Organization and management of R&D projects

Dominic Battré
Ralf Christel
Florian Schopppmann
1. **Project structuring and planning**
   - R&D in general
   - Importance of project planning
   - Planning tools
   
   (Ralf Christel)

2. **Beyond the project hierarchy**
   - Project task
   - Essentials of the scientific method

   (Florian Schoppmann)

3. **Funding**
   - Timeline of project proposals
   - Funding organisations
   - Structure of proposals

   (Dominic Battré)
Part 1: Project structuring and planning

• Ralf Christel •
Problems in project management

What the customer explained
What the project manager understood
What the designer sketched
What the software engineer realized
What the consultant defined

How the project was documented
What has been installed
What was charged to the customer
What maintenance looked like
What the customer really needed
Research vs. Development

Industrialized nations spend 5% of their annual budget on R&D
Every large company has an R&D department

**RESEARCH**
- Process that acquires new knowledge
- Insular process (few individuals)
- Communication via professional journals and conferences
- Immune from business economics

**DEVELOPMENT**
- Process that applies knowledge to create new devices
- Team activity
- Constant communication and coordination
- Contact to sales, production

**Reality**

Indirect piezoelectric effect = Elongation as a result of electric field

Use for valves in common rail injection systems

Without R no new knowledge for D
without D no funding for R
Problems in R&D

The chaos because of a lack of coordination leads to the following problems in R&D projects:

- Research results can not be reproduced (poor methodology, no documentation)
- Bad reports (too long/short, confusing or incomplete)
- Knowledge is locked up in the heads of individuals
- Statistical analysis of results is missing
- Oral presentations are confusing and emphasising the wrong things

Waste of time
Failing of complex R&D projects

Primary objective in R&D:
Rigorous and systematic approach to the planning and conduct of R&D projects (Coordination, Documentation)

Prevention of expensive mistakes
Every team member can make contribution to reduce the chaos in R&D:

- Use a research notebook (ideas, sketches, reminders...)

- Get knowledge of functions and capabilities of useful software packages
  -- Spreadsheet program
  -- Slide show design program
  -- For data analysis and visualization

- Get access to technical knowledge
  -- well stocked technical library
  -- fast internet access
  -- subscriptions of professional journals and magazines
  -- regular participation in professional conferences and workshops
Top-Down project planning

Project task
- Decomposition into single tasks
- Define hierarchy

(Portrait) Task tree

Task 1
  - Task 1.1
  - Task 1.2
  - Task 1.3
    - Task 1.3.1
    - Task 1.3.2

Similarity to botanical counterpart:

• Root = Primary task (one and only objective of the project)
• Leaves = Terminal tasks (work package without subtask)
Houseowner plans to repair the squeaky hinges of his guestroom door.

**Task 1**
Repair Squeaky Hinges

- **Task 1.1**
  Unmount Door
- **Task 1.2**
  Remove Hinges
- **Task 1.3**
  Straighten Hinges
- **Task 1.4**
  Buy New Hinges
- **Task 1.5**
  Reinstall Hinges
- **Task 1.6**
  Remount Door

- **Task 1.2.1**
  Remove Screws

- **Task 1.2.2**
  Pry Off Hinges

After removing 1st hinge:
- Screwdriver broke
- Grinding machine out of order
- Soldering gun out of order

Recursive task invocation:
- Steel too strong to bend

Recursive tasks took long time:
- Hardware shop closed
- Project failed
Important lessons from example

• It is impossible to have alternative plans for every failure that could appear

• Be equipped with high-quality tools and maintain them

• Always try to execute „dry runs“ (pilot tasks) to identify unexpected problems

Main problem:

