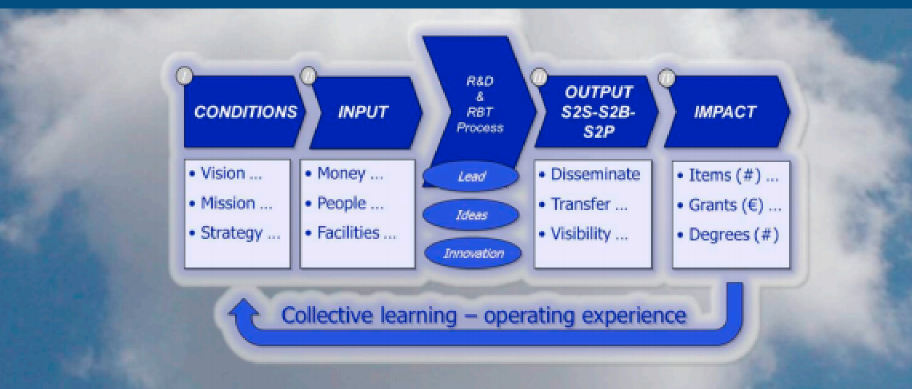
Andreas Holzinger

Successful Management of Research & Development

Guide - Leitfaden



Short.Concise.Precise - Kurz.Knapp.Klar

Guide

Successful Management of Research & Development

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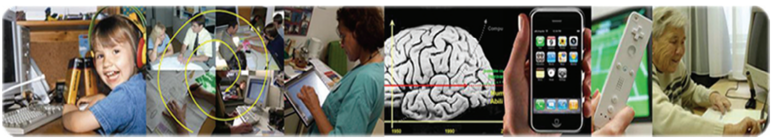

Research & Development play a central role within our knowledge based information society in order to retain and to expand the sustained competitiveness of our Business. Successful management ensures effectiveness, efficiency and the quality of all necessary factors and processes in order to enable sustained R & D.

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Leitfaden
(Diese Arbeit ist in englischer Sprache verfasst)

Erfolgreiches Management von Forschung & Entwicklung

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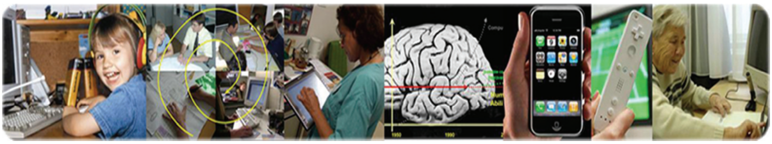

In unserer wissensbasierten Informationsgesellschaft tragen Forschung und Entwicklung wesentlich zum Erhalt und Ausbau der Wettbewerbsfähigkeit unserer Wirtschaft bei. Erfolgreiches Management stellt Effektivität, Effizienz und Qualität aller notwendigen integrativen Faktoren und Prozesse sicher, um Forschung & Entwicklung nachhaltig zu unterstützen.

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Abstract

Establishment, development and management of a successful research and development group require systematic knowledge and skills and a target-oriented process model. It begins with a vision and requires a clear mission and accordant strategy in order to achieve these goals. The people involved in the team work are of primary importance; everything depends on the interaction of this team. To create this team, to develop, scaffold, advance and lead is a challenge. However, even the best team is ineffective if there is no funding. Money is not everything but without money everything is nothing. A substantial budget is required to cover staff costs, premises and basic equipment, travel, computers and basic software, a scientific software portfolio, hosting, special equipment, literature, workshop organization, visiting researcher invitations, etc. In an environment of decreasing public budgets, external funding becomes increasingly important in order to sustain international competitiveness, quality and to maintaining excellence. Ultimately, the team is assessed by output, which is composed of measurable, published "items".

"If you ask what real knowledge is, I answer, that which enables action (Hermann von Helmholtz)".

Keywords

Management, Science, Research, Team, Work group

Zusammenfassung

Gründung, Aufbau und erfolgreiche Leitung einer Forschungs- und Entwicklungsgruppe erfordern systematische Kenntnisse und Fertigkeiten und ein zielgerichtetes Vorgehensmodell. Es beginnt mit einer Vision, erfordert eine klare Mission und entsprechende Strategie um die Ziele zu erreichen. Das wichtigste sind die Menschen, die in einem Team arbeiten. Vom Zusammenspiel dieses Teams hängt alles ab. Dieses Team zu bilden, zu fördern, zu fordern und zu führen ist eine Herausforderung. Doch das beste Team nützt nichts, wenn keine Finanzierung da ist. Geld ist nicht alles, aber ohne Geld ist alles nichts. Ein solides Budget ist notwendig zur Deckung von Personalkosten, Raumkosten und Grundausstattung, Reisekosten, Computer und Basissoftware, Scientific Software Portfolio, Hosting, spezielle Geräte und Ausrüstung, Literatur, Organisation von Workshops, Einladung von Gastforschern usw. Die Einwerbung von Drittmitteln wird bei sinkenden öffentlichen Budgets immer wichtiger um die internationale Wettbewerbsfähigkeit, Qualität und Exzellenz aufrecht zu erhalten. Gemessen wird das Team schließlich am Output, der sich aus messbaren veröffentlichten „Items“ zusammensetzt.

„Wenn Du fragst was rechtes Wissen sei, so antworte ich, das, was zum Handeln befähigt (Hermann von Helmholtz)“

Schlüsselwörter

Management, Wissenschaft, Forschung, Team, Arbeitsgruppe

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1 Introduction

1.1 Research & Development

Science[1] is a quest for expanding our current knowledge (state-of-the-art) and the organisation of this so-called *scientific body of knowledge* in laws and theories. By application of research methods we aim to find novelties in order to go beyond state-of-the-art and to contribute these findings to a scientific community. It is essential that the findings are:

1) inter-subjective,
2) trans-cultural and
3) replicable.

Research follows a certain structural, methodological and *systematic* process. For specific information on this process refer to the "Process Guide for Students" (Holzinger, 2010a).

Research Based Teaching (RBT) is a way to move to a more student centred teaching and to improve student learning by involving them early in research activities, consequently raising awareness for systematic research based approaches.

Development can be seen as the application of the research findings and the appropriate use of design and development methods, conceptual architectures and formal models, in order to change.

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[1] from Latin scientia = knowledge; for a good reader on the Philosophy of Science refer to Chalmers, A. F. (2009) *What is this thing called Science?* Berkshire (UK), Open University Press..

1.2 Validation & Evaluation

Validation, verification and evaluation, and/or experimental examination of the developed applications is invaluable.
Validation is the process of checking if and to what extend the developed system meets the specifications and therefore fulfils its intended purpose.
Verification is a quality control process that is used to evaluate whether and to what extend the developed system complies with official regulations, legal specifications, standards or norms.
Evaluation is the systematic assessment of the application by usage of certain criteria against a defined set of standards.
Experimental Examination is testing the system against stated Hypotheses (e.g. "By use of the system A the task X is performed in shorter time than by use of system B") either in a laboratory or, better, in the field (real life experiment, field experiment).

1.3 Business Case

Along with a contribution to the scientific community, it is also important to progress towards a business case (Geschäftsszenario), which is not to confuse with a business plan (Geschäftsplan). The business case should demonstrate that the work contains merit, brings benefits to the end users, consequently *can* lead to commercial success.

"The most rewarding research is the one that delights the thinker and at the same time is beneficial to humankind (Christian Doppler, 1803-1853)".

1.4 Quality

While it is important that all team members are enjoying their work, and that a research institution provides an atmosphere of trust, inspiration and enthusiasm, all work carried out must be **high quality** work and reflect international standards.

Science is thinking and by nature trans-cultural and inter-subjective, i.e. research follows at all places in the world common principles – and all scientists in the world, disregarding if they are sitting in Stanford, Cambridge or Graz – need the same basic elements. This is what they need; all other stuff is artificial bureaucracy – and I doubt that bureaucracy will really bring international excellency.

The following pages can be used as a navigation aid for setting up a research unit, a team, a group however you may describe it. Disregarding the size, the principles are more or less the same – as are the problems – within the rough waters of international as well as national reality.

However, as Thomas Alva Edison said: "There is a way of doing it better, find it."

Much success for your enterprise!

Graz, January 2011, Andreas Holzinger

2 Abbreviations and Acronyms

A&HCI	Arts & Humanities Citation Index is a commercial citation index of over 1,100 of arts and humanities journals.
CA	Conjoint-Analysis is a multi-attribute compositional model approach including a trade-off analysis
CI	Corporate Intelligence = Business Intelligence
CPCI-S	Conference Proceedings Citation Index- Science
ECTS	European Credit Transfer System (1 ECTS = 30 hours student workload)
EFQM	European Foundation for Quality Model
EPO	European Patent Office
FTE	Full-time equivalent (in German "Vollzeitäquivalent")
IF	Impact Factor = measure reflecting the average number of citations to papers within a specific journal
INSPEC	Engineering Index especially for Physics, Computer & Control, Electrical Engineering & Electronics
IPC	International Patent Classification (Strassbourg)
ISO	International Standardisation Organisation
ISO 9000	Family of standards for quality management systems
KM	Knowledge Management
kEUR	1,000 EUR (k … kilo)
MEUR	1,000,000 EUR (M … Mega)
ÖSTAT	Austrian Statistics

NDA	Non-Disclosure Agreement
NIH	Not Invented Here Syndrome
PM	Person Month
PR	Public Relation (see also S2P)
ROI	Return on Investment
QFD	Quality function deployment
S2S	Science-to-Science (professional level)
S2B	Science-to-Business (commercial level)
S2P	Science-to-Public (see also public relations PR)
SCI	Science Citation Index
SMART	Specific-Measureable-Attainable-Relevant-Timed
SSCE	Science Citation Index Expanded
SSCI	Social Sciences Citation Index
SWOT	Strengths-Weaknesses-Opportunities-Threats
TQM	Total Quality Management
TIPS	Theory of Inventive Problem Solving (aka TRIZ)
UAD	Unifying Action Declarations
USP	Unique Selling Proposition
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization
WP	Work package
WTO	World Trade Organization

3 Research Categories

3.1 Basic Research

Curiosity is (or ideally should be) the main inspiration for doing basic research (Grundlagenforschung) and it is focused primarily to expand fundamental knowledge; thus called *fundamental* research or sometimes *pure* research. It stimulates new ways of thinking, finding new theories, principles and insights and it is *not directed to any purpose.*

3.2 Applied research

Problem solving is a central motivator for doing applied research, which makes use of basic research and past theories, knowledge, methods for solving specific problems.

3.3 Experimental development

Novel applications are in the focus of this type of creative research and it makes use of basic research (theories, methods) and applied research (problem specific state-of-the-art knowledge) in order to devise business cases.

3.4 Mix of different categories

The discussion of the categorization of research is an on-going debate for years (Nason, 1981). Scientists and policy-makers have claimed that the distinction between basic research, applied research and experimental development is increasingly irrelevant and based on misconceptions about modern knowledge production. Most researchers today carry out a mix of different categories (Gulbrandsen & Kyvik, 2010).

4 Elements of Successful Research

The elements of successful research include four big areas:

I) BASIC CONDITIONS
II) INPUT
III) OUTPUT
IV) IMPACT

Management by adequate processes (lead, ideas, innovation) coordinates the four areas (figure 1) in order to gain maximum productivity and excellence – within a pleasant, inspiring and enjoyable environment. Note: Whereas joy and fun are surely necessary factors, which should be considered; what matters most are the results (Malik, 2009).

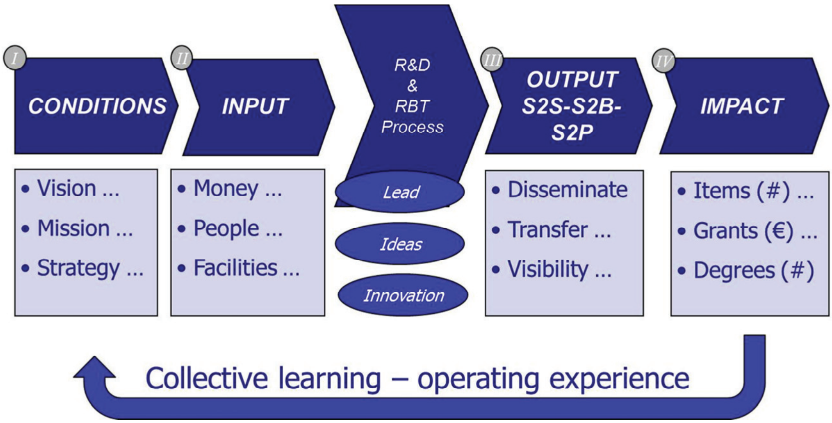

Figure 1 The four areas for successful research – leadership must ensure a pleasant, inspiring and joyful environment to gain high productivity and excellence – results

Before we go into detail, let us repeat each element briefly.

ad I) BASIC CONDITIONS

1. Vision (is a *declaration* about what goal you *want* to achieve and is necessary for successful research)
2. Mission (are *statements* which guides the actions towards the goal and provides a *visible direction*)
3. Strategy (the overall *plan of action* to get closer to the goal[2])

ad II) INPUT

1. Money (money is not all, but all is nothing without money)
2. People (teambuilding is most crucial for success, …)
3. Facilities (infrastructure, equipment, tools, …)

ad III) OUTPUT

1. Dissemination (deliverables leading to measurable items)
2. Knowledge Transfer (teaching, faculty, industry, …)
3. Visibility (community building, science-to-public, …)

ad IV) IMPACT

The impact can be determined by everything which is measurable and countable and which can be enlisted and entered into a science balance (Wissensbilanz), e.g.

1. Items (publications, proceedings, book chapters, …)
2. Grants (amount of raised funding, sponsorship, ...)
3. Degrees (supervised Bachelors, Masters, PhDs, …)

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[2] If a strategy has more than one page (big picture, see figure 19) than it is none!

5 Success Factors: Vision-Mission-Strategy

5.1 Vision

A vision reflects the *focus* of a research team and, moreover, how the team wants to be perceived externally by stakeholders (science, business, public). For a research team it is of tremendous importance to develop a *shared vision*. Peter Senge describes in his “Learning Organization” that successful teams have a flat and decentralized organizational structure and the key success factor is intrinsic motivation – based on a shared vision which leads to identity building (Senge, 1990).

