2

"Eighty-five percent of the reasons for failure are deficiencies in the systems and process rather than the employee. The role of management is to change the process rather than badgering individuals to do better."

W. Edwards Deming (1900–1993)
Professor, statistician, management consultant, inventor of the PDCA (plan, do, check, act) cycle

https://doi.org/10.1017/9781108601993.003 Published online by Cambridge University Press

Organization

https://doi.org/10.1017/9781108601993.003 Published online by Cambridge University Press

2.1 Introduction

Many senior scientists look back at the period they spent as a PhD student or postdoc as when they were able to devote almost all of their time to reading new scientific literature, going wild with novel scientific ideas, designing clever approaches to test intriguing hypotheses, developing new theories and collecting strong supporting information, writing and presenting one or more influential papers, going to exciting scientific workshops and meetings, and so on. It was a great and demanding time spent working on important scientific stuff, even though their future career was insecure.

But then your career progresses and your time schedule gradually change. Now it involves writing a grant proposal to raise funding for your first PhD student ("I think I am ready to start my own group") and talking with financial people to budget the personnel costs ("Why does a postdoc cost so much?") to figuring out which other "mystery" experts should be consulted ("Ah, my department head has to approve the application, but only the president of my university can sign legal contracts"). After one or more attempts, hurray, your grant is awarded. But this marks the end of your earlier life as a PhD candidate or postdoc. From now on you are 100 percent responsible for all kinds of matters: recruiting new team members, evaluating and maybe even firing people, keeping track of your income and expenditure, negotiating new contracts, considering activities to generate research impact through outreach projects to the public, or helping a team member in starting a commercial spinoff. Whether you

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like it or not, you need to learn about the formal management procedures and processes related to human resources (HR), finance, intellectual property (IP), legal contracts, and licenses.

The following four sections cover four different administrative or business areas:

- **Human resources.** Hiring a group member, evaluating the performance of the group and its individual members, go/no-go contract decisions, a person ending his or her contract: what are the formal constraints for these and other aspects of HR management?
- **Financial affairs.** What types of costs need to be accounted for? How do you plan the budget before the start of a project and manage expenditures during its duration? Can the project generate any leads for new income streams?
- **Legal affairs.** What types of legal contracts or agreements are you involved in when working at a university and being funded by external parties? What are your rights and obligations? Are your ideas and work legally protected? Who owns what?
- **Patent affairs.** When will companies want to invest in you or your ideas? Or do you want to start your own company? Do you need to patent an application or idea? Can you still publish articles and present your work at conferences? What's the difference in value between a patent and a published article?

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2.2

Human Resources

There are many formal processes and procedures for scouting, selecting, employing, training, evaluating, and eventually letting your team members move on. For many of these steps, you can rely on support from the staff in your HR department: HR advisors and policy officers, trainers and counselors, administration services, and more. What can they do for you?

- Discuss recruitment strategy
- Help with position descriptions
- Handle job advertisements and where to place them
- Train selection panels
- Monitor inclusion criteria
- Participate in interviews
- Check qualifications/diplomas
- Prepare job contracts
- Negotiate salaries
- Help with moving in new personnel
- Train you in performance interviews

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- Train you in professional and personal skills
- Coach on career choices and job applications
- Advise in cases of conflict
- Implement measures to protect peoples' privacy and data.

But some steps you cannot delegate to others, although support from HR remains crucial. These steps include:

- Choosing between recruiting a PhD candidate and a postdoc
- Specifying the research requirements for a job advertisement
- Selecting the best candidates
- Training them in core scientific skills
- Doing the performance/progress interviews
- Helping your group members with planning their personal and career development
- Deciding about go/no-go points during probation periods.

Several of the human aspects in the preceding lists were addressed in Chapter 1. This section addresses the more formal HR processes so that you can manage your resources properly.

General data protection regulations

As the team leader, you obtain and process other peoples' personal data, e.g., application letters, recommendation letters, employment contracts, appraisal interview reports, and/or information related to illness. Legislation places great responsibility on you and your university in the way that the personal data of students, applicants, and employees are processed and managed, with major penalties for breaches. HR will have designed and implemented measures relating to all its

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processes – discuss with HR what *you* need to do so that you and your university comply with the rules.

Recruitment policies

You, the university, the funding agency, and the candidates all have strong interests that need to be taken care of professionally. Before you can advertise a vacancy, the legal and financial implications need to be checked and approved (signed off on by those responsible, maybe even by the president of your university). The advertisement and hiring procedure need to meet your university's standards; e.g., is it open, efficient, transparent, supportive, and internationally comparable in its field? Your university or institute may also need to comply with national or internal rules; e.g., if it carries the European Union HR logo of excellence (see Box 2.1 for some of the EU policies that should be adopted in this case). All candidates should be treated equally. This may seem hard or not very practical, but a recruitment decision based on having interviewed one final-stage candidate in person and another by Skype only should be postponed until you have met both in person. There may be additional rules, guidelines, and recommendations to comply with, such as:

- **PhD graduates should leave.** PhD graduates need to broaden their scope, so retaining them as a postdoc in your group may seem good for you but is bad for their career progression. The recommendation may be "no internal recruitment of PhD graduates for postdoc positions." Special circumstances may warrant exceptions.
- **No lifelong postdocs.** Postdocs who have several consecutive fixed-term contracts are likely to end up unemployed with poor career prospects. Maybe there's a guideline that after a couple of years postdocs should either be promoted to more senior positions or leave. Your organization may not allow

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more than two fixed-term postdoc contracts or set a maximum of four years of postdoc work in total.

- **Internal candidates.** The general rule may be open, transparent, and merit-based recruitment, but in some instances internal candidates may have priority for job vacancies. For example, a vacancy for a research assistant may need to be first offered to employees who are currently, or about to become, unemployed (because their previous project has ended), or this may be used as a mechanism to stimulate

BOX 2.1 *Example of recruitment policy*

Advertisement policies

- Providing clear and transparent information on the whole selection process, including selection criteria and an indicative timetable.
- Posting a clear and concise job advertisement with links to detailed information on, for example, required competencies and duties, working conditions, entitlements, training opportunities, career development, gender equality policies, and so on.
- Ensuring that the required levels of qualifications and competencies are in line with the needs of the position and not set as a barrier to entry (e.g., restrictive and/or unnecessary qualifications).
- Considering the inclusion of explicit, proactive elements for underrepresented groups.
- Keeping the administrative burden for the candidate (proof of qualifications, translations of diplomas, number of copies required, etc.) to a minimum.
- Reviewing, where appropriate, the institutional policy on languages: is knowledge of the national language a requirement or an asset for a particular position?

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The selection committee should be appropriately diverse

- A minimum of three members.
- Gender balance (e.g., at least a 1:2 gender ratio on the committee).
- Include external experts from outside the group.

Source: Modified from the Working Group of the Steering Group of Human Resources Management in the European Research Area 2015.

internal talent exchange for a certain category of staff. You may be allowed to recruit externally only if there is no internal applicant or if none of the internal candidates meet the job requirements. This is yet another reason to find out about such requirements because if an employee believes that he or she meets all the criteria, it may lead to an official complaint or even a court case.