• Task tree only indicates hierarchy of tasks, but does not specify the order

• Tasks should be executed in parallel (if possible)
# Milestone chart

Shows sequence of the tasks, pilot tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Repair Squeaky Hinges</td>
<td>0800</td>
</tr>
<tr>
<td>1.1 Unmount Door</td>
<td>0900</td>
</tr>
<tr>
<td>1.2 Remove Hinge 1</td>
<td>1000</td>
</tr>
<tr>
<td>1.2.1 Remove Screws 1</td>
<td>1100</td>
</tr>
<tr>
<td>1.2.2 Pry Off Hinge 1</td>
<td>1200</td>
</tr>
<tr>
<td>1.3 Straighten Hinge 1</td>
<td>1300</td>
</tr>
<tr>
<td>1.2 Remove Hinge 2</td>
<td>1400</td>
</tr>
<tr>
<td>1.2.1 Remove Screws 2</td>
<td>1500</td>
</tr>
<tr>
<td>1.2.2 Pry Off Hinge 2</td>
<td>1600</td>
</tr>
<tr>
<td>1.3 Straighten Hinge 2</td>
<td>1700</td>
</tr>
<tr>
<td>OR</td>
<td>1.4 Buy New Hinges</td>
</tr>
<tr>
<td>yes</td>
<td>1.5 Reinstall Hinges</td>
</tr>
<tr>
<td>no</td>
<td>1.6 Remount Door</td>
</tr>
</tbody>
</table>

**Time axis**

**Tasks**

**Pilot task**

**Start, end, status of task**
Contains responsibilities, critical path arises
Conclusions

1. Structure your project with the help of a **task tree** (single objective, hierarchy of tasks)

2. Schedule the project according to the task tree and plan resources with the **milestone plan**

3. Use **pilot tasks** to identify unexpected problems and to estimate the feasibility

Frequently updated planning documents ensure:

- Efficient allocation of resources
- Avoidance of obvious pitfalls
- Prevention of delays
References

• Bock P.: Getting it right
  Academic Press, 2001

• Beckmann C., Specht G.: F&E-Management
  Schäffer-Poschel Verlag, 1996
Part 2: Beyond the Project Hierarchy

What exactly is a project task?

What are the essentials of the scientific method?

• Florian Schopppmann •
• Rough analogy: Function in Mathematics

\[ f: \mathbb{R}_{>0} \rightarrow \mathbb{R} \]

\[ f(x) := \log_2 x \]

Task

<table>
<thead>
<tr>
<th>Task Domain</th>
<th>Task Method</th>
<th>Task Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Unit</td>
<td>Solutions</td>
<td>Knowledge</td>
</tr>
<tr>
<td>Task Resources</td>
<td>Experiments</td>
<td>Devices</td>
</tr>
<tr>
<td>Task Objective</td>
<td></td>
<td>Effects</td>
</tr>
</tbody>
</table>
• **Definition**

  An R&D task applies a specific method to the domain of the task with the objective of obtaining a satisfactory result in the range of the task.

• **Task Objective**

  – Statement what task is intended to achieve
  – Use Infinitive Phrase
  – Name of the task itself should be **short** summary
- **Task Unit**
  - set of objects/concepts undergoing alteration before or during the task
  - Examples:
    - Albert Einstein’s General Theory of Relativity: Space-Time continuum
    - NASA’s Apollo Mission: Saturn V
  - **not** the implementation of the solution for the task
  - must undergo **alterations**
    - internal/external
    - wanted/unwanted
    - ...
Task Domain II

• **Task Resources**
  – Inducers, Sensors
    • Goal: Identify/isolate/minimize biased task units, noisy sensors, unwanted inducers
      → Task is in control
  – Supervisor
    • set of human/automated agents operating and monitoring the task unit
  – Channels
  – Domain Knowledge
• **Task Method**
  - **Solution**: Mechanisms (set of inducers) and Procedures
  - **Experiments**: Resources and protocols necessary to measure performance of the task unit when solution is applied

• **Task Range**
  - All products of the task
  - Knowledge, Devices, Effect
The Modern Scientific Method