Shared Vision inspires a team to be innovative, effective and efficient. Thus, the perception of innovation effectiveness appears to have facilitative effects on teams that are responsible for delivering product and process innovations and this effect appears to carry through to future success in the innovation process. Team potency, teamwork behaviour, altruistic behaviour, courtesy behaviour are direct outcomes of a shared vision (Pearce & Ensley, 2004).

The combination of vision, mission and strategy as shown in figure 1 are essential for excellence (Huan, 2009). Considering this, vision, mission and strategy statements can be constructed as Unifying Action Declarations (UADs, (Tarnow, 2001)), which suggest a competitive action and include a social category and make use of **proactive verbs.**

Example from (http://hci4all.at): *Let us together, today, make information technology of tomorrow more usable, enjoyable and accessible for all.*

5.2 Mission

A mission statement tells in one easy-to-remember sentence what you are doing and contains three key components:

1) Purpose: What are the opportunities, needs, demands etc. that you address?
2) Business: What are you undertaking to address those opportunities, needs, demands?
3) Values: What core principles guide your work in order to address the purpose?

Example from (http://hci4all.at): *Realize usable, enjoyable and accessible Interactive Multimedia Information Systems following Human-Centered Development.*

5.3 Strategy

The vision and the mission are your guiding principles, but the strategies encompass the methods and instruments to reach your goals and how they are applied.

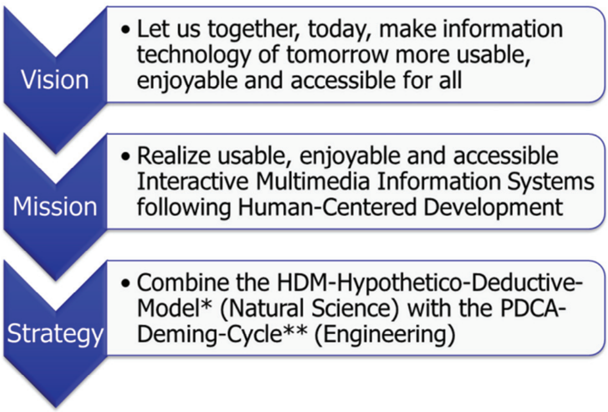

Figure 2 Vision-Mission-Strategy on the example of hci4all.at

5.3.1 Strategy: Deming Cycle (PDCA)

The Deming Plan-Do-Check-Act concept was originally developed by (Shewhart, 1958) as Plan-Do-Study-Act (PDSA) cycle. The roots can be tracked back to Aristotle (384–322 BC) and Francis Bacon (1561–1626). The PDSA follows four steps:

1) PLAN: Study the process;
2) DO: Make changes on a small scale and measure them;
3) STUDY: Observe, assess and analyze the effects and
4) ACT: Identify what you can learn from your observation.

William E. Deming (1900–1993) promoted this model effectively and called it PDCA cycle (Deming, 1994) and is also known as Deming wheel (figure 3):

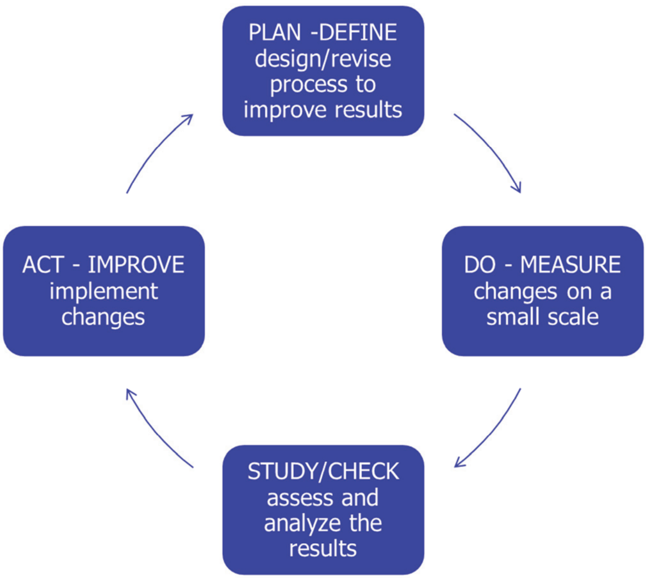

Figure 3 The Shewhart Cycle, later Deming Wheel

PDCA aims for continuous improvement. Every improvement starts with a goal and with a plan on how to achieve that goal, followed by action, measurement and comparison of the gained output. The most important issue is to *act* – on a small scale – but act! Deming introduced a “System of Profound Knowledge”, consisting of four parts (Stepanovich, 2004):

1) Understand the processes;
2) Know the variation and the range and causes of variation and use of sampling in measurements;
3) Find concepts explaining knowledge and the limits of what can be known;
4) Acquire knowledge of concepts of human nature.

From this the following competencies can be developed (Scholtes, 1999):

1) Ability to think in terms of *systems and processes;*
2) Ability to understand *variability* of all work;
3) Understanding for learning and *improvement;*
4) Understanding people and their *behaviour;*
5) Understanding *interactions* of systems and variations;
6) Providing vision, meaning, direction and *focus.*

“Without a purpose there is no system” and Deming provided the example of cleaning a table, where just looking on the process “cleaning” is not enough, you must know the **context:**

a) You can clean a table for repairing an engine;
b) You can clean a table for eating;
c) You can clean a table for a surgical operation.

Consequently, *“What is the purpose?”* is one of the most useful questions, which can be asked (Scholtes, 1999). However, you must do it, alter, e.g. make a device like its predecessor – only *better* (Thimbleby, 2007).

5.3.2 Strategy: Hypothetic-Deductive Approach

Developed by Sir Isaac Newton (1643-1726) during the late 17th century (but named at a later date by philosophers of science), the hypothetic-deductive method assumes that properly formed theories arise as generalizations from observable data that they are intended to explain.
These hypotheses, however, cannot be conclusively established until the consequences, that logically follow from them, are verified through additional observations and experiments.

In conformity with the rationalism of René Descartes (1596-1650), the hypothetic-deductive method treats theory as a deductive system, in which particular empirical phenomena are explained by relating them back to general principles and definitions. This method abandons the Cartesian claim that those principles and definitions are self-evident and valid; it assumes that their validity is determined only by their consequences on previously unexplained phenomena or on actual scientific problems.

Basically, scientific methods include techniques for investigating phenomena with the aim of acquiring *new* knowledge, or *correcting* and *integrating previous knowledge,* i.e. going from state of the art to *beyond state of the art* (Cairns & Cox, 2008).

For more details on this approach please refer to the Student's Process Guide (Holzinger, 2010a).

5.3.3 Strategy: Competency Matrices

The concentration to the core competencies is one of the most crucial success factors for any team, thus it is essential to know *what are the core competencies*. According to (Cheetham & Chivers, 1998) different job roles require a different mix of the core components, hence they address such variations within an occupational competence mix diagram (figure 4). It was accepted that meta-competencies (shown round the perimeter in figure 4) could also vary in their importance between different job roles.

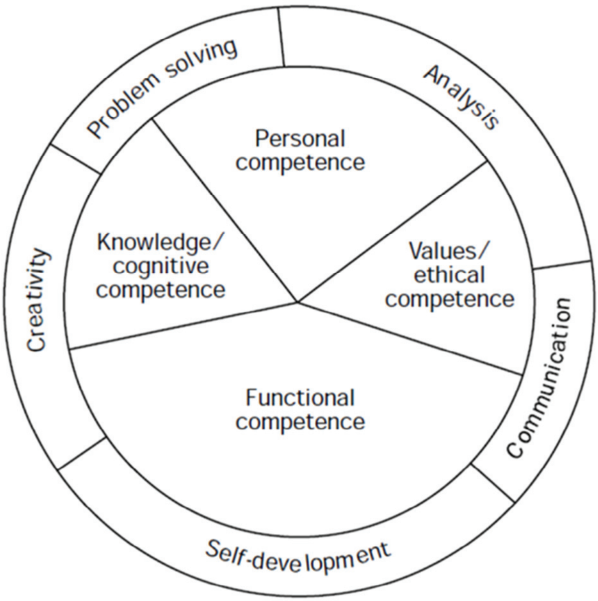

Figure 4 The relative importance of the core components to effective performance within a particular job is indicated by the size of the segments (Cheetham & Chivers, 1998).

5.3.4 Strategy: Thematic Clustering

It is important to concentrate on fields according to the available team competences. In the following an example on how research in Human-Computer Interaction (HCI) can be grouped and categorized (refer to http://hci4all.at):

1) According to Subject (domains)

a) Medicine and Health Care: e-Health, Decision Support, Medical Information Systems, ...
b) Education: e-Education, e-Learning, e-Teaching, e-Didactics, e-Workplace, m-Learning, p-Learning, u-Learning, Life-Long-Learning, ...
c) Business: e-Business, e-Commerce, e-Procurement, ...
d) Governmental: e-Government, e-Voting, ...

2) According to humans (end user groups)

e) Patients, Medical Doctors, Nurses, Managers, ...
f) Children, Elderly people, ...
g) Learners, Teachers, Tutors, Coaches, Administrative Professionals, School Managers, ...
h) Novices, Intermediates, Advanced, Experts, ...
i) Able-bodied, Disabled, Impaired, ...

3) According to context (processes)

j) In the hospital, at the workplace, in the office, at home, at school, in the classroom, at University, in the car, ...
k) Business, Pleasure, Leisure, Emergency, ...
l) Wellness, well-being, joyful, safe, secure, healthy, independent, creating new ways of User Experience, ...
m) Chaotic, hectic, stressful, complex, ...

4) According to Computer (devices)

n) Large screen devices, small screen devices, ...
o) Haptic devices, Multi-touch devices, Tablet-PCs, Smartphones, Handheld devices (e.g. iPod), ...
p) Mobile, wearable Computers, ubiquitous and pervasive, ambient devices, ...
q) Gameboys, Play consoles (e.g. Nintendo Wii + WiiMote,...), interactive Television (iTV), ...

ad 5) According to Interaction (modalities)

r) Creativity, Inspiration, Thinking, Support, Aid, Tacit, Productivity, Decision Support, ...
s) Collaborative, Individual, Personal, Confidential, Passive, …
t) Security, Stability, Quality, Sustainability, ...
u) Speech, Gestures, Face recognition, Eye-Movement based, Smell, Haptical, Taste, ...

ad 6) According to Innovation

v) Extreme Mobility, Hyper-Connectivity[3], Affective Computing, Perceptual Interfaces, ...
w) Multiple mixing & mashing, changes in thinking & learning, ...
x) Transdisciplinary (learning from other areas, import models from other disciplines), ...
y) Tangible Interfaces, non-WIMP[4] Interfaces, context-aware interfaces, virtual/augmented reality (VR, AR).

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[3] see Harper, R., Rodden, T., Rogers, Y. & Sellen, A. (2008) *Being Human: Human-Computer Interaction in the Year 2020.* Cambridge, Microsoft Research.

[4] Windows-Icons-Menus-Pointers

6 Input Success Factor: Money

For every activity you need money, consequently you need a budget. The principles are very simple, you just have clearly to determine and identify:

1) INCOME (primary budget, funding, …)
2) EXPENSES (staff, equipment, travel costs, …).

Direct costs. Usually you calculate with direct costs, which include expenses for staff, equipment, consumables, travel, etc.

Indirect costs. There are also other costs, which are called overheads and basically include electricity, room rent, services, etc.

From the perspective of the balance sheet you also have to consider two further elements:

1) ASSETS (intellectual property, royalties, sponsoring, …)
2) LIABILITIES (mortgages, loans, fees, …)

Budget constraint. This is the case if you have a limited amount of money and must plan according to the money available – not on the basis what you need.

Financial Plan. Although under budget constraint it is good to provide a financial plan, based on the real needs you have.

Let us figure out the expenses of a typical example of setting up an academic research group.

I) STAFF COSTS
Although staff costs are usually the lion's share, apart from people you have also to finance:

II) ADDITIONAL COSTS

1) MINIMUM BASIC HARDWARE
2) SCIENTIFIC SOFTWARE PORTFOLIO
3) SPECIAL RESEARCH EQUIPMENT
4) COSTS FOR PUBLICATIONS/LITERATURE
5) TRAVEL COSTS
6) FLEXIBLE MINI-BUDGET (creditcard) for consumables, e.g. hosting research guests, providing catering for meetings etc.

6.1 Staff costs

When calculating the total cost of staff you must make sure to include everything that is a cost for your company, not just how much an employee gets paid, it must also include e.g. taxes, insurances, benefits costs, payroll tax contributions, etc.

Gross/Net calculator (Brutto/Netto Rechner) is a helpful tool provided by the Austrian Government:
http://www.bmf.gv.at/service/Anwend/Steuerberech/NettoBrutto/NettoBrutto.htm

Indirect labour costs calculator (Lohnnebenkostenrechner) of the Austrian Government is also helpful:
http://www.bmf.gv.at/service/Anwend/Steuerberech/Nebenkosten/Lohnnebenkostenberechnung.htm

6.1.1 Costs for Leader (Professor)

The gross income[5] of a professor in Austria (2011) is negotiable between 53 kEUR (min.) and 160 kEUR (max.) per annum. The average of these two extremes is 107 kEUR. According to the additional dues (Lohnnebenkosten, Dienstgeberbeiträge), we must add approx. 27 % to get the overall costs of 135 kEUR per year for such a position.

6.1.2 Costs for Postdocs (Senior researcher)

The costs of a postdoc researcher, according to the Austrian Science Fund (FWF) are approx. 60 kEUR/a.

6.1.3 Costs for PhD Students (Junior researcher)

The cost for a doctoral student, according to the Austrian Science Fund (FWF), is approx. 33 kEUR/a. Note that this is on the basis of 30 hours/week. If you calculate for 40 hours/week you must put 44,2 kEUR/a.

6.1.4 Costs for non-scientific support staff

Costs for support staff vary from 28 kEUR/a to 38 kEUR/a.