- **Recommendation.** A minimum of three letters of recommendation may be required for final candidates. You may be tempted to make your favorite candidate an offer immediately, but there may be hidden factors that you only discover too late (see Table 2.1).

Performance policies

Most universities have annual performance or evaluation interviews conducted by supervisors with their PhD candidate or postdoc and often supported by an HR officer. The meeting has a formal status (i.e., the supervisor may have to grade the performance), and the report of the meeting will be signed by all parties and archived for legal purposes. If each new PhD student or postdoc starts with a clear work plan in the first month, and if you regularly meet and discuss progress with members of your group, there should be no surprises; everyone

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TABLE 2.1 Example of the mandatory HR processes for recruiting a PhD student or postdoc

Start project: advertise	
1	Obtain formal approval for hiring (signoff by bosses)
2	Write job advertisement (use HR template)
3	Agree on allowance/salary grade (min-max)
4	Develop attraction plan (where/when to advertise, etc.)
5	Develop selection plan/tools (interview, etc.)
6	Arrange selection panel (names, meetings)
7	Advertise
Start project: select	
1	Filter candidates (diploma check, etc.)
2	Short-list candidates (selection panel)
3	Request references/recommendation letters
4	Interview/test short-list candidates (selection panel)
5	Rank short-list candidates (selection panel)
6	Make formal offer to selected candidate
7	Onboard the new PhD or postdoc (all formal aspects)

Note: Color indicates who is primarily responsible: you (black shading), HR officer (gray shading).

knows the project is going well and that the meeting will be a relaxed one. It may focus on:

- **Project strategy**. The progress of the project and its academic output should be evaluated in relation to the original plans. Obviously, at the end of a PhD project, there should be a decent PhD thesis, several of the thesis chapters may already have been submitted for publication, and results will have been presented at workshops and

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conferences, possibly complemented by some media attention or other forms of dissemination. But since most projects go beyond the original plans due to increased insight during the course of the project, it is essential to refine – or sometimes even redefine – the scientific tasks on a yearly basis or more often. If time permits, some side projects may be initiated (e.g., a follow-up study on some striking or surprising observations).

- **Skills-development strategy.** You can reflect on professional and personal skills: which of the individual's technical and personal skills need extra attention for them to be more successful in the project, and which are important for a successful career after this project. Develop a strategy and concrete implementation plan; take into consideration massive open online courses (MOOCs), traditional classes, coaching, training, mentoring, internships, and similar (see Table 2.2).

PhD candidates are your trainees at the beginning of their contracts and need to grow professionally and personally

TABLE 2.2 Examples of some mandatory HR processes during the running of a project

Run project	
1	New PhD student or postdocs starts work
2	Match newcomer to buddy who helps them feel at home
3	Arrange special working conditions (e.g., disability)
4	Performance evaluations and reports (probation)
5	Performance evaluations and reports (regular)
6	Contract issues (e.g., extension due to parental leave)
7	Training career perspectives

Note: Color indicates who is primarily responsible: you (black shading), HR officer (gray shading), or both of you (white shading).

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into independent researchers by the end of the project. It is in the interests of both the candidate and the supervisor that the project succeeds, but it is also in the interests of both parties (and the team) that the contract is discontinued if growth is insufficient for finishing a thesis within the allocated time. Therefore, it may be appropriate to start with an initial contract for, say, 12 months and then decide whether the individual's progress warrants renewing the contract for another two to three years (depending on local employment regulations, of course). Postdoc researchers often get contracts of one to three years at most. These may still include a probation period of, e.g., a maximum of two months (in the Netherlands). By the end of that period, you have to decide about continuing their contract or not – it should have a very high chance of being right for them and for you. Luckily, in almost all cases, this deadline is passed almost unnoticed because the work is proceeding well.

However, supervisors sometimes run into cases where, in retrospect, a no-go decision would perhaps have been wiser and better for both parties. A prolonged stay as a PhD candidate or postdoc may have turned into an unsuccessful struggle that reflects badly on the individual's future career prospects within and outside academia. It is therefore very important to plan and monitor your team members' professional and personal development so that you can base your decisions on mutually agreed-on performance requirements. If well implemented and also well documented, the PhD student or postdoc and you should be able to agree about the situation, and the facts should show that progress and growth were sufficient (go) or not (no-go). You should provide maximum clarity about the requirements for a go, mention in advance if you have any doubts, and warn about a likely no-go, but do allow some time for improvement and offer enough supervision, support, mentoring, and training. Box 2.2 provides an example of clear communication with advance warning, objectives, targets,

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BOX 2.2 *Example letter about an upcoming go/no-go decision and what is required for a go*

Project progress, October 1, 2018

Dear [Albert],

You have now been working as a PhD candidate for nine months, while on an initial contract for 12 months. By January I will need to consider your chances of completing a PhD thesis in four years, and the director and I will decide about renewing your contract for a period of up to four years in total.

I had a meeting with you and our HR officer to evaluate your progress after six months, and we outlined an improvement plan for July to September. Recently we met again to evaluate your progress at nine months. My summary of our meeting is given below.

1. On the positive side [refer to action plan]:
   - [write here what went well]
   - [describe points that improved]
2. On the negative/critical side [refer to action plan]:
   - [what failed]
   - [what did not improve]
3. An action plan for the next three months includes
   - [make actions smart, i.e., specific, measurable, acceptable, realistic, time dependent]
   - [meet on weekly basis to allow for lots of support]

We will evaluate your progress again by December 29 at the latest to reach a definitive go/no-go decision about continuing the project. I would stress that, at the moment, it is still possible that this will be a no-go.

Best wishes,

[Ben]

Signature	Signature	Signature (to Show Who Has Read Text)
Ben Supervisor	Ann Director	Albert PhD candidate

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and timeline; of course you should first meet face-to-face and afterwards provide (and archive) the written confirmation. Consult your HR advisor for the formal procedures to follow. Most likely you will only be able to legally opt for a no-go if clear agreements have been made and filed at one or more formal meetings and the conditions that would have to be met for a go have been clearly outlined. After a no-go decision, your HR department should help the individual to develop an alternative career path.

The lives of PhD candidates and postdocs can be hectic for many reasons (see Section 1.5). Some may find it very hard or impossible to share their problems and worries with you. As their supervisor, you have a prime responsibility for ensuring that each team member can develop, which is easier if they are happy, but difficult (if not *very* difficult) if they have hidden problems. You need to create a culture in which people can talk to you before it's too late. You need to listen carefully, ask open questions, check whether you have understood the message properly, ask whether there are more issues, be empathic and use your ears, eyes, and heart, and as much as possible try to step into their shoes. Do recognize that there is always the temptation to project your own history and solutions onto the other person. So be aware of your own biases and prejudices, and refrain from making early conclusions, judgments, or condemnation. You can consider asking other people to help: a senior researcher, an HR advisor, a professional psychologist/specialist, or a confidential advisor. Be ready and open to face yourself in the mirror as well. Perhaps you need to learn to show more empathy or to improve your communication or supervisory skills. In some ways, a failed team member reflects on you and your team. Seek a mentor for yourself, and take some courses – your HR advisor can advise you on options. Continue to learn and hopefully you will do better next time.