• **Definition**

The **Scientific Method** comprises four sequential phases—as shown below—which are applied to a task iteratively and recursively to achieve the task objective.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Describe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Performance Criteria</td>
</tr>
<tr>
<td></td>
<td>Related Work</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Specify Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goals</td>
</tr>
<tr>
<td></td>
<td>Define Factors</td>
</tr>
<tr>
<td></td>
<td>Performance Metrics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Synthesis</th>
<th>Implement Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experiments</td>
</tr>
<tr>
<td></td>
<td>Reduce Results</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Validation</th>
<th>Performance Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Documentation</td>
</tr>
<tr>
<td></td>
<td>Solicit Peer Review</td>
</tr>
</tbody>
</table>

- Expect several passes, perform iteratively
- Stepwise refinement
Iterative Execution

• New iteration (or abandonment of task)
  – At end of Synthesis Phase: Results indicate failure
  – Validation: Conclusions do not survive peer review

• Vast majority of R&D task are unsuccessful!

• One possible remedy: Feasibility pilots
Feasibility Pilots

• **Simplified and informal investigations**
  – Similar idea as, e.g., prototypes in engineering

• **Record details of every pilot in research notebook!**
  – Failures, Successes, **Everything**!

• **However:**
  – Pilots are not conclusive
  – Potentially useful results to be confirmed and validated!
• **Rough postulate:**
  - # iterations inversely proportional to task planning time
  - Too little planning time incurs much heavier penalties in overall task time than too much planning time!

- **Analysis**
- **Hypothesis**
- **Synthesis**
- **Validation**

  - Refined idea: Each iteration repeats only half of the ideal task time
  - Saddle Point where task planning ~70%

  - Too little planning time incurs much heavier penalties in overall task time than too much planning time!
Recursive Execution

• **Single level in task hierarchy unlikely**
  – as unlikely as accomplishment of task w/o iteration…

• **When spawning subtask, reinvoke the entire Scientific Method!**
  – Analysis might be shorter
  – Hypothesis, Synthesis, and Validation often more detailed

• **Make project task tree and milestone chart primary (also first!) planning documents!**
  – Let them evolve during the project
Conclusion: DOs and DON’ Ts

• **DOs**
  – Plan thoroughly in advance
  – When noticing that a deadline cannot be met, inform manager immediately
  – Accept that workplace is not a democracy
  – Limit the work of each person to one or two concurrent projects

• **DON’ Ts**
  – Make it up as you go
  – Managers: Burden scientists with bureaucratic jobs— that is the manager’s job
• Bock P.: Getting it right (Chapters 4, 9) Academic Press, 2001
Part 3: Funding

- Dominic Battré -
Why me?

• Graduate School ensures funding for your PhD program…

… but then…
Why me?

Think about your funding now!

- Application takes >1 year
- Take part in writing proposals and conducting projects
  - Gain experience
  - Acquire students helping with your research
  - Build network
- Inform yourself about existing institutions
- Inform yourself about calls for proposals
- Read funding proposals
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>Hints about upcoming call</td>
</tr>
<tr>
<td></td>
<td>Call, Information events, Concertation meeting</td>
</tr>
<tr>
<td></td>
<td>Find your consortium, meet regarding ideas, write proposal</td>
</tr>
<tr>
<td>Sept.</td>
<td>Submit proposals (80-100 pages for STREP)</td>
</tr>
<tr>
<td></td>
<td>Wait</td>
</tr>
<tr>
<td>Dec.</td>
<td>Evaluation Results, Ranking</td>
</tr>
<tr>
<td>Jan.</td>
<td>Invitation to (Pre-)Negotiation</td>
</tr>
<tr>
<td></td>
<td>Revise proposal according to comments</td>
</tr>
<tr>
<td></td>
<td>Write “Description of work” (becomes part of contract)</td>
</tr>
<tr>
<td></td>
<td>1. Negotiation</td>
</tr>
<tr>
<td></td>
<td>2. Negotiation</td>
</tr>
<tr>
<td>Jul.</td>
<td>Project commencement, kick-off meeting, official announcement</td>
</tr>
<tr>
<td>Sept.</td>
<td>European Technology Days, present your project, find collaborators</td>
</tr>
</tbody>
</table>
Proposal Preparation

