</th>
<th>Date and location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Meeting</td>
<td>Tile Cal. Team (including technicians)</td>
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<td>CERN-based Tile Cal. Team</td>
<td>29.05.02, Meyrin</td>
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<tr>
<td>Pre-ATLAS Week</td>
<td>Tile Calorimetry Team Members</td>
<td>20.06.02, Meyrin</td>
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<td>Tile mechanics Meeting</td>
<td>Tile Calorimetry Team Members (CERN-based and external)</td>
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Index of websites

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http://dor.hbs.edu/fi_redirect.jhtml?facInfo=res&facEmId=dleonard@hbs.edu (Harvard Business School Faculty – Dorothy Leonard)

http://atlas.web.cern.ch/Atlas/internal/Organisation.html (CERN’s internal ATLAS site)

http://atlas.web.cern.ch/Atlas/documentation/EDUC/glossary_index.html (Glossary of high-energy physics terms)

http://public.web.cern.ch/Public (CERN-Website)

http://www.pbs.org/faithandreason/physgloss/partphys-body.html (PBS Television)

http://www.zdnet.co.uk/pcmag/columns/2000/07/jackson.html (ZDNet UK)
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**Olivier Maugain**  
Born on the 14th April 1976 in Delft, The Netherlands  
French nationality  
olivier.maugain@alumni.unisg.ch

### Education

<table>
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<th>Period</th>
<th>Institution</th>
<th>Details</th>
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<tr>
<td>1995 - 2000</td>
<td><strong>University of St. Gallen</strong> - Switzerland:</td>
<td>Diploma thesis: “Corporate Governance in International Airline Alliances” (in German)</td>
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### Work Experience

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<tr>
<td>Nov. ‘02 - Jan. ‘03</td>
<td><strong>Ebel SA</strong> - La Chaux-de-Fonds, Switzerland:</td>
<td>Business Analyst</td>
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<tr>
<td>Apr. ’01 - Oct. ’02</td>
<td><strong>University of St. Gallen</strong> - Switzerland:</td>
<td>Career Services Consultant</td>
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<tr>
<td>Sept. - Nov. 1998</td>
<td><strong>Bertelsmann Fachinformation</strong> - Munich, Germany:</td>
<td>Project Assistant</td>
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<td>July - August 1998</td>
<td><strong>European Patents Organisation</strong> - Munich, Germany:</td>
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### Extracurricular activities

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<tr>
<td>2002 - 2003</td>
<td>Member of the board of the Swiss Fencing Federation (treasurer)</td>
</tr>
<tr>
<td>2001 - 2002</td>
<td>Member of the board of the St. Gallen Fencing Club (sponsoring)</td>
</tr>
<tr>
<td>2001 - 2002</td>
<td>Event marketing</td>
</tr>
<tr>
<td>1999 - 2000</td>
<td>Assistant in statistics: tutoring of 2nd year students</td>
</tr>
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### Hobbies

Fencing: foil, hiking, tennis, skiing, travelling