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After a go decision, various new problems may arise that warrant you taking action (e.g., serious issues with behavior, performance, or misconduct). An HR officer can help you to resolve the issues by using informal procedures, which may include internal or external mentoring, coaching, review, advice, and mediation, with the right to challenge each other's views. These are nearly always preferable to invoking formal procedures.

Training and advancement policies

The career prospects of the PhD candidate and postdoc should be discussed. This may be obligatory for PhD candidates in their final two years, but considering future career options at an earlier stage is recommended. You need to help them realize where their talents can be useful in society because that is where their next job could be found. Discuss the opportunities for jobs within and outside academia and strategies to improve their curriculum vitae (CV) over the course of the PhD period. Do develop a plan with concrete action points. For postdocs, discuss strategies of how to fund their own research line and how they can be implemented. Strategic questions to discuss should also include how they can build a network of potential collaborators in their field or across other fields to better position themselves for opportunities. Which smaller or larger national or international grants could they apply for? Which organizations offer the best career prospects?

Give your team members time to explore potential career opportunities, e.g., by participating in a career perspectives exercise (see Table 2.3).

You need to support your group members as they come to the end of their projects, so take the writing of honest recommendation letters very seriously. If there are still loose ends to the project, such as manuscripts that may

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still need revision, do make agreements about who is going to do what and when. Perhaps you can offer a group member a short-term unpaid contract as a guest researcher (e.g., zero-hours appointment) so that your former group members are not disconnected from everything they may still need (e.g., access to proprietary data and computational infrastructure for revising a manuscript or access to the email addresses they have used for a long time). As team leader, you should ensure that they hand over any data, software, methods, and other valuable items relevant to your group's research and that you (or someone in your group) completely understands what this involves and where to find it (maybe to complete or revise manuscripts). Ideally, the new team member will start the day after the old one finishes or even have some overlap with them. Archive the lab notebooks and any other documents and manuals that contain essential background information for the data, software, and methods. You should also archive all your email correspondence for a couple of years, too.

Keep in contact with team members who leave: you never know whether, when, and how the future may bring you together in mutually beneficial ways. They can become your best ambassadors, collaborators, industrial or philanthropic sponsors, employers of your graduates, or perhaps even your direct boss in the distant future – who knows?

Perhaps you can offer the one leaving a solution to having one or two months' unemployment before their next job starts. If you have some spare money and tasks that need doing, a short-term paid contract may be a good solution. But do check first with HR because there may be legal obstacles (see Table 2.4).

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TABLE 2.3 Examples of career perspectives steps for PhD candidates at the University of Groningen

Prepare for your career as PhD graduate		
Before	PrePhD program to write your own PhD project	
Year 1	Intro to graduate school	
Year 1	Career awareness program	
	Inside academia	**Outside academia**
Year 2	Intro to academic career	Intro to other careers
Year 2	CV and meet scientists	CV and meet alumni
Year 3	Write personal development plan	
Year 3	Academic skills	Other skills
Year 4	Networking and visits	Matchmaking and internships
Year 4	Write grant/job applications	Write job applications
After	Job in academia	Job outside academia

Note: PhD candidates can follow both tracks inside and outside academia to develop their plan A and plan B.

TABLE 2.4 Example of some mandatory HR processes during closing of a project

Close project	
1	Write recommendation letters
2	End of contract issues (unemployment, email access, etc.)
3	Archive relevant material (data, software, etc.)
4	Agree on finishing unfinished business (articles, etc.)
5	Check out
6	Keep in touch

Note: Color indicates who is primarily responsible: you (black) or HR officer (gray).

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A YOUNG TEAM LEADER'S ANECDOTE

Paying a high price for a high-impact paper

I obtained a major grant that allowed me to recruit a postdoc for four years. Among the many candidates, a smart young PhD candidate stood out. She was pretty close to finishing her thesis and proactively preparing for her next career step. A phone call with her thesis supervisor, a renowned scientist, confirmed that the PhD work was almost done and that the final version of her thesis would be submitted and approved soon, certainly before she would start working with me. Everything seemed under control, so we signed a postdoc contract. Then we had a wonderful time working together … ahhh, quite the contrary.

The thesis supervisor wanted her to publish the final part of her thesis in a high-impact journal. And he decided to postpone approval of her thesis until this manuscript was accepted. This required a lot of extra work for her, and she was, by then, my postdoc. This was very stressful for her and very annoying for me and my project. It's practically impossible to have two major jobs to do at the same time. It was almost time for her to look for her next position when she finally graduated with her PhD. We were both unhappy with the lack of success in my project.

I learned my lesson: never again will I hire anyone who hasn't clearly rounded off their previous job obligations.

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TRY THIS!

You are part of a large organization, and this assignment challenges you to get to know your organization better in two ways. First, what are the explicit HR rules and processes for you and your team members to adhere to? Second, what are the hidden or implicit HR rules and processes that have shaped your organization and how it behaves now? Check the university internet or intranet for relevant documents, and consult your HR officer to discuss whether you have understood the rules and processes well in all the following assignments.

Find out more about local HR rules and processes for appointing a PhD candidate or postdoc

- How many recommendation letters are required?
- How many staff should be involved in short listing candidates, and how should this be arranged (e.g., independent scoring based on well-defined criteria and electronically stored). Is this followed by a discussion of discrepancies in a panel meeting?
- What is the composition of the interview panel for a PhD or postdoc vacancy? Is one member from a different institute or faculty? Is there at least one male and one female panel member? Are there any other guidelines?
- How long is the probation period for a new position? What steps do you need to take before you can decide on a no-go at the end of a probation period?

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Find out more about local HR rules and processes for appointing a research assistant or support staff

- What are the redeployment rules? Can only internal candidates apply, or should they have priority?

Find out more about local HR rules and processes during the life course of a project

- Evaluation interviews: what forms, instructions, and training courses are available?
- Underperforming team member: what documents are there outlining the rights and obligations of the team member and team leader? What steps need to be taken, and who should be involved in the evaluation process?

Find out more about training courses offered by HR

- Leadership-development assessments or courses you can take yourself. Role plays can be very instrumental to spot your areas for improvement, especially if you can see yourself on video.
- Skills and career perspectives courses for your team members.
- Mentoring, coaching, and counseling for you and/or your team members. How can you arrange this and in what instances (e.g., can you arrange a mentor when you become a team leader, and are there counselors to help solve conflicts)?

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Find out more about your organization's mission and vision and other HR and HR-related policies that may affect your research

- Discuss general data protection regulations (GDPRs): how should individuals' personal data be managed and processed? What are the penalties for breaches?
- Check for policies on diversity, equality, and inclusion. Check texts, photos, and videos on your team website and your university's website: what can you conclude about the effectiveness of policies on the information they give?
- What measures are in place to foster cross-disciplinary work? What would it take to move your group from one institute/faculty to another (if this would benefit your team's research)?

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2.3

Financial Affairs

You, as project leader, write a project plan and specify the personnel, equipment, travel, potential publications or patents, and other items needed to successfully achieve your project's scientific aims and impact. You are held fully responsible for all expenses during the project and especially for not having a negative financial balance at the end of it. You might spend large amounts during your project, at a level much higher than your normal domestic budget, so you may be anxious about being responsible for so much money. The financial officers, project controllers, funding officers, and purchasers at your institute, faculty, or university are the experts to consult for advice and support on direct and indirect costs, the timing of payments, the purchase of goods, liquidity planning, and any other financial matters (see Table 2.5).