6.1.5 Costs for Master students

According to the Austrian Science Fund (FWF) the financial support for a master's thesis is a maximum of 5,280.- EUR per student per thesis – usually it is 2,300 EUR. Usually this is paid from third party funds, e.g. Forschungsscheck Austria.

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[5] Note that the net income is much lower due to taxes and insurances, and that the net income depends on the family status

6.1.6 Sample staff costs

A small research group consists of the following core staff[6]:

FTE	Job description	Job level	kEUR/a
1	Leader	University professor	135
1	PostDoc	Senior researcher	60
2	Docs	Junior researcher	66
0,75	Secretary	Administration staff	24
0,5	Technician	Technical Staff	15
5,25	TOTAL COSTS PER ANNUM		300

All other staff is paid by funding (Drittmittel).
This 6-people core group must be budgeted with 300 kEUR per annum from the basic Budget (Basisfinanzierung), which results in the typical 60kEUR/person/year rule-of-thumb, as the average cost for one full-time equivalent (FTE, in German Vollzeitäquivalent, VZÄ). FTE is a key business metric, i.e. one person occupying a paid full time job all year is equivalent to 1 FTE. However, it is also possible to employ two people half-time or four people quarter-time and it is still 1 FTE on the payroll. In Austria we usually work 8 hours a day, 40 hours a week, 160 hours a month and (considering 4 weeks of paid holidays per year) we have 1,760 hours a year equivalent as 1 FTE. Yearly raises, in average 3 % per annum must be calculated.
For running such a 5,25 FTE research team for a typical financial period of 3 years you need a staff budget of approx. 0,9 MEUR.

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[6] These are responsible for teaching, strategic thinking, cooperation and for permanent fundraising to expand the team like an Artichoke

6.2 Minimum Basic Hardware

Obviously, the better the equipment of your staff, the higher is the *possibility* of higher performance – at least motivation increases, if your staff can work with the most modern equipment. Typical basic equipment includes

1) workgroup server,
2) mobile workstations (including separate screens, keyboard and mice),
3) mobile video-beamer for progress meetings, and
4) smart phones for internal group communication.

You can estimate for the 6 people workgroup initial costs (Erstausstattung) of a minimum of 24 kEUR (4 kEUR/person) for the first three years. Keep in mind that for iPad, iPhone development you need at least one Mac.

6.3 Scientific Software Portfolio

Usually with the hardware you purchase the operating system (e.g. Windows 7 or Mac OS X) and the standard software (e.g. Microsoft Office 2010), which is usually covered by campus licenses of the university.

For scientific purposes it is essential to have some further software, including drawing software (e.g Visio 2010), Library software (e.g. End Note X4), Statistical packages (e.g. SPSS, although R is a serious alternative), and special experimental software including recording technology Software for indexing clicks, keystrokes etc. (e.g. Morae, Interact, etc.).
You should budget at least 5 kEUR/year for such software[7].

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[7] First check for campus licenses!

6.4 Special Equipment

Today's modern scientific society and research community demands special equipment, space and room for diverse and complex activities (figure 5). However, designing such rooms (refer to section 6.7) and equip them with appropriate facilities, instruments and devices includes many diverse aspects including security, privacy and safety and a smart integration of new equipment into *existing* university equipment and facilities (Crosbie, 2004).

Figure 5 A best practice example of an interaction lab from the Fraunhofer-Institut für Arbeitswirtschaft und Organisation (IAO)

Please consider that it is *not* necessary to possess things – sometimes it is sufficient just to have *access* to them – this is especially true for special equipment.

It is absolutely necessary to check in advance, if and to what extent there is a clear benefit and a **return-on-investment.** Usual special equipment may encompass:

a) Videowall (figure 6),
b) Whiteboard,
c) Smartboard,
d) Eye tracking equipment and cameras,
e) Biological usability testing equipment (sensors etc.) and
f) interactive devices (see figures 5 and 6),

Costs are highly dependent on the research plan and can range from some 10 kEUR to more than 100 kEUR. It is essential that it is in close accordance to the room concepts of new and existing facilities (see section 6.7).

Figure 6 A best practice example of a Videowall for multi-purpose research from the RWTH Aachen (Alagöz et al., 2010)

6.5 Publications and Literature

6.5.1 Publication Costs - Open Access

Open access journals are scholarly journals that are available online to the reader without any payment, because they are

a) subsidized, i.e. financed by academia or government, or
b) the authors pay for their paper to make it open access.

There are also mixtures possible, e.g. hybrid open access journals and delayed open access journals.

The directory of open access journals is accessible via http://www.doaj.org

The costs for a publication in an Open Access Journal or in a standard journal with open access contingency are up to 3kEUR/publication.

6.5.2 Publication Costs - Proceedings Books

When organizing a Workshop, Symposium or Conference (refer to section 6.6) it is necessary to provide high quality proceedings. Authors must have a clear motivation to publish in these proceedings, consequently you must ensure that it is listed in a science database (e.g SCI, DBLP, etc.).

There are three main proceedings possibilities:

a) Springer Lecture Notes in Computer Science (LNCS)
b) ACM Conference Proceedings
c) IEEE Conference Proceedings

One of the premier proceedings is the Springer LNCS series. You must submit a proposal to the editorial office of LNCS which will be reviewed by international experts and approved by the chief officer in Heidelberg. The formal requirements include:

a) Ensuring an international (not just European) outstanding conference committee.
b) Performing strict peer reviewing (double-blind, at least three reviewers per paper), preferably by using the Springer conference tool.
c) Ensuring top quality of the papers (more than 60 % rejection rate)

The costs are depending on the page numbers, e.g. for 500 pages you must calculate 50 EUR per book. For an average conference of 150 participants you must at least order 100 books (you get 50 free, but please consider to provide some exemplars to your conference committee as a personal present). For these 100 books you must budgetize 5 kEUR.

6.6 Organization of Workshops & Conferences

Workshops and Conferences can support international knowledge exchange and team building for international project proposals. The financial organization of such an event is relatively simple: At first you calculate all your cost items and then you divide it by the number of people who are expected to come – usually the number of contributors – then you have the conference fee which the participants have to pay. The conference venue can be either at the university or at a hotel. Both options have advantages and disadvantages.

6.7 Rooms and Facilities

The size of offices and workstations in order to increase work efficiency is a core topic, since employees are there much time per day, consequently topics including office-space design, environmental psychology, architecture and interior design are essential to enhance performance. Productivity and stress levels are affected by lighting, ventilation, temperature, noise, and furniture layout (Vischer, 2005) – understanding those effects can help a lot to increase work performance.
On the basis of our 6-people research group a possible room concept would be:

q.	Type	Utilization	sqm
1	Representative Office	Group Leader	25
1	Office	Secretary	20
3	Think offices (a 15 sqm)	Post Doc and Docs	45
1	Computer Lab/workshop	Technician	20
1	Seminar/Discussion room	Team Discussion	40
TOTAL space for 6-people core team			150

Apart from the Seminar-room, this results in the typical 18 sqm/person space concept. More space is needed for expansion due to funded project personnel:

q.	Type	Utilization	sqm
1	Multifunction Office	For up to 6 people	60
1	Multipurpose Project Space	For Experiments	40
1	Kitchen	Social room	20
1	Office	Visiting Professor	15
1	Storage Room	Equipment	20
TOTAL additional space			155

7 Input success factor: People

People in a research team can be categorized in four groups:
1) LEADER,
2) RESEARCHERS,
3) SUPPORT STAFF (Secretary, Technician, Librarian, …), and
4) YOUNG ACADEMICS (in German: “Nachwuchs”).

Before we discuss the genuine characteristics of these people, let us discuss some basic issues first, such as team building and team performance.

7.1 Team Building

The excellence of the team – all together - their motivation, enthusiasm and engagement are the core success factors of any enterprise disregarding whether they are at a university, in industry or in a private research organization.

People first. The team members must have a vision, a mission, a clear strategy, the necessary skills and must live an atmosphere of inspiration, trust and pleasantness. Consequently, the people must treat each other first class and with great care. Finding the right people who fit in the team is of paramount importance.

With the ideal team you can nearly solve (every) problem.

Not all groups are teams. Teams are characterized by a specific team purpose that the team itself delivers and collective work products (e.g. a paper). The performance can be measured directly by assessing the collective work products.

7.2 Recruitment on basis of competencies

Integrating new people into an existing team is a difficult task, which need much care. The main criteria for successful selection of team candidates includes to identify which essential and desirable competencies matter most to the overall performance of the group. It is not astonishing that personal effectiveness competencies are counting most – workplace competencies can be gained but it is harder to change personal competencies.

The US Department of Labor provides a competency pyramid model (http://www.careeronestop.org/competencymodel), consisting of a set of building blocks arranged on three levels and nine tiers (layers), see figure 7:

A) Top-Level: Occupation Related Competencies

Tier 9 - Management Competencies
Tier 8 - Occupation-Specific Requirements
Tier 7 - Occupation-Specific Technical Competencies
Tier 6 - Occupation-Specific Knowledge Competencies

B) Mid-Level: Industry/Subject Related

Tier 5 – Industry/Subject-Specific Technical Competencies
Tier 4 – Industry/Subject-Wide Technical Competencies

C) Basic-Level: Foundational Competencies

Tier 3 - Workplace Competencies
Tier 2 - Academic Competencies
Tier 1 - Personal Effectiveness Competencies

Tier 1: Personal Effectiveness Competencies

1) Interpersonal skills
2) Integrity & Ethics
3) Professionalism
4) Initiative, Motivation & Drive
5) Dependability & Reliability
6) Willingness to learn, Self-development

Tier 2: Academic Thinking Competencies

1) Reading & Writing
2) Mathematics
3) Science & Technological Fundamentals
4) Communication skills: Listening & Speaking
5) Critical & Analytic Thinking
6) Active Learning
7) Basic Computer Literacy

Tier 3: Workplace Specific Competencies

1) Collaboration/Cooperation/Teamwork
2) Adaptability & Flexibility
3) Innovative Thinking/Customer Focus
4) Planning & Organizing
5) Creative Thinking, Problem Solving & Decision Making
6) Working with Tools & Technology
7) Workplace Specific Applications
8) Scheduling & Coordinating
9) Checking, Examining & Recording
10) Business/IT Fundamentals

Competencies on tier 4 to tier 9 are highly dependent on the respective subject and the job role (the example in figure 7 is given for “Information Technology”)

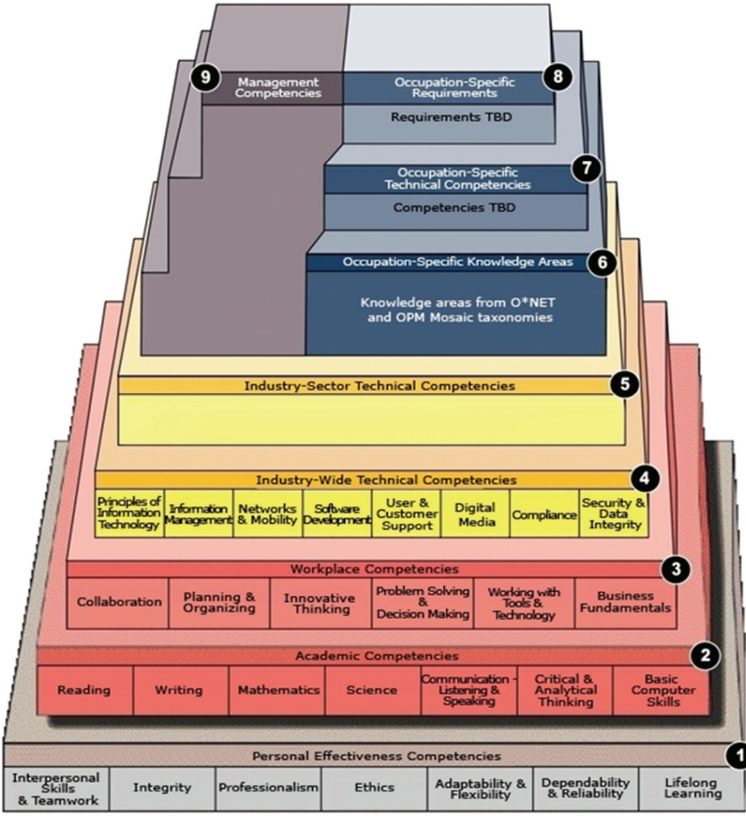


Figure 7 Information Technology Competency Model, the clickable model can be retrieved 27.12.2010 via http://www.careeronestop.org/competencymodel

When selecting future group members people usually are biased toward others who have a reputation for being competent, hard working and with whom they have developed working relationships in the past. People strive for predictability when choosing future work group members (Hinds et al., 2000).

7.3 Ensuring Team Performance

According to (Katzenbach & Smith, 1993) successful teams share some observable approaches:

Establishing urgency. All team members must perceive that the team has urgent, meaningful and worthwhile purposes. The more urgent and meaningful the rationale, the more the team will bring its performance potential. Teams work best in a compelling and fascinating context. That is why companies with strong performance ethics usually form teams readily.

Selecting potentials. To have nice people is not enough. You must select members always for their skill potentials – not for their personality. The wise manager will always select people for their *existing* skills AND also for their *potential* to improve existing skills and learn new ones.

First appearance. First impressions are most lasting, thus pay particular attention to first meetings and actions.

Clear rules. Effective teams develop rules of conduct at the kick-off to achieve their goals. The most critical initial rules pertain to attendance (e.g. no interruptions to take phone calls), open discussions (no sacred cows), confidentiality (the only things to leave this room are what we agree on), analytic approach (facts are friendly), goal orientation (everyone gets assignments and does them).

Small sub-goals. Effective teams trace their advancement to key performance oriented events. Such events can be set in motion by immediately establishing a few challenging goals that can be reached early on. The sooner results occur, the sooner the team sets.

Setting challenges. Provide the group regularly with fresh facts and new information. New information causes a team to redefine and enrich its understanding of the performance challenge, thereby helping the team to shape a common purpose, set clearer goals, and improve its common approach.

Spending time together. Successful teams spend much time together, especially in the beginning of their mission in order *to learn to be a team.* It is interesting, that this is not necessarily physical time – what also counts are videoconferences, telephone calls or at least e-Mail contact.