1. Define project
   - Goal, Objectives, Scope
   - Who benefits?
   - What are measurable outcomes?

2. Identify right funding organization
   - Apply at several organizations
   - Look for matches of goals
   - Previously funded projects
   - Inquire about average funding

3. Acquire proposal guidelines

4. Build consortium
The DFG: Funding Programs

- **individual research grants:**
  - funding for individual projects
  - funds for staff, equipment/supplies or travel expenses
  - eligibility: applicant must hold PhD

- **support for young researchers:**
  - fellowships, networks

- **coordinated programs:**
  - research units (multiple researchers working on one project)
  - collaborative research centers (interdisciplinary, “Sonderforschungsbereich”)
  - DFG research centers (centers of excellence)
  - priority programs (broad subject area)

- **scientific prizes**

- **infrastructure funding:**
  - library services, information systems, research facilities

**application:** proposal and résumé
Funding Programs of EU

- **STREP:** Specific Targeted Research Project
  - objective-driven, limited scope

- **IP:** Integrated Project
  - on specific areas, direction given, no [applicable] results expected

- **NoE:** Network of Excellence
  - collaboration of researcher of one topic, structuring of research

- **CA:** Coordination Action
  - Support co-ordination, co-operation, networking of range of research

- **SSA:** Specific Support Action
  - Support implementation of Framework Programme, analysis and dissemination of results
## Funding Programs of EU

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Minimum participants</th>
<th>Typical Participants</th>
<th>Typical Duration</th>
<th>Typical Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>STREP</td>
<td>3</td>
<td>4-8</td>
<td>2-3 years</td>
<td>1-3 M EUR</td>
</tr>
<tr>
<td>IP</td>
<td>3</td>
<td>8-15</td>
<td>3-4 years</td>
<td>6-25 M EUR</td>
</tr>
<tr>
<td>NoE</td>
<td>3</td>
<td>6-12</td>
<td>3-4 years</td>
<td>2-8 M EUR</td>
</tr>
<tr>
<td>CA</td>
<td>3</td>
<td>3-12</td>
<td>1-3 years</td>
<td>0.5-2 M EUR</td>
</tr>
<tr>
<td>SSA</td>
<td>1</td>
<td>3-12</td>
<td>1-3 years</td>
<td>0.5-2 M EUR</td>
</tr>
</tbody>
</table>

STREP: Specific Targeted Research Project  
IP: Integrated Project  
NoE: Network of Excellence  
CA: Coordination Action  
SSA: Specific Support Action
Funding Programs of EU

• The intention of the proposal must not be “What can the EU do for me?”, but: “What can I do for the EU?”

• Focus on
  – Exploitation
  – Dissemination
Proposal Writing: Objectives

- draw attention to project
- demonstrate competence
- explain feasibility
- justify funding request

Write Proposal
A funding proposal usually consists of:

- **project overview** (short abstract)
- **background information**
  - literature review
  - prior research (own / 3rd party)
- **detailed project description:**
  - motivation
  - goals & objectives
  - methods
  - project plan
- **requested resources:**
  - personnel
  - equipment / supplies
  - travel expenses

- **demonstrate competence** in your area of research
- **clearly explain** your goals and their scientific value, convince the reader that you are able to achieve them
- **justify your funding request**, be reasonable!
Evaluation

- Grades on scale from 1 to 5
  - Relevance (threshold: ≥ 3)
  - Potential Impact (threshold: ≥ 3)
  - Scientific and Technological Excellence (threshold: ≥ 4)
  - Quality of Consortium (threshold: ≥ 3)
  - Quality of Management (threshold: ≥ 3)
  - Mobilization of Resources (threshold: ≥ 3)
  - Overall Remarks (threshold: sum ≥ 21)
Final Tips

• Make detailed plan about distribution of work
  ⇒ Writing a proposal is a project!