Project preparation

Your financial officers will help you calculate the personnel, overhead, and other costs. The project budget shows the total cost and a breakdown into specific items. The financial officers also interpret the funding agency's formal guidelines and can:

- Explain the funding agency's rules on direct and indirect costs and advise you on which costs are eligible to pay from your grant.

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TABLE 2.5 Costs that can be directly or indirectly linked to your project

Direct costs	
New personnel	PhD candidate, postdoc
Other personnel	PI (you) and a permanent technician
Travel, hotel, subsistence allowance	In line with usual practices of your university
Goods, services	Lab consumables, supplies, computers
Equipment, small infrastructure, assets	Depreciation, rental, lease, in-kind, paid
Large infrastructure	Operating costs
Dissemination	Editing costs or charges for Open Access publication
Intellectual property protection	Trademarks, registrations, patents
Indirect costs	
Personnel	Replacement for pregnancy leave, extended sick leave
Unemployment	PhD, postdoc still searching for next job; the university may be charged for Social Security allowances
Housing	Office space, organization's desk charges, lab space
Overhead	President and council, administration, PR, teaching services, libraries, etc. "facilities and administration" [F&A]

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- Advise you of any costs made before the project starts; such costs will generally not be reimbursed, unless allowed for explicitly in the guidelines.
- Inform you about procurement rules (i.e., when you or your organization can buy goods only via an open-tender procedure so that any external party can make a bid). This often includes the buying of standard materials such as lab consumables or any large-scale supplies you use.
- Help you to obtain quotes from different independent parties for major goods or services you need to buy or lease. You will need to ensure that you get the best value for money. They can help you avoid conflicts of interest and stick to the procurement rules (e.g., not buying goods from a former colleague who is now in business unless you can prove with several quotes that you really got the best value).
- Inform you about local seed money for doing exploratory or pilot studies, making short visits to experts to acquire new knowledge needed in the project, getting strategic and editorial support for writing a professional grant application, etc.
- As a rule of thumb, PhD students are somewhat cheaper to employ than postdocs on an annual basis but not necessarily on an output per euro or dollar basis. And for PhD candidates, you will need to budget for a contract of three or four years. Postdocs are often recruited for one or two years (see Table 2.6).

  Universities may receive a substantial financial bonus for training PhD candidates, with a sustainable financial model requiring a university to have 100 PhD graduations per year or more. Indirectly you will benefit, and in some universities your group may even receive a direct share of the PhD bonus (e.g., $5,000 per thesis. Postdocs have more possibilities to find their own funding or a personal grant, so the financial benefit for your group can be large (i.e., on the order of $100,000 or more, unless the postdoc then chooses to move elsewhere with the grant).

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TABLE 2.6 Examples of some mandatory financial processes for getting internal approval to start your project

Start granted project	
1	Share formal award letter or signed contract
2	Inform about changes (e.g., delays)
3	Check whether funds are sufficient (e.g., given delays)
4	Cover shortfalls in budget from other resources
5	Open project account
6	Authorize HR to advertise open positions

Note: Color indicates who is primarily responsible: you (black shading) or financial officer (gray shading).

During your project's lifetime

You are responsible for the financial flow during the course of the project. Luckily, the financial officers will do lots of the budgetary work for you. For instance, they may:

- Open an account for managing the finances for your project.
- Instruct you on how to archive all invoices, payroll transactions, or other documents that prove your expenditures.
- Instruct you on how to complete timesheets that prove when and how much time has been spent on the project by you and/or your team members.
- Communicate with the funding agency and book the prefinance, interim, and final payments on your account.
- Pay your project's bills from this account after formal (signed) approval by you and by the project controller who safeguards (stores) the bills and checks their eligibility against the project's guidelines.

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- Monitor the expenditure and inform you about timing or if you are spending too little or too much. For example, do not buy a new computer or expensive equipment close to the end of the project because with depreciation over several years, the agency may only partly refund the purchase cost. Often you cannot submit any costs after the project ends; these will not be reimbursed unless explicitly allowed for in the project's contract.
- Prepare the financial paragraphs in interim reports that you (or they) are required to submit to the funding agency.
- Inform you on a regular basis about the financial state of your startup package (if you had one) and of your other projects. They may also inform you about any annual or other financial support given by your institute (e.g., a standard travel budget, bonus for teaching a class, royalties from intellectual property). You will need to have a good overview of your money flow (in and out) and the total balance at all times.
- Charge the legitimate absence of team members to accounts other than the project account, thereby preventing your project from burning up money without making progress, e.g., during parental leave or extended illness or time out to take care of relatives. Unfortunately, some countries still don't have decent maternity, paternity, or care leave (see Table 2.7).

It is likely that you will want or need to make changes to your project plan. Perhaps the field has moved on since you wrote the grant proposal, new technologies have arrived, costs for certain items have changed, or you simply discovered better ways to achieve your overall aim – research projects are to a certain extent unpredictable and therefore funding agencies are generally open to you making changes to the original plan. Thus, they are also open to changes in the budget. Although it is very unlikely that the budget will be increased, you are often

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TABLE 2.7 Examples of some mandatory financial processes while running and closing the project

Run project	
1	Archive proofs of all financial transactions
2	Fill out timesheets
3	Report changes (e.g., intention of project extension)
4	Rebook major absence costs (e.g., parental leave)
5	Monitor expenditure against budget and advise/alert
6	Submit financial reports and invoices to funding agency
Close project	
1	Prepare final financial statement
2	Confirm all costs on final financial statement
3	Submit final financial statement to funding agency
4	Resolve residual balance issues (shortage or surplus)
5	Close project once final payments received
6	Assist financial (external) auditors
7	Answer queries from auditors and funding agency

Note: Color indicates who is primarily responsible: you (black shading), financial officer (gray shading), or both of you (white shading).

permitted to move money within or sometimes even between cost categories – but do first ask the funding agency for formal permission.

It goes without saying that you should use your funding wisely and efficiently. The funding agency may be paying hotel and travel expenses for visits to other labs or to conferences, but do not claim anything related to a subsequent holiday. Separate your business expenses from personal ones. Unethical use of any research funding can lead to trouble.

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Raising Additional Money

Although the contract with the funding agency has been signed and the project budget has been accepted, there may still be ways to "gain" some extra money:

- If you buy essential equipment that will be used only part time or for less than the depreciation time, then the costs may be only partly covered by the funding agency. But you can offer use of such equipment to other parties for payment.
- Project results can be protected and licensed or sold to other parties, with the permission of the funding agency. This can generate a one-time or continuous cash flow, e.g., from royalties (see Section 2.5 for several examples from the humanities to the exact sciences). Any royalties should, of course, be paid into your research account because they arise from your work (but check your university's rules about sharing revenue). In fact, even your articles and books are protected by copyright and licensed to the publishers, who may pay you royalties for books or chapters you have written (see Section 3.2).
- You can apply to other agencies for small grants to arrange workshops, or you can stimulate your team members to apply for their own travel stipends. This can save some project money that you may be allowed to spend on other activities. You should also put team members forward for prizes, which can include an amount that will cover a conference visit as well as looking good on their CV.
- If your salary is covered in part or completely by the grant, then you are saving your university money if you were already paid by them, say as a tenure-track assistant professor. You should try to negotiate your share of the money saved and keep it in a separate account from the grant so that you can spend it freely, even after the grant period has finished.