Ability and Motivation. According to a formula of Lawler (1973) we can see that ability and motivation are the two top factors for performance:

- Performance = f (Ability x Motivation)
- Ability = f(Aptitude x (Training + Experience)
- Motivation = f (Extrinsic + Intrinsic Rewards)

Aptitude is (besides understanding, knowledge and attitude) an important component of competency, which is needed to perform work at a certain level.

Besides of the basic abilities, which an average academic researcher should have acquired anyway (refer to the Process Guide for Students, (Holzinger, 2010b)), some other factors are directly related to success – motivation is only one of them.

Motivation = Σ (Valence × Instrumentality × Expectancy)

Expectancy is based on the perceived effort-performance relationship and dependent of past experience, self-confidence, and the perceived difficulty of the goal.

Instrumentality is based on the perceived performance-reward relationship and is the belief that if one does meet performance expectations he or she receives a greater reward.

Valence refers to the value, which the individual personally places on the rewards. This is a function of his or her needs and demands, goals and values.

Motivation as an issue for performance can be intrinsic and/or extrinsic and has been seen e.g. by (Maslow, 1943) as key factor, whereas e.g. (Herzberg, 1968) proposed a two-factor theory, where he distinguished between **Motivators** (e.g. challenging work, recognition, responsibility) which results in positive satisfaction, and so called Hygiene factors.

Hygiene factors (e.g. status, job security, salary, fringe benefits) that do not motivate if present, but, if absent, result in demotivation (The name Hygiene factors is used due to similarity of life: presence will not make you healthier, but absence can cause illness).

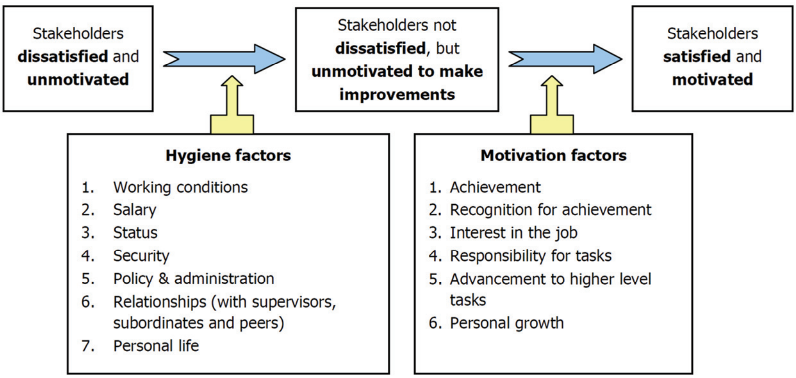


Figure 8 Hygiene factors and Motivation factors relevant for performance (Hoat et al., 2009), (Gawel, 1997)

7.4 Leader

Fredmund Malik exclaims that modern managers are expected to be a mixture of 1) an ancient war commander, 2) a Nobel-prize winner in physics and 3) a television show master (Malik, 2009). Although this is of course unrealistic, we may ask: "What makes a leader successful?"

7.4.1 Leadership quality

Many people consider traits including vision, intelligence, knowledge, training, ideas etc. as the most important qualities of a leader. Although such traits are necessary, a successful leader needs emotional intelligence (Goleman, 2004):

Self-awareness. The ability to recognize and understand your own moods, emotions, drives, as well as their effect on others (self-confidence, self-assessment, self-deprecating sense of humor).
Self-regulation. The ability to control upsetting impulses and bad moods: thinking before acting (trustworthiness, integrity).
Motivation. Passion to work for reasons that go beyond money or status (a propensity to pursue goals with energy and persistence, strong drive to achieve goals, optimism, even in difficult and complex situations)
Empathy. The ability to understand the emotions of your team and treating people according to their emotional reactions (expertise in building and scaffolding talent, cross-cultural sensitivity)
Social skill. Including proficiency in managing relationships and building networks, ability to find common ground, build rapport (effectiveness in leading change, persuasiveness).
(Goleman & Boyatzis, 2008) provide a checklist:

EMPATHY. Do you understand what motivates other people, even those from different backgrounds?
ATTUNEMENT. Do you listen attentively and think about how others feel?
ORGANIZATIONAL AWARENESS. Do you appreciate the culture and values of the group or organization? Do you understand social networks and know their unspoken norms?
INFLUENCE. Do you persuade others by engaging them in discussion and appealing to their self-interests? Do you get support from key people?
DEVELOPING OTHERS. Do you coach and mentor others with compassion and personally invest time and energy in mentoring? Do you provide feedback that people find helpful for their professional development?
INSPIRATION. Do you articulate a compelling vision, build group pride, and foster a positive emotional tone? Do you lead by bringing out the best in people?
TEAMWORK. Do you solicit input from everyone on the team? Do you support all team members and encourage cooperation?

7.4.2 Leadership style

(Misumi, 1985) identified four types of leaders on the basis of two factors which are known as maintenance (M) and Performance (P):
M … maintenance = paying attention to people, help, support, scaffold, inspire, stimulate, etc.
P … performance = production, output, deliverables, items etc.

mp = little maintenance, little production
mP = little maintenance, high production
Mp = high maintenance, little production
MP = a combination of high maintenance and high production

Leaders often ignore to appreciate how the organizational climate can influence performance, and how this is influenced by the leadership style (Goleman, 2000).
There are six generally known leadership styles, which derive from different emotional intelligence (Goleman & Boyatzis, 2008) competencies and work only optimal in particular situations:

Directive style. This strong “Do what I say!” approach is very effective in an emergency or similar situations, when something must be done immediately. In most other situations this coercive leadership dampens the motivation of the people.

Authoritative style. This “Come with me!” approach provides the goal, however, lets people choose their own methods of how they can achieve it. This style works best when overall goals (vision) are unclear, but less effective when the leader is working with a team of highly experienced experts.

Affiliative style. This “People come first!” approach is best for building team harmony and increasing morale. Its focus on praise might allow poor performance to go uncorrected. If additional advice is missing, people are in a dilemma.

Democratic style. This “Everybody is equal!” approach can help to generate fresh ideas, sometimes the price is endless deabates and confused people who feel leaderless.

Pacesetting style. This “Let’s roll!” approach sets high performance standards and has a positive impact on people who are self-motivated and competent. Some people feel overwhelmed by such a leader’s demands for continuous excellence.

Coaching style. This “Let’s to it together!” approach sets on personal development and works, when people are aware of their weaknesses and want to improve, but not when they are resistant to change.

Success is in flexibility! The more styles a leader can master, the better. In particular, being able to switch flexible among these various mix of styles on particular demand creates the greatest organizational climate and raises team performance.

Moreover, there are other factors, which seems to be soft, but have hard consequences on success:

- Teambuilding abilities (at local, national, European, international level);
- Team culture enhancement (providing attitude, motivation, climate, satisfaction, pride, …); and
- Conflict Management.

7.4.3 Conflict Management

Conflict is a natural part of human interaction, since no two individuals have the same expectations and desires. Signs of rising team conflict include: gossiping, name-calling, sharing irrelevant information but hiding relevant information, pretending to be democratic, but making decisions the other way, lack of results (“can’t deliver”), missed deadlines, etc.

Exercise in advance on how to deal with conflicts before the team start working is a good method. Team members need to stay on a subject based level (“matter - not emotion”) and to deal with opposing viewpoints (“what can I learn from an opposite view”).

Learning from conflicts is essential, to identify how and why a conflict occurred and to avoid such a situation in the future.

Listening skills are most essential for a good team and listening goes beyond just hearing the words other team members are speaking: Good team fellows also pay attention to the tone of a voice and are aware of body language.

Conflict management is the ability to reduce disagreements and coordinate resolutions amongst team members. Conflict resolution is important for team performance and help to reduce negative impact of all types of conflict by restoring fairness, effectiveness, resource efficiency, relationships and satisfaction (Behfar et al., 2008). According to (Tyson, 1998) there are five different strategies (see figure 9):

Coercion is assertive and uncooperative, e.g. by using brute force, used when quick decisive actions are vital, e.g. in emergencies. The drawback is that conflicts can escalate or losers may strike back.

Accommodation is unassertive and cooperative, one neglects his own needs in order to satisfy the others ("Appease others by downplaying the conflict"). It is used when preserving harmony outweighs other goals, or when it is useful to build up credit for later use. The drawbacks include that credibility and influence can be lost.

Avoidance is both unassertive and uncooperative, the conflict is not addressed, avoids conflict by withdrawing, sidestepping, or postponing. It is used when the conflict is trivial, unimportant but relationships are at stake. Drawbacks include that important decisions may be made by default and the postponing may make matters even worse.

Compromise is both intermediate in assertiveness and cooperativeness. Fundamental premise: Winning something whilst losing a little is ok. It is used e.g. when time can be saved by reaching intermediate settlements on individual parts of complex issues. Drawbacks include that important values and long-term goals can be disrupted and might seed distrust and the conflict may re-emerge later.

Collaboration is both assertive and cooperative and literally means co-labour – let's work together ("I win – you win"). Teamwork and cooperation help everyone achieve their goals while also maintaining relationships and the process of working through differences will lead to creative solutions that will satisfy both teams concerns. Drawbacks include that the process takes time, energy and trust.

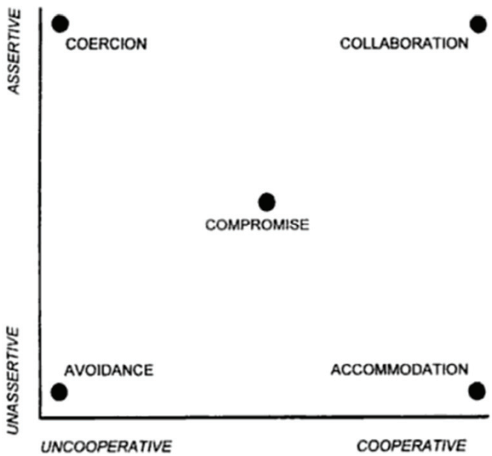


Figure 9 The five conflict management strategies assertive vs. cooperative, originally according to Thomas & Kilman (1974), in: (Tyson, 1998), p. 121

8 Research & Development Process

8.1 Innovation & Knowledge Management

Innovation and knowledge are *the* vital sources for sustaining *competitive advantage* of a group (Nonaka & Takeuchi, 1995). **Future performance** is positively related to innovation. This finding is robust across the specificity, scope, focus and stage of innovation (Bowen, Rostami & Steel, 2010).

The leader is responsible for innovation drive; consequently a successful leader will gather creative people and ensure an **inspiring environment** and an **atmosphere of trust** where ideas can be generated and developed (Lawler, 2003).

The knowledge management model of (Alavi & Leidner, 2001) explains the activities for innovation: knowledge *creation* and knowledge *usage*. On this basis (Xu et al., 2010) identified five phases (see figure 10):

1) Define the knowledge *requirements,* i.e. searching, acquiring, retrieving existing knowledge inside and/or outside of the group and to identify the gap between the existing knowledge and the requirements;
2) Create *new* knowledge by use of creativity;
3) Focus on the retaining and spread of new and old knowledge, which acts as a bridge between the phase of creation and usage;
4) In the phase of usage, the new knowledge is put into practice to solve problems and to inspect their authenticities and validity;
5) Finally, knowledge is refined, integrated and evaluated for a new cycle.

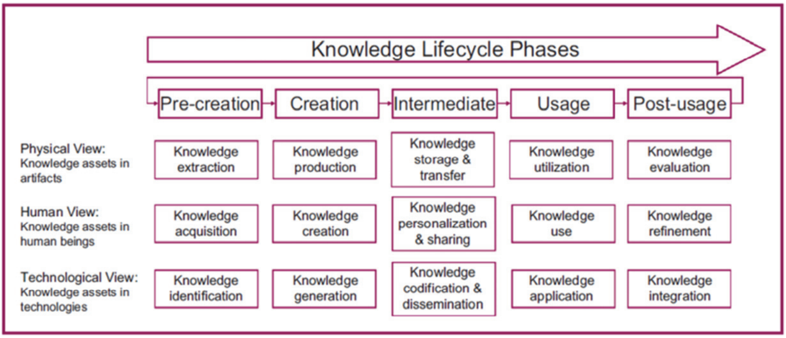


Figure 10 The macro process for Knowledge Management as continuous innovation (Xu et al., 2010)

Rapid advances of Web 2.0 teambuilding technologies can facilitate the innovation process by improving collaboration hence enhancing creativity. However, technology can NOT substitute human creativity, due to the complexity and uncertainty of new knowledge. (Xu et al., 2010) developed a hierarchical model consisting of four layers (figure 11):

1) the knowledge repository layer;
2) the computer supported layer;
3) the human centred layer; and
4) the knowledge synthesis layer.

The knowledge repository layer is aimed at the organization of knowledge bases used in innovation; different knowledge assets are managed by the knowledge management system. Considering the nature of knowledge flow in KM activities in pre-creation, intermediate and post-usage, they are arranged on the computer supported layer. Organizational knowledge is retrieved from the knowledge repository layer and processed on this computer supported layer for knowledge creation and usage.