• Do not focus only on scientific part

• Have a layman and a native speaker read the text

• Use help of others !!!!
  ⇒ Dezernat 2.2
References

- References and further reading on proposal writing:
  - John O ‘del: Grants and Grant-Proposal Writing http://eweb.slu.edu/grants.htm
  - Gerdes, Horstmann (Department 2.2 UPB): Antragstellung in EU Forschungsprogrammen
• Thank you for your attention
Thank you for your kind attention

Please feel free to ask a lot of questions!

• What is more time efficient: „Wasting“ time with planning and updating documents or solving upcoming problems?

• Do you think the mentioned tools (notebook, task tree, gantt-chart) could help you with your phd-project?

Exercise: Design a task tree and a milestone chart for a simple household project, so that it could be performed by a third person.

Try to implement pilot tasks.

Find a person who performs the task as quickly as possible according to your plan.

Record your observations!
Discussion Part 3

- Better to apply for EU project/DFG or for smaller project?

- Better to focus on research and get PhD quickly or spend time on projects?

- Writing project proposals and milestone reports is a lot about lying/tweaking numbers (everything fits in the end)/paper work, can we fix that?

- What do you think is a reasonable management overhead?

- Question: How much are you involved in projects?
  Should we have compulsory classes about writing project proposals?

- Is distribution of project proposals fair? Researchers in natural sciences and arts often are very happy if they get half a position.

- What is the importance of networking for acquiring projects? How can we make it fair? What is effect of Elite Universities?

- A lot of funded projects are about knowledge transfer, is that still science?
Think about the Reviewers
!!!!!!!!!!!!!!!!!!!!!!
👍👍👍👍👍👍
General Experiences: Time

- Start early (takes time to proof-read)
- Make detailed plan about distribution of work
  ⇒ Writing a proposal is a project!
- Do not focus only on scientific part
- Use help of others !!!!
General Experiences: Formal Aspects

- Arrival of application before deadline
- Send to correct address
- Use current forms for the respective funding instruments
- Check completeness of application
General Experiences: Layout and Structure

• Respect font size and number of pages
• Short paragraphs
• Enumerations
• Highlight keywords by bold font or italics
• A picture is worth a thousand words: Include images and Eye-Catchers!
• Figures should be self-explanatory
General Experiences: Language

• Correct and easy to understand English language
• Write clearly and precisely
• Avoid redundancies
• Punchy self-explaining title
• Easy to remember acronym
Experiences from FP6

- Comments of the Commission
  - Industry is rarely the coordinator
  - Better description of partners, describe benefit for the partners
  - Description of "state-of-the-art" too brief; state of competitors insufficient
  - Value creation chain and commercialization not depicted thoroughly enough
  - Financial planning not detailed enough
  - Often: too many partners
Experiences from FP6

• Typical Errors
  – At Integration Projects
    • Too many partners – Collaboration impossible
    • „Unclear structure of partners“
    • No „critical mass“ – project description suggests STREP
    • Too little industry participation, esp. SMEs
    • Too extensive budget
  – At traditional instruments
    • Ask Department 2.2…
DO’s and DON’Ts

• DOs ...
  – The intention of the proposal is not "What can the EU do for me?“, but: "What can I do for the EU?“
  – Abstract and first pages need to arouse interest at the reviewer
  – Have a layman and a native speaker read the text
DO’s and DON’Ts

- Proposal in German
- Use of expired / wrong forms / guidelines
- Boring / difficult to read text, bad English, verbose / imprecise description
- Project goal not clear
- State of the art description is replaced by references
- Understanding the proposal is only possible after reading quoted literature
- No adherence to guide lines (content, number of pages, etc.)
- Presentation of project partners insufficient
- Project consortium is chosen arbitrarily
- Competency of project partners / coordinator is doubtful
- Work packages / sub projects are not structured logically
- Description of work packages too broad
- Sequence of loose activities
- Inefficient management structures
- Reasoning for required resources incomprehensible, too high budget
- Too many tpyos, no proof-reading because of lack of time