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- Funding agencies often allow those who are awarded a major personal grant to transfer it to another institution where the conditions are more favorable, in terms of facilities, presence of top peers, or better financial support through a substantial startup budget. Once you have a major grant, other universities may compete for you or try to seduce you by offering you more attractive (financial) conditions than your existing institution. Such offers can be used to bargain with your home institution to gain yourself more financial support. It's a reality check for the ambitious. But your current and potential future employers may see your lack of loyalty as a negative.

Financial barriers

Finances also bring various risks. A grant may cover the direct costs for a PhD candidate but not the overhead costs; the funding agency can simply argue that these overhead costs (e.g., the salaries of administrative staff or the cost of office space) would have existed without your project. But your institute may charge these overheads to you, and consequently your project funding will be depleted more quickly than you imagined. A grant may also cover the direct costs for a PhD candidate for two years only. You may need to apply for another grant to be able to complete your project.

Finances can create barriers between different institutes if they are each financially independent entities, making cross-disciplinary collaboration more difficult. If your government were to pay a bonus per graduated PhD candidate, who would be given the bonus: the university, your faculty, your institute, or perhaps your own research group? Such bonuses can be substantial and should be negotiated at the start of a new PhD project. Cross-disciplinary collaboration may also prove problematic if the funding agency only pays for PhD candidates and postdocs and not permanent staff (after all, they are already paid by the university). If a permanent staff member

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of one institute spends time (e.g., as a supervisor) on a project that is formally managed by another institute at the same university, the personnel costs may be passed on to that institute. While the project is neutral at the aggregate level of the university (the university pays the supervisors), one institute will now have funding in hand, while the other has a financial deficit. Such short-term win-lose situations may frustrate collaboration between different institutes or faculties and can lead to a lose-lose situation, with fewer grant proposals for cross-disciplinary projects being initiated and the university as a whole obtaining less funding than in a win-win situation. You are leading your team in your organization and must negotiate the best conditions for your team *and* for your university. See the end of Section 1.5 for the negotiation steps.

Financial value

Who are the users and end users of the results arising from your project? Why do they need or want your results? These are essential questions to ask yourself before, during, and after the project. Step into the shoes of the users and end users and try to estimate the financial value of your results for them. Should you still share your results for free, or should you opt for payment? If you do a consultancy project for a commercial company, should only your hours be charged or should you claim a share of the revenues generated from using your input? Perhaps you wrote some software: can you sell it to multiple parties and generate a stream of income so that you can hire someone to maintain the software and hardware, support users and end users, and further develop the software (which can be in the interests of all the purchasers)? Consider the need for further agreements (Section 2.4) and/or protecting commercial interests (Section 2.5). See also the following anecdote.

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A POSTDOC'S ANECDOTE

Champagne, but not for me

A startup company is located on the same campus as my office. The company does pretty cool things. One day I met one of the directors, and we talked about a bottleneck in their new technology. I thought I could potentially write some software to solve the issue, and I was happy and proud to receive an offer to work with them – my hours would be paid to the university on the basis of a simple consultancy contract that was quickly signed. And yes, with just 10 hours of work, I solved their problem. My five years of building up specialized knowledge on so-called linear finite mixture models and my experience in implementing these models in software were exactly what the company needed. This was the breakthrough the startup needed to move on to marketing its technology vigorously. The director told me how happy the company was and showed me the champagne bottles the staff had emptied to celebrate this milestone. While being proud of my work, I started to realize how naive my director and I had been: no champagne for us, only a small payment to cover my 10 hours of work, and no share of the huge revenues the company was now generating. On top of this, the company imposed a ban on my publishing the ideas behind the breakthrough. This won't happen to me a second time.

TRY THIS!

You are responsible for your project's budgets and expenditures and don't want to risk problems here. But do you really know which expenses are eligible and which are not according to the rules and regulations of your university and of the specific

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agency funding your project? Find the correct answers to all the following questions (and consult your financial officer for assistance).

- **Champagne.** You celebrate the project's newest and great publication with one or two bottles of champagne. But who should pay for this: you, the funding agency, or your university? How about the food and drinks served at your Friday afternoon cocktail sessions or at a group retreat?
- **Booking a flight and hotel.** Your team member is going to a conference abroad, which has been specified in the project plan and budget. You can simply book the flight and hotel yourself? Or do you need to follow a formal authorization procedure and/or use a particular travel agency to ensure that the costs are refunded? Can you charge any daily subsistence costs (e.g., meals, taxis, hotel, etc.) or only up to a certain limit? For example, would a first-class train ticket be covered or a business-class flight?
- **Buying a laptop.** You want to buy a new laptop for your team member at a supplier who has a special offer. Can you just go ahead and order it? Find out what the purchasing rules are at your university. And are there procurement rules?
- **Buying expensive equipment.** Your project is moving forward successfully, and after two of its four years' duration, you have the material ready for further analysis, for which you now need equipment that will cost $50,000. Will the funding agency still cover these costs completely? Its depreciation time might be four years, so will you then end up with a financial deficit of $25,000?
- **Printing posters, editing and publishing papers, filing patents.** Posters and open-access papers are standard output from your project, and they can cost you a lot of money to produce. Can you charge them to your project? What about all the costs associated with protecting your intellectual property (IP) by filing for a patent?

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- **Overtime.** Your group member works 60 hours a week. Can you charge all his or her hours to the project? What happens if the labor contract between the university and the individual states only 40 hours a week?
- **Work-related hours.** Can you charge the time you spent in preparing the project (before its official start)? Can you charge to the project grant the time spent in preparing meetings, for visiting a general rather than specific scientific conference, for traveling, for work phone calls taken during traveling, and for weekends when certain experiments needed to be monitored or executed?
- **Two or more projects.** If a group member works on two or more projects, do you have to fill out timesheets, and if so, to what level of detail (time units), how frequently should they be checked and signed off – and by whom?
- **Changing internal policies.** What happens if the university changes its internal rates for indirect or direct costs during the course of your project? If this leads to a deficit, who will cover it?
- **Changing currencies.** Your project budget was calculated and approved for one or more years on the basis of estimated costs. But what should you do in the following cases: unfortunately, you now need to buy goods that have become much more expensive due to a less favorable exchange rate. Or what if your grant amount suffers from changes in the exchange rate because your funding agency is based in another country?

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2.4

Legal Affairs

If you work with people, you may simply trust their blue eyes or friendly face and work and share your bright ideas and much more with them. And it may all go pretty well. But, just as in a marriage, a signed agreement may be needed when things don't work out well. Because you are probably working with different people and organizations, you will soon have a range of different agreements (Figure 2.1 and Table 2.8).

Preparing for agreements is work for specialist legal affairs officers, who will guide you through the steps from advance notice to the final signing of the agreement (Table 2.9).