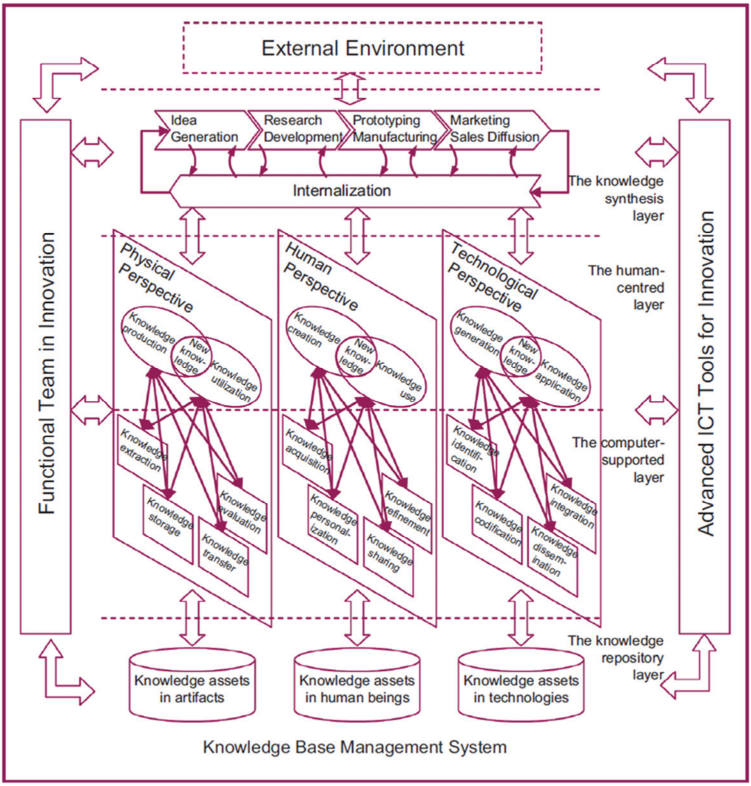


Figure 11 The Macro process of knowledge management for continuous innovation according to (Xu et al., 2010)

The knowledge “flows” into the human cantered layer, on which activities about knowledge creation and knowledge usage are positioned. Their interactions lead to the emergence of new knowledge and a creative recombination of existing knowledge for innovation. The process of continuous innovation is organized on the knowledge synthesis layer.

On this layer new and existing knowledge is implemented and the value of organizational knowledge is embodied in the innovative products or services. Finally, the knowledge created and used in the innovation process flows back to the knowledge repository layer for a new cycle of innovation (Xu et al., 2010). Web 2.0 extends traditional collaborative software by direct user contributions, rich interactions and community building (Lanubile et al., 2010):

- Content Management Systems, for example: WordPress (http://wordpress.org);
- Geosocial networking, for example: Skype (http://skeype.com)
- Image/Video hosting services, for example: Flickr (www.flickr.com
- Microblogging services, for example: Twitter (http://twitter.com);
- Wikis, for example the Portland Pattern Repository (http://c2.com/cgi/wiki),
- Social networking sites, for example LinkedIn (www.linkedin.com), or XING (www.xing.com)
- Collaborative tagging systems, such as Delicious (http://delicious.com).

Within software engineering, so called Knowledge Centers are in use (Lanubile et al., 2010): content management systems allow team members to share explicit knowledge on the Web, for example the Eclipse help system (http://help.eclipse.org) or KnowledgeTree (www.ktdms.com).

8.2 Evaluation of Strengths and Weaknesses

SWOT is a strategic planning method *to evaluate* the **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats involved in your team to identify internal and external factors that are favourable and unfavourable to achieve the envisioned goals (see figure 10 and figure 11).

	Past and Present	Future
Positive	*S* *Strengths (Stärken)*	*O* *Opportunities (Chancen)*
Negative	*W* *Weaknesses (Schwächen)*	*T* *Threats (Gefahren)*

Figure 12 Basic SWOT Table

	Past and Present	Future
Positive	*What can our team good?* *What is the team proud of?* *What projects did the team perform particularly like?*	*What is the future chance of the team's expertise?* *What can the team bring into future projects?*
Negative	*What was particular difficult for the team?* *What are the team's biggest weaknesses?* *What is the team afraid of?*	*What are potential risks?* *What could the team lose when doing this?* *What difficulties can the team expect?*

Figure 13 SWOT Example

It is always necessary to monitor results and always gain commitment among all stakeholders (faculty, university, industrial partners).

8.3 Trend Scouting and Strategic Foresight

Trends are cultural, societal and technological *changes* over longer periods of time (years) and are a key source of inspiration and creativity; we can determine between:

Trend scanning –non-focused seeking for *possible* trends;
Trend monitoring – systematic pursuing of *known* trends; and
Trend scouting – concrete *goal-oriented trend analysis.*

Scanning is the simplest way for trend detection and is undirected search through news, magazines, conference calls, journals etc. to monitor existing trends, to detect the appearance of potential futures, or to find interesting anomalies or weak signals that herald disruptions or paradigm shifts. Today, futurists use Web 2.0 services including Twitter, Delicious, Digg etc. A typical example is "Tweet the Future" (http://tweetthefuture.com), which monitors Twitter for tweets containing the word "future". Most of this content is a real time-reflection of what people are reading – and provides a picture of the collective attention of the futures community (Pang, 2010).

Trend analysis is a concept of finding patterns ("trends") in information and can be used as a *systematic* inquiry of past knowledge and is utilized in order to determine possible changes from an established baseline. Within our rapidly changing technology environment it is a key competitive factor to monitor such changes. One possible approach is simulation (Schonenberg et al., 2010). An example for a trend analysis tool is (http://www.google.com/trends) or (http://trendistic.com).

Business Process Simulation (BPS) is an essential technique for Business Process Re-engineering (BPR) where it is not only important to understand the static behaviour of the process, but also to accurately predict the outcome of proposed and/or expected changes for the process to judge the effect on the organisation performance. The question is "How will a trend affect the performance of an existing business process?". Simulation offers support for randomness, uncertainty and interdependencies. The biggest challenge in the development of a simulation model is obtaining an accurate model that is close to reality. For example (Rozinat et al., 2009) present a method to generate simulation models based on actual information from log data.
Many other methods have been developed to recognize progresses of technologies, and one of them is to analyse patent information (Kim, Suh & Park, 2008).

Patent Alert Systems (PAS) automatically and systematically extracts patent data and extracts the trend *changes* on the obtained data set. Such a PAS can be set or configured to a technology class or subclass on which the end users want to be informed of trend changes. Technically, it retrieves data of associated patent counts by use of existing Extended Markup Language (XML) schemes of patent offices and a trend analysis is performed through a trend extraction algorithm. These trends are used to generate alerts, which are forwarded on-line to the people who request/set the alerts. With such a software, it is possible to evaluate the importance of existing technologies and to help to decide on whether the own technology is trendy or not.

This can be used as Decision Support System (DSS) on which promising technologies and corresponding investment areas can be determined and irrelevant investments can be avoided, consequently following to a long-term strategic technology plan (Dereli & Durmusoglu, 2010).

We can summarize some basic and generally known rules:

1) Scan and monitor developments in other branches
2) Search for problems that seem to have no current solutions
3) Seek inspiration for innovative solutions from sources on the peripheral and ephemeral (Harper et al., 2008)
4) Sense emerging opportunities that could be seized for competitive advantage
5) Construct future scenarios, anticipating how trends may impact and shape industry

8.4 Coolhunting

Coolhunting refers to marketing professionals of the 1990s who made observations and predictions for changes of new or existing trends. In the Web 2.0 era many webloggers serve as online coolhunters, in a variety of cultural and technological areas. The basic idea is that in today's Web economy the Web displays a mirror of the real world. TeCFlow is a social networking tool developed at MIT, which measures popularity and influence of brands by looking at their relative position on the Web. It is based on the simple insight: "You are who links to you". It applies the Social Network Analysis (SNA) metric of "betweenness centrality" to the Web, looking at the linking structure of Web sites to find how Web pages discussing brands and stars are connected and it uses high-betweenness Web sites returned to a search engine query for a brand name as a proxy for the significance of this brand or star (Gloor, 2007).

8.5 Idea Generation

Innovation starts with creative ideas. It has been shown by many studies that the social environment *can* influence both the level and the frequency of creative behaviour (Amabile et al., 2004), although exceptions do exist (Bawden, 2006).

Creativity is the production of novel and useful ideas and innovation is the successful *implementation* of such ideas. Of course successful innovation depends on other factors as well. (Amabile et al., 1996) describe an instrument to assess the climate for creativity and a conceptual model underlying it:

Organizational encouragement. Ideas emerge within a team culture which encourages through a fair and constructive judgment of ideas and recognition for creative work.

Supervisory encouragement. The leader as supervisor must serve as a good work model, sets goals appropriately, supports the team and values individual contributions, and shows confidence in the work of the team .

Team support. Free and open communication within a diversely skilled team – an atmosphere of trust is essential.

Sufficient resources. Team members must get access to appropriate resources, including funds, materials, support, facilities, equipment and information.

Challenges. Challenging work is definitely inspiring.

Freedom. A proper degree in deciding what work to do or how to do it is essential for inspiration and idea generating.

On the other hand factors which hinder creative work encompass: extreme time pressure (deadlines are not bad!), unrealistic expectations, distraction, and bureaucracy.

Creativity and information systems. Computer software may facilitate creativity on at least two fairly distinct levels (Eaglestone et al., 2007):

1) Support in knowledge gathering, knowledge sharing, knowledge integration, and ultimately, idea generation; and
2) Support in enabling the generation of creative artefacts in a particular domain by providing critical functionality in clear, direct, and useful ways.

This has been a challenge for Human–Computer Interaction researchers and user interface designers (Shneiderman, 1999) to think about implementable processes to support such creative processes with software (Shneiderman, 2000). Many methods for promoting creative work have been proposed ranging from structured work plans to disruptive set-breaking scenarios. Classic Problem Solving methods include:

Theory of Inventive Problem Solving (TIPS, aka TRIZ), was developed by Altshuller and his colleagues based on examining more than 200,000 patents.

Mind mapping is a creativity technique that both reframes the situation and fosters creativity.

Brainstorming is a group activity designed to increase the quantity of fresh ideas. Getting other people involved can help increase knowledge and understanding of the problem and help participants reframe the problem.

Lateral Thinking was developed by Edward de Bono who promoted an approach to creative problem solving and creative thinking called lateral thinking.

Creative Problem Solving Process (CPS) is a six-step method developed by Osborn & Parnes that alternates convergent and divergent thinking phases.

(Couger, 1996) reviewed 22 creative problem solving methodologies with simple plans such as preparation, incubation, illumination, verification and identified five phases:

1) Opportunity, delineation, problem definition;
2) Compiling relevant information;
3) Generating ideas;
4) Evaluating, prioritizing ideas; and
5) Developing an implementation plan.

Shneiderman adopted this and developed a four phase process (Shneiderman, 2002):

1) Collect: Learn from previous works stored in libraries, the Web, and other sources.
2) Relate: Consult with peers and mentors at early, middle, and late stages.
3) Create: Explore, compose, and evaluate possible solutions.
4) Donate: Disseminate the results and contribute to libraries, the Web, and other sources.

8.6 Research Based Teaching (RBT)

Research-based teaching is basically understood as the nexus between research and related teaching. Following (Griffiths, 2004), this teaching–research relationship can be categorized in the following ways:

Research-based teaching (RBT) implies that the curriculum itself is designed around actual research topics and both teachers and students are engaged in such research, for example in mini-projects, mini-conferences etc.;

Research-led teaching (RLT) implies that the course content is structured around personal research interests of the research staff, who are teaching and do not see teaching as their primary existence;

Research-oriented teaching (ROT) implies that the curriculum includes a certain focus on methods and skills to teach students necessary competences; with the intention of educating future researchers (Nachwuchsförderung);

Research-informed teaching (RIT) implies that the curriculum design, learning, teaching and assessment are informed by systematic research;

There has been a long debate on the impact of research on undergraduate teaching performance in engineering education with contradictory results: several studies expressed that research can enrich teaching, while at the same time some studies have consistently failed to show a measurable linkage between research and teaching (Prince, Felder & Brent, 2007).

A further issue is that established engineering education is mostly **deductive,** i.e. the teacher starts with basics, fundamentals, theories and is consequently progressing to the applications of those theories.

Alternative teaching approaches are more **inductive,** e.g. topics are introduced by presenting specific observations, case studies or problems and theories are taught on examples or the students are facilitated to discover them.

For example, the emphasis in software engineering education has been always on providing students with a thorough grounding in engineering principles in order to underpin their discipline. However, the constraints on software engineering problem-solving today are increasingly *not* technical, but rather lie on the societal and human side of engineering practice, including a thorough understanding of the end user group.

Inductive Teaching Methods (ITM) can be helpful in reaching the above mentioned goals (Prince & Felder, 2006), (Holzinger, 2002) and include different approaches to learning methods (in the following list you can replace learning with teaching as well):

- Inquiry learning;
- Problem based learning;
- Project based learning;
- Case-based learning;
- Discovery learning; and
- Just-in-time learning.

Problem-based learning (PBL) raised mainly from medical education (Barrows & Tamblyn, 1976), (Schmidt, 1983), (Hasman, 2001) and from theories of constructivism (Knuth & Cunningham, 1993), (Ben-Ari, 1998) and led to the so-called LCD (see next entry). The main characteristic of a PBL setting is that learning is driven by challenging problems, students work in collaborative groups, and teachers are facilitators of the learning process.

Learner-centred design (LCD) is to put the learners into the foreground, which actually means to *involve them into the learning activity* and focusing education to realistic, intrinsically motivating problems. Students should work by themselves to solve these problems, often in pairs or groups (Norman & Spohrer, 1996). In general, learner-centred design must follow three principles (Holzinger & Motschnik-Pitrik, 2005):

1) *Enabling* the learner's understanding (e.g. strengthened through structuring, coaching, critiquing etc.);
1) *Sustaining* motivation (Holzinger, 1997) (e.g. through low-overhead and immediate successes or putting learning into the context of doing);
1) *Offering* of a diversity of learning resources (e.g. using different media and different tools);

Problem based learning is of special interest, due to the fact that many educational concepts scaffold this approach, e.g. constructivistic learning

8.7 Transdisciplinarity

Transdisciplinarity connotes a research strategy that crosses many disciplinary boundaries to create a holistic approach. It applies to research efforts focused on problems that cross the boundaries of two or more disciplines, such as research on effective information systems for biomedical research (see bioinformatics), and can refer to concepts or methods that were originally developed by one discipline, but are now used by several others, such as ethnography, a field research method originally developed in anthropology but now widely used by other disciplines.

Interdisciplinary research means involving at least two different disciplines working on one shared problem. Because most participants in interdisciplinary teams were trained in traditional disciplines, they have to appreciate other perspectives and methods.

Multidisciplinary research means that each discipline works in a self-contained manner and that an issue is approached from a range of disciplinary perspectives integrated to provide a systemic outcome. Researchers working jointly but from individual disciplinary perspectives.