A common element in all these agreements is confidentiality and the ownership of existing and new intellectual property (IP; see Box 2.3). What are the implications for you and all the people you work with?

1. **You and the university.** The most important work-related agreement you have signed is the "labor agreement" between you and your employer, the university: your "job contract." It describes the rights and obligations of the employee and employer. It's a right (and a privilege) to enjoy academic freedom to work on your own ideas and benefit from the buildings, laboratories, information technology (IT) infrastructure, peer interaction, support staff, students, management, and the university's branding and reputation. However, you also have an obligation to properly protect the rights associated with your ideas in the interests of your university: you must first keep new ideas and other valuable

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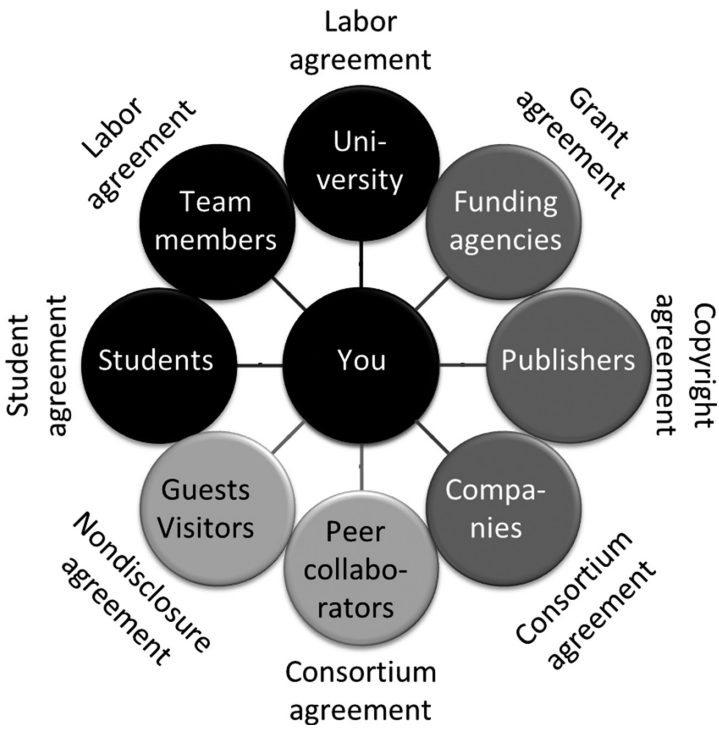

FIGURE 2.1 Examples of the different parties you work with and the types of agreements needed to clarify intentions, expectations, rights and obligations: university-based partners (black), peer-based partners (light gray), and third parties (gray)

information confidential and impress this on your whole team; second, inform and report to the relevant offices; and third, transfer your IP rights to the university. Read your labor agreement carefully to see what else you have signed up for! What if you are also a visiting fellow or honorary professor at another university or if you have two or more part-time jobs at different universities or at a university and a commercial company? Your ideas may result from the synergy between any two environments, which may have set out different obligations, procedures to adhere to, and rules to comply with. Ideally, the two parties should have settled these details in advance by drawing up a supplement to your two labor agreements.

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TABLE 2.8 An overview of different types of agreements and the clauses they contain

Generic clauses	
Parties to the agreement	Be crystal clear about who is involved and who is not.
Duration	When the agreement starts and when it ends.
Law	The country whose laws apply to the agreement.
Noncompliance to the agreement	Administrative and financial penalties.
Disbanding agreement	Circumstances under which the agreement can be disbanded.
Confidentiality or nondisclosure agreement (NDA)	
The type of information to be held confidential	This can cover almost anything. Describe the information as completely, accurately, and precisely as possible.
Permissible disclosure of confidential information by receiver	E.g., if the same or similar information becomes lawfully available through other sources or via public channels.
Use of confidential information by the receiver	Be explicit about what the receiver can use and how, when, and for how long.
Rigor of protecting confidentiality	Who needs and can receive the information? Should all parties sign the NDA? How should this information be stored?

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Grant agreement (includes all of the above)	
Research plan	Full description of the work, timeline, and anticipated results.
Exploitation plan	Protecting intellectual property (IP); funding agency has a right to object to transfers or licensing to other parties.
Dissemination plan	Are publications and data to be open access? Will there be a time lag in submission of papers so that IP can be protected?
Monitoring progress	Send scientific and financial reports, inform funding body about any circumstances affecting agreement.
Financial compensation	Defines eligible costs, reimbursement rates, payment schedule; rules for purchasing goods, works, or services.
Portability of grant	What happens if you change institutions?
Crediting the funding agency	Precise description of how and when to credit the agency.
Consortium agreement (includes all of the above)	
Division of work	Roles and tasks of parties described as carefully as possible.
Preexisting IP	List of IP that will be made available to the consortium or not.
New (joint) IP	Outline the ownership and access rights. If appropriate, delay publication to protect IP registration.
Governance	Management bodies, their responsibilities and voting rules; how to settle disputes.

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Community	How and when to communicate and meet up; what information, forms, and documents need to be submitted and when.
Finances	Division, timing, and distribution of funding.
Letter of intent, memorandum of understanding (MoU)	
Shared interests	All parties have explicitly stated an interest in preparing for or performing a joint activity.
Continuation or disbandment	A statement outlining the circumstances that would lead to either action.

Note: All agreements start with a number of generic clauses. Confidentiality agreements go on to describe how to treat valuable information. Grant agreements describe what the funding agency offers you and expects from you in return. These typically include confidentiality clauses. Consortium agreements describe how different parties are to work together, e.g., if you are working with peers from other universities on a shared goal (often funded by a grant where one party is the coordinator or principal and other parties are the coworkers).

2. **You and the funding agency.** The funding agency is investing in you and your work. It will specify how it wants you to deliver a return on its investment. The agency may want to know your plan for protecting and/or exploiting your IP, so it will want to have a full and clear statement on the IP made available to the project (preexisting IP) versus that generated during the project (new IP). The agency may also want to be co-owner of and/or have a share in potential revenues and/or have the right to object to certain exploitation (e.g., licensing your results exclusively to one party).

   We're all used to keeping our research ideas confidential to a certain extent so that we don't compromise our future publications. Sharing a bright idea too early and openly at a conference may allow one of your competitors to legitimately embrace it and perhaps even scoop you by publishing

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TABLE 2.9 Examples of mandatory processes for getting a project agreement signed by funding body

Prepare contract	
1	Provide advance notice.
2	Provide contract details (funding body, parties, IP, etc.).
3	Internal bodies approve (finance department, etc.).
4	Assess parties (legal, financial, ethical issues, etc.).
5	Advise on contract requirements.
6	Draft contract or comment on draft contract received.
7	Negotiate and revise contract.
Sign contract	
1	Legal representative approves (e.g., dean, president).
2	Parties sign supplements (e.g., host agreement).
3	University's legal representative signs.
4	Complete and submit signed documents.
5	Funding body signs.

Note: Color indicates who is primarily responsible: you (black shading) or legal officer (gray shading).

BOX 2.3 Intellectual property (IP)

IP includes know-how, ideas, concepts, inventions, improvements, products, texts, photos, images, videos, music, other artwork, software, databases, access rights, trade or funding secrets, other confidential information, and so on, and it may be protected by copyright, trademark, or patent.