Crossdisciplinarity is any method, project and research activity that researches outside the scope of its own discipline, however, without cooperation or integration from other relevant disciplines. Within a crossdisciplinary relationship disciplinary boundaries are crossed but no techniques or ideals are exchanged.

Transdisciplinary research means that the focus is on the organisation of knowledge around complex heterogeneous *domains* rather than the disciplines and subjects into which knowledge is commonly organised. The latin prefix “trans” denotes transgressing the boundaries defined by traditional disciplinary modes of enquiry.

The research community makes a distinction between the research group, which will always remain interdisciplinary by the very nature of disciplinary education, and the research itself which, if transdisciplinary, implies that the final knowledge is more than the sum of its disciplinary components.

While interdisciplinary approaches are just a “mix of disciplines”, trandisciplinary” approaches tend towards a “fusion of disciplines” – including to reach a business impact.
The team members from various disciplines work together by application of a shared conceptual framework, which draws together concepts, theories, and approaches from multiple disciplines (Mobjörk, 2010), (Wickson, Carew & Russell, 2006), (Lawrence & Després, 2004).

Transdisciplinary research is carried out with the explicit intent to solve multidimensional, complex problems, particularly problems (such as those related to sustainability) that involve an interface of human and natural systems (Wickson et al., 2006).

9 Output success: Knowledge Transfer

The ability to transfer (tacit) knowledge and to facilitate the learning process from one group to another contributes positively to organizational performance (Argote & Ingram, 2000). Knowledge transfer manifests itself through changes in the knowledge in a relevant context, resulting in a clearly measureable increase of performance of the recipient group. Knowledge transfer can take place between different subjects and between different stakeholders and must be inspired and driven by the research group (figure 12).

Tacit knowledge is inherent in individuals, consequently is difficult to describe, yet mostly cannot be explained precisely (Polanyi, 1958), (Polanyi, 1983). Within a research group tacit knowledge is internalized in a constituent and has unique characteristics. Mostly, it cannot be documented and is very difficult to imitate. However, it is exactly this tacit knowledge which is the valuable resource that determines and maintains the competitive advantage of the research group.

Competitive advantage can only be gained if tacit knowledge can be shared and transferred within the group, within the organization and within collaborative teams, because knowledge by itself is necessary but not sufficient to create value and competitive advantage (Kang, Rhee & Kang, 2010). Consequently, it is necessary to externalize and integrate the tacit knowledge in order to gain a sustainable competitive advantage for the whole organization. Newly created tacit knowledge is gradually transformed into codified and explicit knowledge (Nonaka & Takeuchi, 1995) by social processes, because the more explicit the knowledge is, the more the organization can share and transfer the knowledge.

Therefore, the effort to codify tacit knowledge, such as frequent contact with the knowledge source, is extremely significant for organizations which attempt to transfer tacit knowledge from the knowledge sources (Kang et al., 2010).

Knowledge transfer plays an important role in creating value from knowledge, due to the fact that innovations are most often generated by a recombination of different knowledge. Consequently, a competitive advantage for a large institution can be to have knowledge management experts for knowledge brokering (figure 14), which can be of benefit for the whole institution.

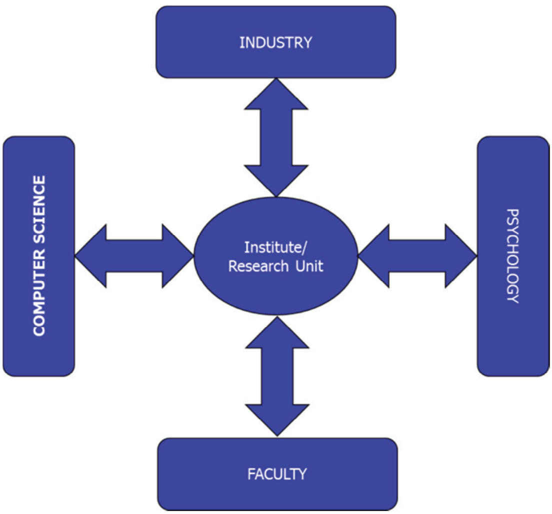


Figure 14 A possible position of a Research Unit as a knowledge broker at the intersection of two subject domains, industry and faculty

10 Output success factor: Dissemination

10.1 Measurable Output: Publications

10.1.1 Categorization of Publications

Publications can be distinguished in five categories – refer also to the Process Guide for Students (Holzinger, 2010a).

A. Original articles in journals (Originalarbeiten in Zeitschriften);
B. Original contributions to edited books (Originäre Beiträge in Sammelbänden);
C. Edited books & edited issues of journals (Herausgegebene Sammelbände und Zeitschriften – special issues);
D. Original papers in conference Proceedings (Originäre Beiträge in Tagungsbänden, Tagungsbeiträge);
E. Authored student textbooks and Monographs (Lehrbücher und Monografien).

10.1.2 Science Citation Index (SCI)

An important criterion is: in which database is the publication listed. The basic rule is: everything which is listed in the Science Citation Index (SCI) is *considered* to have a good reputation; however, that does NOT mean that publications, which are not listed, are not any good. However, it also does not mean, that all publications, which are listed, are all good.
The SCI was produced by the Institute for Scientific Information (ISI) in 1960, now provided by Thomson Reuters and meanwhile covering 10,000+ journals from 256 categories and 110,000+ proceedings from the most significant conferences, symposia and workshops worldwide. For search procedures please refer to (Holzinger, 2010a).

10.1.3 Impact Factor & Citation Metrics

Since Universities must contract performance agreements with the government, publications in journals having high impact factors are important for ranking, benchmarking and finally for getting money. Moreover, a measurable research track record is also important for research proposals for getting grants.

Bibliometrics studies the measurement of texts and information by citation and content analysis in order to investigate the impact of a field, of a group of researchers, or the impact of a particular paper. In addition to simple statistics (number of papers, citations, etc.) the following metrics are popular:

Impact Factor. The IF was created by (Garfield, 1972), who is the founder of the Institute for Scientific Information (ISI) and the Science Citation Index (SCI). The IF is calculated yearly for journals included in ISI SCI, reflecting the average number of citations to the articles published. Related values include the

a) immediacy index (number of citations of articles in a journal receive divided by the number of articles published), .
b) cited half-life (median age of the articles that were cited in Journal Citation Reports each year), and
c) aggregate impact factor for a subject category (calculated taking into account the number of citations to all journals in the subject category and the number of articles from all the journals in the subject category).

Although it is necessary that the paper appears in a journal having an impact factor, more essential is *how relevant* the work for the scientific community really is. A measure for this relevance is how often other scientists reference your paper. The score of references are called citations. A good possibility to figure out the citations is e.g. the Harzing-Tool (www.harzing.com) or Arnetminer (www.arnetminer.org).

Citation metrics. Publish or Perish (Harzing, 2010) calculates the following citation metrics (see figure 15):

1) Total number of papers
2) Total number of citations
3) Average number of citations per paper
4) Average number of citations per author
5) Average number of papers per author
6) Hirsch-Index (h-index) and related parameters
7) Egghe-Index (g-index)
8) Age-weighted citation rate
9) Number of authors per paper

The **h-index** was proposed by Hirsch (Hirsch, 2005) reflects the number of publications and the number of citations per publication. The h-index raises as citations accumulate, consequently depending on **academic age** of a researcher. The goal is to measure the cumulative impact of a researcher's output by looking at the amount of citation the work has received. The properties of the h-index have been analysed in various papers; for example by (Egghe, 2006), basics can be found in (Egghe & Rousseau, 1998).

The **g-index** was proposed by Leo Egghe (Egghe, 2006) in order to improve the h-index by putting more weight to highly-cited articles.

The **AWCR** (age-weighted citation rate) measures the number of citations to an entire body of work, adjusted for the age of each individual paper. It is an age-weighted citation rate, where the number of citations to a given paper is divided by the age of that paper.

The **Contemporary h-index** aims to improve on the h-index by giving more weight to recent articles, therefore rewarding academics who maintain a steady level of activity.

The **Individual h-index** divides the standard h-index by the average number of authors in the articles that contribute to the h-index, in order to reduce the effects of co-authorship.

Results

Papers:	135	Cites/paper:	10.84	h-index:	20	AWCR:	274.18		
Citations:	1464	Cites/author:	1009.66	g-index:	34	AW-index:	16.56		
Years:	12	Papers/author:	81.57	hc-index:	15	AWCRpA:	172.59		
Cites/year:	122.00	Authors/paper:	2.14	hI-index:	11.11	e-index:	23.17		
				hI,norm:	18	hm-index:	17.42		

Figure 15 Citation Analysis of Andreas Holzinger on 15.12.2010 via the Harzing-Tool (www.harzing.com)

10.2 Measurable Output: Patents

10.2.1 Types of Intellectual Property

Intellectual property (IP) include copyrights, trademarks, patents, and industrial design patents (Gebrauchsmuster). Note: There are huge differences from country to country.

Copyright. Basically, this is the exclusive right granted to the author of an original work, including the right to copy, distribute and adapt the work. Attention: Copyright does *not* protect ideas, only their expression (referencing!). Copyrighted material principally needs permission from the copyright owner – who can license or permanently transfer this copyright to others (publishers). The German "Urheberrecht" for example is not the same as the anglo-american Copyright. The "Urheberrecht" automatically applies and cannot be transferred.

Trademark. Names, words, logos, symbols, designs, images etc. can be trademarked, i.e. they can be registered by the national patent office. The trademark (eingetragenes Warenzeichen) is designated by the following symbols:
™ for an unregistered trade mark, just to promote brands,
℠ for an unregistered service mark, to promote or brand services,
® for a registered trademark (to protect the brand by law).
Within you work you are required to designate trademarks, at least the first time they appear, or you put an remark on the beginning (e.g. in form of a list).

Patent. The procedure, requirements and extent for granting a patent vary widely between countries according to national laws and international agreements.

Carefully determine between a Patent application and a granted patent. Only the granted patent is a “real” patent, which is the result of the application process, most often after many years. And have a look on economically successful patents (which are rare).

The essence of a patent application are one or more **claims** defining the invention which must be:

1) new (original),
2) non-obvious (non trivial), and
3) useful and industrially applicable.

In many countries, certain areas are excluded from patents, such as business methods, mental acts, or software. The exclusive right granted to a patentee is the right to prevent others from making, using, selling, distributing, or exploiting the patented invention without permission.

10.2.2 Software Patents

Software based or computer implemented inventions are a matter of long debate. Some countries grant patents for all types of software, but in Europe this is extremely difficult and basically software (i.e. code, algorithms) are principally NOT patentable. Even if you mention that your invention has something to do with software the bureaucrats will immediately reject you.

Technizität. In German speaking countries there is much debate around the terminus “Technizität”, which must be proven by the applicant: the developers must explicitly show that their invention actually makes a novel contribution in a technical field. In the US this is much easier because the rule is that it must be a **solution for a technical problem.**

10.2.3 Patents as a threat for progress

Patents along with Papers constitute the state of the art. If you want to cover the state of the art, or even want to go beyond state of the art then it is a must to know the relevant patents in your area. However, please take into consideration that especially software patents can be bogus and consequently a threat for progress.

Illegitimate patent applications make their way through the US patent examination process without thorough review, especially in the software and web domain where state of the art is widely spread but poorly documented in archival literature. The result are trivial patents. Have a look at the Electronic Frontier Foundation: http://w2.eff.org/patent/wp.php

10.2.4 Patent requirements

Legal Requirements. Although there are huge differences amongst different countries, to call something patentable you have to proof that invention is: 1) novel, new, original (originär), 2) non-obvious, non trivial, and it must be 3) useful and industrially applicable (gewerblich nutzbar).

ad 1) Novelty. Novelty refers to the fact that it is not yet published anywhere – even the Web. Any publication in any medium immediately makes it non novel. The rule therefore is: First patent, then publish. In Europe, any publication anywhere prevents you from a patent.

ad 2) Non-obvious. This means that the invention is not trivial, however, this is a pure legal definition and not a scientific one. Finally, the patent examiner decides, consequently, the applicant can rebut the examiner's presumption through argument and written evidence.

ad 3) Utility. Finally, utility says that an invention must perform some function, be operable, and must be beneficial to society – this is exactly what HCI & UE is striving for.

Scientific requirements. A patent must contain a method AND a technical solution to go beyond state of the art. In some countries, certain subject areas are excluded from patents, for example business methods and pure mental acts (Gedankenmodelle).

Commercial requirements. A patent costs money (we are speaking about a range from approximately 10k EUR to 250k EUR), consequently the most important question is: Who pays for it? Therefore a market analysis is an absolute must. At least the costs for the patent should be gained – otherwise the patent is a failure (of which 90 % are).

US Kind Codes. Before January 2001 patents had the label A and patent applications the label B1, B2, …; however, since January 2001, US Patents are labelled differently: A1 is the first patent application, A2 the second, etc., whereas B1, B2, … are the granted patens! X-documents are problematic, because every X-document is detrimental for any further patent application in the area of the X-document!

Patent family. This is a set of patents from various countries to protect one single invention, when a first application in a country (priority patent) is extended to other offices.

Utility Patent. A lighter version of a patent is the utility patent (in German "Gebrauchsmuster").

Design Patent. Kind Code S is for the industrial design of a functional item, e.g. furniture, computer icons, etc.

Patent document parts. A patent consists always of:
1) First page showing title, abstract and patent information;
2) Detailed description of the invention, indicating how it is constructed, how it is used, and what benefits it brings compared with what already exists in this field (state of the art);
3) claims containing a clear and concise definition of what the inventors want to protect legally
4) Drawings.

10.2.5 Patent Search

For a more detailed instruction on how to search for patents please refer to the Process Guide for Students (Holzinger, 2010a).
Start your patent search via the European Patent Office (EPO) http://ep.espacenet.com/advancedSearch?locale=en_EP

INPADOC Legal Status. It is important that you **at first** check the legal status of every patent, e.g. if the fees are not paid, the patent is void.

Sample Patent A. The example EP771280 (US5490072, DE69515118), Method and System for detecting the proper functioning of an ABS control unit utilizing dual programmed microprocessors, by (Hornback, 1996), shown in figure 8, is a good example for a patent granted.