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a paper before you can; ideas are free and cannot be protected. But this is a tricky situation because discussing your ideas with colleagues helps you to better work out the details and allows feedback to be given on your ideas. Sharing any details, even a minor one, may render the opportunities for patenting the results originating from your bright idea invalid. It would be too bad to lose publications and patents because of not thinking ahead or preparing (see Section 2.5 for more on patents).

No matter how strongly you believe in or are pressured toward transparency, open research, open data, and open access, issues of confidentiality often remain pivotal and are necessary for publication, as well as legal, commercial, medical, or ethical reasons (such as protecting the privacy of human beings) or to address public concerns (e.g., hazardous biomaterials that can be made into weapons). You should also note that unpublished data, draft project proposals, review reports of papers and proposals, evaluation reports of your group's performance, strategy documents of your group, department, or university, and the names and letters of job applicants should all be considered to be confidential.

The fact that you and your university have signed a labor agreement (a public services contract) and the grant agreement with your funding agency is not the end of the matter. There are more people involved in your research.

3. **You and your team members.** You have recruited group members for one or more projects. If they are employees like you, they will have also signed a job contract. Your team may be running several projects in parallel, and researchers from one project will learn about the progress on other projects during group meetings and when they review each other's draft manuscripts, etc. It may be hard for them to see where and when confidentiality is crucial for their own project, let alone for other projects in which they are not formally involved. Did you share the IP section from the project agreement and

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discuss it with the whole team? Did you discuss the intent and implications of the IP section of the job contract? It is up to you, as team leader, to raise their awareness and educate them about such issues, not just once but continually.

4. **You and your students.** They will act like a group member for several weeks or months, perform degree or Bachelor's or Master's thesis projects in your group, and join group meetings where the progress of other people's research projects is discussed. Students have rules to stick to, and they probably know these (it's worth checking), but they may not be aware of the specifics. So be clear about confidentiality and ownership and discuss these issues when they join your group. Help them to prepare their reports and presentations, and instruct them about the issues of confidentiality when they meet external people or even when presenting a poster or speaking at external events. Show them the university's policy documents for students, which they must obey. Some students will stay with you for an internship, e.g., during the summer holidays, while they are officially studying at another university, perhaps with different rules from yours. Get them to sign the appropriate (student) confidentiality or nondisclosure agreements.

5. **You and your guests/visitors.** What should be treated as confidential may be even less clear to colleagues from outside your group who join a group or departmental meeting. They may simply get excited about some of your ideas and use or share them elsewhere, perhaps instantly on Twitter or other social media. Scientists from other universities may also visit your group. They may be young and inexperienced or senior and highly esteemed. They may stay for only a day, a week, or several months. Whatever they learn, they can also take away. Be aware of what you and your group members want to share, especially with peers who have no contract and therefore no obligations, unlike you and your group members who have these defined in job contracts and supplements. If needed, ask guests to sign a confidentiality or nondisclosure agreement when they arrive.

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6. **You and your peer/company collaborators.** Your team may collaborate with scientists from several universities and/or companies on projects funded by one or more different agencies. Your ideas meet with other people's ideas, and new ideas pop up from the synergy. Project or consortium agreements spell out who brings in what by way of confidential IP (pre-existing IP) and who owns the new ideas (new IP). Learn to read and negotiate project or consortium agreements when leading or coworking on projects.

7. **You and your publishers.** Scientific journals or publishers will specify the conditions that apply to you as the author of an article and to the people who want to access your paper or book. These conditions define the level of openness of your article, and you should review them carefully before submission of the manuscript. Such conditions can be agreed on as a license between you and the journal/publisher. But do check your freedom of operation: your employer or funding agency may accept certain licenses (e.g., a green model for open access; see Section 3.2) but reject others (articles being made available for a fee). Scientific publishers may claim exclusive rights to the final versions of your articles/books (printed or PDF) or full ownership of them. They will receive revenues from selling these and may offer royalties for book sales. Read more about license models in Section 3.2.

Obligation to report ideas

Any creative work, ranging from an outline of your initial idea to any concrete outcome from that idea, should be properly protected by a copyright, trademark, and/or patent (see Section 2.5). You are obliged to report such work to the relevant university offices as soon as you are "reasonably able to conclude that there is a question of such a creative work."[1] They will then assess the nature of your idea or work and may plan,

[1] Collective Labour Agreement Dutch Universities; see "Further Reading."

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or ask you to plan, further action. For some creative work, the action required is pretty standard (e.g., specify your name and your affiliation correctly on the article, book, or other publication so that you are credited as the creator/author and thereby also raise your university's standing (which is good for you too). Other types of creative work may require more customized action. Perhaps your software can be distributed under license either freely or for a fee, which could be a source of funding for maintenance, user support, or further development. Brand names, domain names, or logos you create can be registered or given a trademark (but this should comply with your university's policy). Last but not least, knowledge and technology transfer officers scout for patent opportunities (as a welcome sources of extra funding), and you should inform and involve them at an early stage. A patent application must mention your affiliation (patents count in university rankings just as normal publications do). But because there are investments and returns involved, there is more to agree on than simply who owns the IP (see Section 2.5).

Transfer of rights

You may see yourself as an entrepreneur developing your own scientific business and thus deserving all the credit and revenues. In reality, you are more like a franchisee within a host university, and the costs of the holding are huge (way more than your salary and the facilities you use). This warrants a transfer of IP rights in whole or in part from the employee to the employer. You will still be identified as the creator or inventor (this is a moral right), and revenues may be divided between you and the university. Typically, the university will first be compensated for the application/registration, maintenance, and protection of IP (e.g., by a patent), and the remaining revenues may be distributed to the inventors (including students), research groups, faculty, and university (e.g., 25 percent for each). Funding agencies and any third parties involved may claim a share, too.

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You can reclaim the transferred IP right if the university does not want to make use of it within a reasonable period of time. In this case, you and/or your research group will make the registration and be compensated first for the protection of your IP, while the remaining revenues may be divided between the inventors, research group, faculty, and university using your university's standard distribution model.

Always be clear about confidentiality

Add a very clear "Confidential" or even "Strictly Confidential" watermark to documents (reports, PowerPoints, emails, etc.), or put this in headers or footers (see the email disclaimer in Section 3.5). You can also say that something should be treated as confidential, but such an oral statement should be followed by a written statement within one or two weeks for your message to be legally valid. Saying something is "Confidential" suggests that the information should, at the very least, not go public, but who may actually see and/or use it (inner circle) and who may not (outer circle) remains unclear. "Strictly Confidential" may suggest that information is meant only for you (i.e., only the sender and recipient are in the inner circle), but without further clarification, the recipients may still make their own interpretation. So be very clear what you mean, and inform others appropriately.

Copyright

Copyright protects your written work but *not* the idea expressed in the text. The same is true for photos, videos, and software. Copyright protects your work in two ways:

- You are the only one allowed to publish, share, or reproduce the work (you have an exclusive right to exploit it).
- Should you license other people (e.g., a scientific publisher) to exploit your work, then they (e.g., the publisher and their

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readership) should credit you properly, and they cannot change the work in any way that would damage your reputation (you have moral rights; they have moral obligations).