Sample Patent B. The example EP1139245 (US5749785, WO9804991), *"A betting system and method",* applied by Sireau in October 2001 (see figure 8) is interesting: A quick look on the INPADOC legal status shows that the patent application has been refused in November 2003 – after exact 2 years of check (yes, bureaucracy takes a while).

Patent Rules. The EPO has updated their guidelines for Examination in one single document (597 pages) which is valid from April 2010 on and supersedes all previous rules. The rules can be downloaded for free in all three EPO languages (EN, DE, FR,) from the EPO website (last visited 15.8.2010):
www.epo.org/patents/law/legal-texts/guidelines.html
- The US Patent office is reachable via:
http://www.uspto.gov/
- The German Patent office is reachable via:
http://www.dpma.de
- The Austrian Patent office is reachable via:
http://www.patentamt.at

10.3 Output: Visibility

It is important to represent the subject and to make the workgroup visible on local, national and international level threefold: Science to Science (S2S); Science to Business (S2B); and Science to Public (S2P).

10.3.1 Visibility Science to Science (S2S)

Apart from publishing, in order to reach a certain visibility amongst the scientific community it is necessary to build, continuously maintain and expand a sustainable network and to serve in this network on various levels:

Representative in international committees. Example: International Federation of Information Processing (IFIP, http://www.ifip.org). The Technical Committee and Working Groups have following aims and scopes:

1) To establish and maintain liaison with national and international organisations with allied interests and to foster cooperative action, collaborative research and information exchange.
2) To identify subjects and priorities for research, to stimulate theoretical work on fundamental issues and to foster fundamental research which will underpin future development.
3) To provide a forum for professionals with a view to promoting the study, collection, exchange and dissemination of ideas, information and research findings and thereby to promote the state of the art.

4) To seek and use the most effective ways of disseminating information about our work including the organisation of conferences, workshops and symposia and the timely production of relevant publications.
5) To have special regard for the needs of developing countries and to seek practicable ways of working with them.
6) To encourage communication and to promote interaction between users, practitioners and researchers.
7) To foster interdisciplinary work and, in particular, to collaborate with other Technical Committees and Working Groups.

Member of international scientific societies. Examples: Association of Computing Machinery (ACM), founded in 1947 is the oldest and the world's largest scientific computing society (www.acm.org).
Institute of Electrical and Electronics Engineers (IEEE), founded in 1963, and not to be confused with the Institution of Electrical Engineers (IEE), is the largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity (www.ieee.org).

Member of national scientific societies. Examples: British Computer Society (BCS), established in 1957 is a society to promote wider social and economic progress through the advancement of information technology science and practice (www.bcs.org).
Gesellschaft für Informatik (GI), established 1969 is the German Computer Society and is a network of professionals who promote informatics (www.gi-ev.de)

Österreichische Computer Gesellschaft (OCG), established 1975 is the Austrian Computer Society and a network of professionals aiming to promote IT with respect on its impact on human and society.

Member of Editorial Boards of Journals. These have demonstrated scholarly expertise and leadership and are responsible for the support of the editors and the promotion of the journal and handling of review processes etc. Example: Elsevier International Journal on Computers & Education (www.elsevier.com/wps/find/journaleditorialboard.cws_home/347/editorialboard)

Reviewer. One of the duties amongst a scientific community is to be ready to act as a reliable reviewer. Usually, such reviews are double-blind, but the comments are frequently open to the authors.

Member in Programme Committees of Conferences, Workshops, Symposia. The members of a Technical Program Committee (TPC) are expected to

a) promote the event – spreading the Call for Papers (CfP), asking colleagues also to do so (snowball effect)
b) act as a reviewer
c) contribute personally to the event (e.g. paper, workshop, tutorial, round-table, special thematic session etc.)
d) participate personally (e.g. talk, session chair, discussant, etc.)

10.3.2 Visibility Science to Business (S2B)

According to a study of an expert group of the European Union (Saublens et al., 2008) the development of the knowledge-based economy puts an increasingly high emphasis on the need to produce, exploit, transfer and apply knowledge. Consequently, there is a general agreement about the need to develop and strengthen networking activities between the actors of the so-called **Triple Helix Model** (Leydesdorff, 2000) in figure 16, i.e. business, science and government (state). Intermediaries can facilitate the interaction between these three key groups and bridge them with public and private R&D funding and venture capital organisations. Figure 16 shows the value chain of an example cluster from Glasgow.

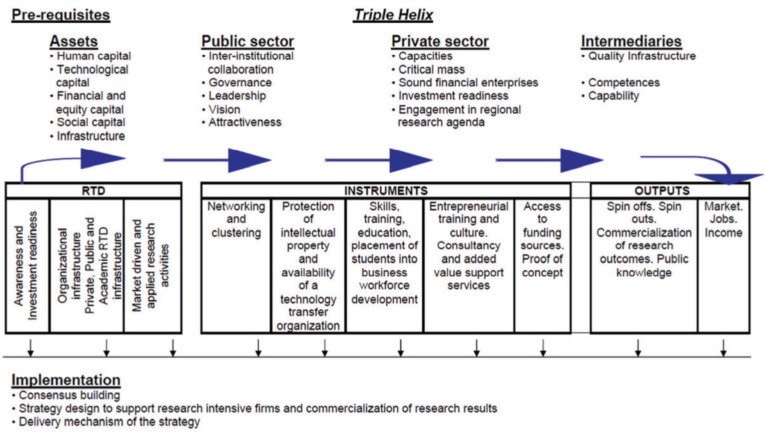


Figure 16 The Value Chain of building a science to business cluster on the Example of the Glasgow Development Agency & EURADA (Saublens et al., 2008)

A long term (up to 20 years) timeline can be seen in figure 17 which has been developed by the Glasgow Development Agency (Saublens et al., 2008) and is a perfect example on the development of such a cluster and emphasizes the different stakeholders approach according to the cluster life cycle as well as the type of strategy to put in place. If the stakeholders are interested in short-term results, they can either strengthen a specific stage of development or support it to become international. A multiplicity of stakeholders results in diverse expectations about research and while researchers provide new knowledge, policymakers and other societal actors have expressed their demand for knowledge transfer (Schmoch & Schubert, 2010).

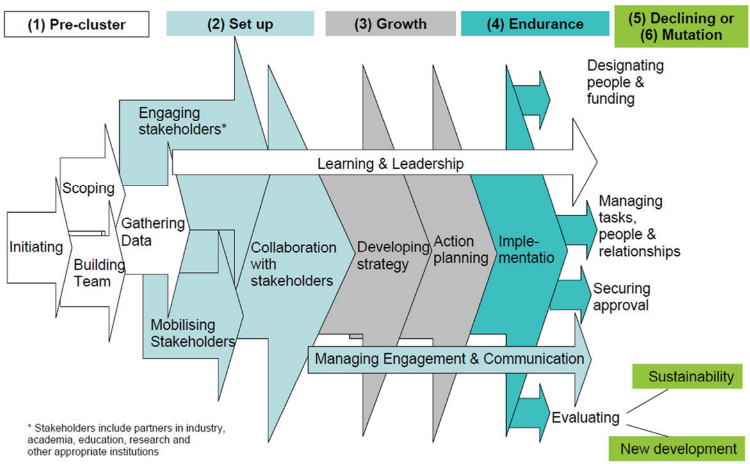


Figure 17 A cluster development process between science and business on the example of the Glasgow Development Agency & EURADA (Saublens et al., 2008)

10.3.3 Visibility Science to Public (S2P)

It is very important to promote the subject, the research team and the results to the general public. Indirectly this is of high importance for all stakeholders, due to the fact that the public perception and the resulting public opinion is spreading widely. Public opinion can be defined as the complex collection of opinions of many different people and the sum of all their views (collective opinion).

The specific term for all activities in that respect is **public relations** and there are many possibilities to communicate to the public, including:

a) Articles of general interest in all sort of printed matters, e.g. in newspapers, magazines etc.
b) Press releases – for example when a large project starts or a project has gained results of public interest.
c) Yearly printed reports (book style), made available to the public.
d) Events, e.g. during public fairs etc.
e) Public Symposia or workshop with some public events.
f) Awards, e.g. to gain attention by advertising awards amongst the greater public.
g) Workshops for schools, especially for awareness raising amongst potential young scientists (Nachwuchsforscher).
h) All sort of modern social media (e.g. Blogs, Wikis, Twitter etc.) which can be used by the public.
i) Establishing support groups and lobby groups.

11 Impact: Research Grants

In this section we discuss some possibilities on how to acquire funds for research, starting from local to global on examples from Graz – Styria – Austria - Europe.

It is necessary to provide information on the research group and on the research topics. One-page factsheets or leaflets and a clearly understandable website can help. It must be clearly visible which benefits the group can bring to potential stakeholders, sponsors and promoters. The complex landscape of funding organizations can be seen in figure 18 on the example of Austria.

11.1 Local Funding

City of Graz. The Department for Economic Development maintains a Business Information Server:
http://www.wirtschaft.graz.at/cms/ziel/285011/EN

Styrian Business Promotion Agency. The Steirische Wirtschaftsfoerderung (SFG) aims to contribute to the strengthening and growth of the Styrian economy – especially towards the exchange between Academics and Industry:
http://www.sfg.at/cms/1312/English

Human Technology Cluster Styria. This network was launched by the SFG in cooperation with successful enterprises, regional universities, public and private institutions.
http://www.humantechnology.at/index_eng.htm

Styrian Government. Department A3, Science and Research, is the Styrian platform for funding:
http://www.verwaltung.steiermark.at/cms/beitrag/10220927/9654/#tb2

11.2 National Funding

Austrian Grant Database of the Austrian Federal Economic Chamber:
http://portal.wko.at/wk/foe_suche.wk?sbid=190&ttid=21&dstid=0

FFG Austrian Grant Assistant. The FFG "Förderassistent" is provided by the Austrian Research Promotion Agency (FFG) and is *the* national funding institution for applied industrial research in Austria, and is a very effective tool:
http://www.ffg.at/content.php?cid=307

FWF Austrian Science Fund. This is Austria's central funding organization for basic research. Funding of individual research in the area of non-profit oriented scientific research:
http://www.fwf.ac.at

OeNB - Jubiläumsfonds Österreichische Nationalbank.
http://www.oenb.at/de/ueber_die_oenb/foerderung/jubilaeumsfonds/antrag/antrag.jsp

ÖAW – Austrian Academy of Science. This is the funding organization for non-university academic research:
http://www.oeaw.ac.at

BM:WF Austrian Ministry of Science and Research:
http://bmwf.gv.at

The ministry of science provides the Austrian online platform for the European Research Area, which is a promotion initiative aiming at providing comprehensive information on the implementation of the ERA:
http://www.era.gv.at

BM:VIT - Bundesministerium für Verkehr, Innovation und Technologie. Federal Ministry for Transport, Innovation and Technology:
http://www.bmvit.gv.at

FIT-IT Forschung, Innovation, Technologie – Informations-technologie is a special service oft the BM.VIT:
http://www.ffg.at/fitit

CDG - Christian Doppler Forschungsgesellschaft is a non-profit association aiming at promoting development in the areas of natural sciences, technology and economy as well as for their economic implementation and utilisation:
http://www.cdg.ac.at

LBG – Ludwig Boltzmann Gesellschaft is a private sponsor of research establishments in Austria, which are divided in institutes and clusters, and are characterised in particular by their cooperation with institutional partner organisations:
http://www.lbg.ac.at

AWS Austria Wirtschaftsservice Gesellschaft is a federal development bank for the promotion and financing of companies and special services for exploitation of inventions:
http://www.awsg.at

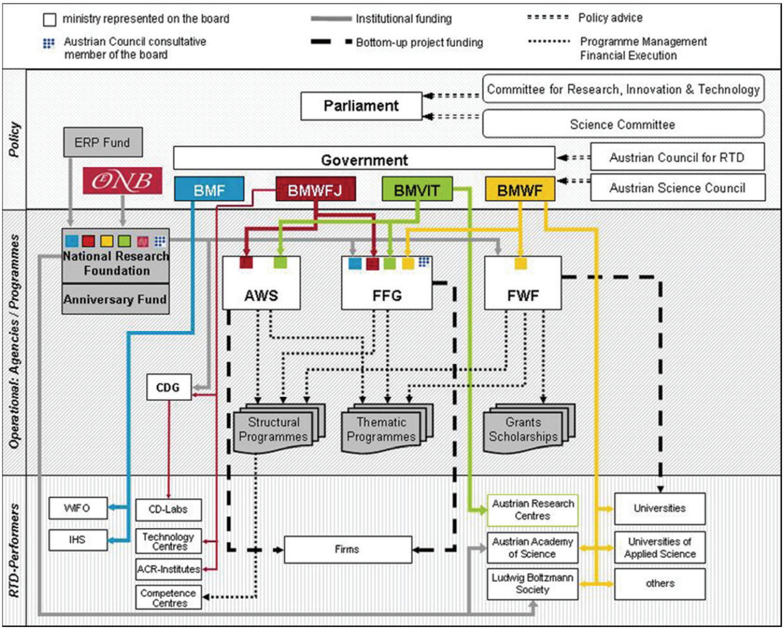


Figure 18 The diversity of the research landscape in Austria, according to ERA-watch (2009) retrieved from http://www.era.gv.at on 29.12.2010

National Funding on the Example of European Countries

Slovenian Research Agency [ARRS]. Slovenia is a border country in the south of Austria, e.g. Graz and Maribor are only 45 minutes by car:
http://www.arrs.gov.si/en/dobrodoslica.asp

German Research Agency. The „Deutsche Forschungsgemeinschaft (DFG)“ is the central, self-governing and largest research funding organisation in Germany and promotes all fields of science and the humanities.
http://www.dfg.de/en/index.jsp

German Research Data base. The „Deutsche Förder-datenbank“ is a very useful tool to get a good overview:
http://www.foerderdatenbank.de

UK Wellcome Trust. This is a global charity dedicated to support improvements in human health:
http://www.wellcome.ac.uk

11.3 European Funding

European Research Information. The CORDIS portal is the gateway to European research and development:
http://cordis.europa.eu/home_en.html

European Project Partner Search. The CORDIS Partners Service is a free on-line tool to help organizations locate suitable partners for both EU funded and/or private collaboration:
http://cordis.europa.eu/partners-service/search_en.html

11.4 Example US Funding

US National Science Foundation. The NSF is an independent federal agency to promote the progress of science with an annual budget of 7 Billion USD (2010). In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal backing:
http://www.nsf.gov

11.5 International Funding

US National Institute of Health. The NIH is the nation's medical research agency, making important medical discoveries that improve health and save lives.
http://www.nih.gov

World Health Organization. The WHO is the directing and coordinating authority for health within the United Nations system and shapes research agendas, norms and standards, technical support to countries and monitoring and assessing health trends:
http://www.who.int/en

COS Community of Science (COS). This is a good international resource for hard-to-find information across all disciplines. Their mission is: "We aggregate valuable information so you spend less precious time and money searching for the information you need, leaving you more time and money for your projects".
http://www.cos.com
A good source for international funding opportunities is:
http://fundingopps.cos.com

IFS International Foundation of Science. This is a NGO (non-governmental organisation) founded in 1972 with 135 affiliated Organisations in 86 countries, of which three-quarters are in developing countries and one-quarter in industrial countries, with the office in Sweden:
http://www.ifs.se

11.6 Project Proposal Writing – Short Example

Before starting a project proposal it is important to sketch a big picture of your idea first (figure 19), including:

VISION – Where do you want to go (e.g. your objectives)?
MISSION – Why do you want to do it (e.g. your convictions, what do you want to change or achieve with this project)?
STRATEGY – What instruments do you use (e.g. project funding targets, project partners, topics, methods etc.)

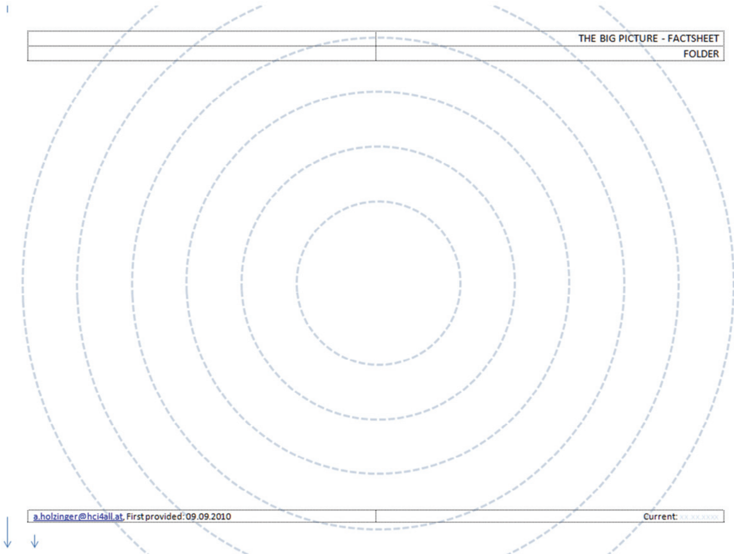


Figure 19 The Big Picture – a factsheet should be generated first, also for bringing partner on board of a grant proposal

All proposals follow the following logical style:

Title and Acronym. The Title must be convincing and the acronym should be catchy and easy to remember.

Abstract. This is the most important part of the proposal and must be absolutely convincing for both cases:
1) expert readers, working in this field for many years, will evaluate it, but also
2) non-expert readers, having a different background will evaluate it.

The abstract can be in unstructured or structured form but in both cases must contain the same parts.

a) Introduction and motivation:
<clearly state what the core problem is and why there is a need for a research project, the abstract is the most important part, it must be absolutely convincing >

b) Objectives: This project will ...
<clearly state what the project will do and what the benefit is and why it should be funded>

c) Methods:
<which methods will be used in this project>

d) Expected Results:
<What are the main expected outcomes of this project, again: Why should somebody release money for this project, what is the unique proposition point>

Keywords: Human–Computer Interaction, Usability Research, (up to five keywords) …

OESTAT Topics[8] < exactly 4 topics and the percents relevant>:

Table of content

Abbreviations and Acronyms

Content

1. Introduction and motivation for research
<Why is this research necessary? Why should it be done? What is the main reason for this?>

2. Background and Related Work

The background constitutes the necessary theories, concepts and fundamentals; the related work constitutes current work that relates to the topic – state of the art – body of knowledge, it is the work of other colleagues, most obvious the reviewers of the project proposals. It is essential nothing to ignore or forget; if a reviewer is referenced the chances raises ;-)
Basically, the related work includes the shoulders were we stand and which we should know, this includes all state-of-the art papers (journals and conferences) and – most important – patents!
<what is the work we are building on ? These are the shoulders were we stand and which we should know, this includes all state-of-the art papers (journals and conferences) and patents >

---

[8] For an international proposal the ACM classification is also useful: http://www.acm.org/about/class/1998/

3. Project Objectives

Coarsely describe the MAIN research targets and point to the detailed work plan and research agenda in section 5. Here just provide convincing what the main QUESTIONS are and how you address them and what you expect to find.
This should be just **convincing** (e.g. the reviewer must see that you are not only know your field, that you want to go beyond state of the art and are motivated, but also that you are able to achieve your goals).

4. Methods and Materials

Describe the systems, equipment, development kits etc. which will be used during this project, however, be aware that it is a research project so describe the methods which will be applied in the research during this project (e.g. Heuristic Evaluation, Cognitive Walkthrough, Action Analysis; Thinking aloud, Field Observation, Questionnaires; Task Analysis; Video Analysis; Contextual Inquiry; Verbal Protocols; Interviews; Concurrent Ethnography; Rapid Ethnography; Rapid Prototyping, Co-Discovery Method; Biological Usability Testing; EEG Methods, EOG Methods, Formal Methods (Petri Nets, Markov Models, etc.).

5 Research agenda (incl. Gantt-Chart)

5.1 Work package 1: <WP Title>

< as many work packages as are needed>

The most important part of a grant application is a convincing presentation of work packages with clear inputs, processes and outputs.

The whole project is divided into <number> Workpackages (WPs) having various duration (see Gantt-Chart on page <pagenumber>). Some of the tasks can be done concurrently, others sequentially, with some overlap. In the areas, where the project goals are to ambitious, where not all and every research question can be addressed, it shall be emphasized that this parts will serve as pilot studies with the central aim of providing a well-grounded prototype development which can be used for further research.

WP Number	xx	Duration: x months	PM: x
WP Title	<A concise title of the work package>		
Motivation for WP	<Give a justification of why this WP is necessary and important>		
WP Objectives	<Provide the objectives, goals and aims of this WP>		
Related Work: Main Publications	<Describe at least three main related publications, patents>		
Research Questions	<Define the most important research questions>		
Methods and Materials	<Describe the main methods and the material used within this WP>		
Expected Outcomes: Deliverables	<Provide a list of expected outcomes, e.g. Technical Report; Contribution to conference X; Submission to journal Y; Mock-Up; Conceptual model; Proof of Concept; Prototype; Patent>		

Figure 20: A typical Workpackage Sheet

Gantt charts can be used to illustrate a project schedule, including start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project.

PERT is short for Program Evaluation and Review Technique and is a graphical method to analyze the involved tasks in completing a project, especially the time needed to complete each task and identifying the minimum time needed to complete the total project.

6. Project Cost Calculation

6.1 Table of Expenses

6.2 Details to costs of requested materials

6.3 Details to costs of requested travel expenses

6.4 Details to costs of planned workshops

7 Information on the Institution (Infrastructure)

Information should be provided on three levels:
1) the whole institution (University)
2) the Institute (department, faculty)
3) the research group

Example:

The Medical University of Graz (MUG) comprises 40 clinical and non-clinical institutions. It is closely associated with a top quality hospital – one of the largest in Europe – offering essentially all fields of medicine. There are about 700 academics (among them 80 university professors) and more than 300 other personnel. More than 4000 students pursue their studies at the university, thus many of the academics are regularly involved in teaching. MUG is within the core of a network of 22 general hospitals of the province Styria (population approx. 1.200.000 people). There are also good connections to residential home for the older people.

The Research Unit Human-Computer Interaction for Medicine and Health "HCI4MED" of the Institute for Medical Informatics, Statistics and Documentation (IMI) of the Medical University of Graz, integrates – in addition to the necessary technological aspects – human-centred, cognitive aspects of information processing. The RU HCI4MED has established cooperation's to the Department of Psychology (Cognitive Science Section) of Graz University and the Department of Information Systems and Computer Media (IICM), thereby having access to a large method pool (EEG, Eyetracking, EOG, observation equipment, etc.). The Research Unit is also internationally well connected. The Research Unit HCI4MED has interdisciplinary experience in EU programs and national research programs and experience in supervision of PhD students. The MUG has an PhD school for the research area: sustainable health.

8 Team

Example:
The following team members contribute to this project
(short 100-words bio):

Dr. Andreas Holzinger is head of the RU HCI4MED, Associate Professor for Applied Informatics at Graz University of Technology and elected chair of the Workgroup Human–Computer Interaction and Usability Engineering (HCI&UE) of the Austrian Computer Society and leader and founder of the national Special Interest Groups HCI4MED and HCI4EDU. He is Austrian representative in the Technical Committee TC 13 HCI of the International Federation of Information Processing (IFIP). He was visiting Professor in Berlin, Innsbruck, Vienna and London. To date 259 publications and 177 lectures/talks, h-factor: 20, g-factor 38, 1433 citations (December 2010). More Info: http://user.meduni-graz.at/andreas.holzinger.

< bios … 100 words each >

9 Dissemination Strategy

<What conferences do you want to target? In which journals would you like to publish your results?

10 References

<finally, the literature used in the proposal>

The proposal should within 20 pages maximum include everything, which a reviewer needs for judgement.

12 Further Reading

Jain, Ravi K., Triandis, Harry C., Weick, Cynthia W. (2010): Managing Research, Development and Innovation: Managing the Unmanageable (2010). Third Edition.
3rd Edition. Hoboken (NJ): John Wiley. 396 pp. EUR 113,-

This book is like a bible, written by a Dean of Computer Science, a Professor of Psychology and a Professor of Management – which is an excellent interdisciplinary mixture of scientific fields and provides tremendous information. The book covers theories which are essential for success in research and development.

+ Strengths: A great collection of management and leadership theories, neatly presented; covers many aspects of both research and development, addresses diverse aspects including motivation, performance appraisal, etc. etc., supported by 18 pages of references. Focuses on the human management function.

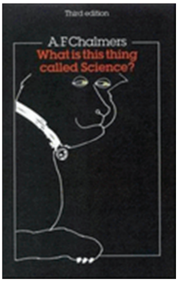
– Weaknesses: Since it is intended as a student textbook, the practical applicability is limited. Clear recommendations or applicable rules are to a large extent missing; it is much information and one can easily loose track. Moreover, many references are dated back to the 1970ies, which is ok, however, having recent literature at hand would increase the value of the book, especially for practical oriented engineers.

Betz, Frederick (2011): Managing Science: Methodology and Organization of Research (Series Innovation, Technology and Knowledge Management).
New York, Dordrecht, Heidelberg, London: Springer. 388 pp. EUR 97,-

Starting with a historic view on Rutherford's Experiment on the Structure of the Atom this book covers the origins of the scientific method, research techniques, communities of scientists , paradigms and perceptual spaces and some issues on objectivity in social sciences, paradigms of systems and logic and measurement.

+ Strengths: A good reader on the basic principles of Science with a strong focus on historical aspects. The book provides a good overview on the paradigms and basic methodologies of science, on perceptual space and phenomenological laws and principles. The book inspires thinking and reflection on models of research, especially on the hypothetic-deductive model.

– Weaknesses: Although one would expect a "bible" on managing science, the coverage of topics is rather limited and many aspects are not even mentioned and cannot be found in the book (creativity, . The literature list is rather short for such a large work and the many Wikipedia references look not professional. Whereas the book is an excellent basis for deep philosophical discussion it is rather of limited practical applicability.

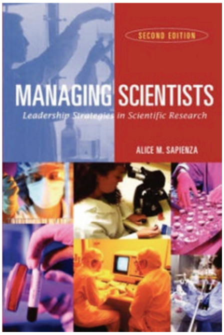


Chalmers, Alan F. (1999): What is this thing called Science?
1999, 3rd Edition. Berkshire (UK), Open University Press. 288 pp. EUR 29,90,-

This is a must-read for all people who are involved in science, naturally for science managers, to *understand* what makes science so specific. The book is a classical reader from a professor of History and Philosophy of Science. Chapter 12 contains an introduction into the Bayesian approach. The German Translation “Wege der Wissenschaft: Einführung in die Wissenschaftstheorie“, has an interesting appendix, i.e. a selection of books on the Theory of Science of various disciplines (including computer science).

+ Strengths: Interesting, nice and easy to read, this book provides an excellent introduction to the methodological approach of scientific research and discusses some of the most important aspects of Falsificationism and the Bayesian approach.

– Weaknesses: Very general and very exhaustive, verbose, needs some time to read. The big disadvantage is that the book can rapidly lead astray – finding in a philosophical debate. Although the book provides a good insight into the methods of science it is actually of limited practical applicability.



Sapienza, Alice M. (2004): Managing Scientists: Leadership Strategies in Scientific Research, Second Edition
2004, 2nd Edition. Hoboken: Wiley. 264 pp. EUR 44,-

This book is specifically written for biotechnology and pharmaceutical research and development industries and can be useful for other subjects, too. The book offers practical advice, including real-life case studies on improving the quality of interactions amongst team members and fostering creative output in an R&D setting.

+ Strengths: Lively written, easy to read and one can learn in very short time, the book covers interesting insights, especially on managing conflicts and provides real-life case studies. For example the good laboratories – bad laboratories one pager is worth reading (p.17), because it is in essence what reality needs.

– Weaknesses: The title is managing scientists, consequently it is mainly concentrated on dealing with people, however, many other issues are necessary but not covered in this book, therefore the practical applicability is limited to personel management.

13 Index

14 References

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