The copyright claim "made by you" holds only if the work is not trivial and not derived from someone else's work. It should clearly show signs of your intellect, your creativity, or your personal touch. What do you need to do to obtain a copyright in your work? The answer is simple: you only need to indicate your copyright by adding a copyright symbol (©) whenever you think it is appropriate, or "© [your name here]" to mark yourself as the author, or "© [your name and date]" to mark the date you started work on the item. But you do not actually have to add anything because the copyright claim does not depend on the symbol but on you being the "author" of the work.

In the scientific literature, people are allowed to copy (quote or paraphrase) short fragments from your text in their own texts, provided that they credit you properly and reference the original source. Larger fragments, figures, tables, images, photos, or artwork can only be reproduced with your or your publisher's explicit permission, with proper credit given to you and possibly for a fee. Copyright also applies to anything that you put on your website or blog: no one can reuse the content without your permission, but with your consent you, and the source should always be properly acknowledged. In contrast, people are free to add a link to any information on your website because the link is considered an appropriate credit mechanism. You can protest against unsolicited use of your content by accusing people of "plagiarism." This includes content in all the versions of your unpublished articles and project proposals, which fall under the confidentiality of the evaluation procedure; this content is your IP and cannot be shared by anyone (not even by a colleague) with someone else who is outside the confidential procedure of your university and/or at the funding agency.

Trademarks

Brand names, domain names, or logos you create for your products or services can be registered or given a trademark. One can mark almost any name, sound, or appearance under a trademark (annotated by TM for concrete products, etc.) or a servicemark (annotated by SM for services used in the United States and several other countries), but potential confusion with existing trademarks has to be ruled out. Two names may be spelled differently, while the appearance (e.g., font or color) or sound may be considered too similar to an existing item. After official registration, you can use ® as the symbol to indicate your IP. You will need to pay the maintenance fee to the Trademark Office to keep the trademark valid. No one else in your field can capitalize on your success by introducing a similar name in writing, sound, or appearance.

Most names used in science are not registered as trademarks. You simply devise a catchy acronym for your method, tool, or project and put it on your funding proposal or in the title of your article. Unless reviewers complain, the name will then appear in the list of funded projects and published articles. You cannot expect reviewers to do a proper check of registrations or trademarks to see whether the name you chose will cause a problem (e.g., because "ParallelX" appears to be trademarked and you receive a letter from a lawyer with instructions to stop using "Xparallel" as the name for your method because it is too similar). Too bad if you have to change the name after your paper has been published.

In the case of licensing or selling a patented invention to another party, trademark choice and protection are their business. They may want to give your invention a name and maybe even a logo; having a name and logo can help to advertise the product.

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A YOUNG TEAM LEADER'S ANECDOTE

The $1 million bonus project

I knew people from the research and development (R&D) department of a leading multinational corporation whom I had met at a select Gordon Research Conference. They liked my work, and we started a small project together, which they later offered to scale up. They suggested a long-term collaboration and would fund a group of four people to work with me on their challenges. We agreed on permission for me to publish, a promise to patent our results, and to protect the company's efforts from competitors, I was not allowed to work for their main competitor. This was an offer I could hardly refuse. But I realized that I was capitalizing on the innovative outcomes of my PhD and postdoc projects. Would this large-scale collaboration really allow me to develop and innovate to a level that I would remain a partner interesting to the company in the future? I shared my concerns with them and suggested I needed an extra $1 million of free money for just this purpose, which would ultimately benefit both parties. They agreed!

TRY THIS!

Discuss with your team

- **Job contracts.** Put the contract on the table, and discuss the sections on rights and obligations relating to IP.

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- **Student and visitor agreements.** Check with the legal affairs department whether they offer such agreements, and discuss the sections on rights and obligations with your team.
- **Grant agreements.** Your team is working on one or more funded projects. Discuss *all* the sections of these agreements, one by one, and agree on their implications for your daily work.
- **Existing IP.** Make a list of all your proprietary IP (ideas, knowledge, tools, materials, software, and so on), and estimate its commercial value.
- **Confidential information.** What confidential information about your research would you be willing to present at your next meeting? Check for meeting policies. For example, the Gordon Research Conferences (GRCs) maintain a "no publication policy" (www.grc.org/about/grc-policies-and-legal-disclaimers/) to promote discussions and the free exchange of ideas at the research frontier. Read their clause carefully, and explain your decisions.

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2.5 Patent Affairs

The public, through their taxes, pays your salary and funds your project and expects that your ideas and inventions will sooner or later benefit humankind. In return, you should do whatever is reasonable to achieve this sooner rather than later. Some inventions can be applied right away; others aren't ready and need to be further developed by you or by other parties. Such further development and subsequent marketing of the "product" may require huge investments, in which case the filing of a "patent without any prior release of information about your idea" is almost always the way to proceed. Once you can show a proof of concept, patenting opens the way for companies to invest in your product, and this can be the quickest, best, and often only path toward achieving real benefits for humankind.

You can patent technical and process inventions of different types, for example:

- A computer program
- A mathematical algorithm
- A new therapeutic indication or target
- A specific process or route to produce a compound.

Patenting is necessary unless you are absolutely sure that no one can reinvent your innovation (e.g., the recipe for Coca Cola) or because reinventing would be too costly (e.g., completely

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rewriting extensive software to bypass the copyright on your text).

If granted, a patent will provide you with the necessary protection for your innovation for a maximum of 20 years. This means that in this period you are the only one who can use the invention and that no one else can (commercially) exploit it without your consent. With such protection and your consent, other parties may be willing to work with you and invest in developing your concept into a marketable product. As outlined in the preceding section, you should note that you may be obliged to report your concept to officers in your university as soon as you are "reasonably able to conclude that there is a question of such a creative work." In other words, you may be in trouble if you decide (for whatever reason) that you do not want to consider submitting a patent application, for example, because you think it will prevent you from publishing a scientific article in a high-visibility journal, while the university's patent officer may conclude that you have spoiled the university's opportunity of earning a major amount of money. Equally, the agency funding your project or your partners on collaborative projects might sue you for infringement of the contracts you have signed with them.

What exactly is a patent?

A "patent" is defined as the description of an innovative solution to an existing problem. The patent application describes:

- The problem
- The state of the art in the field
- Your solution to the problem
- Why your solution to the problem is innovative
- Examples of your finding to support commercial applicability
- Exactly what you want to protect, i.e., the "claims" marking out the limits of the invention

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- A detailed benchmark to existing products or processes to define the technical or other differences.

Legally, the patent provides the inventor with "exclusive rights" granted by a sovereign state for a "limited period of time" in exchange for detailed public disclosure of an invention. "Exclusive" means that it forbids others to perform commercial activities that fall under the patent. "Rights" means that you can commercialize the invention, e.g., sell products based on the patent or sell licenses for its use. If your patent is built on top of one or more other patents, you will first need to obtain licenses to make use of these inventions if the other patents are held by someone else.

When can you apply for a patent for an innovation?

There are three strict conditions:

1. **It should be new.** The field's state of the art on the "priority date," the day of filing your first patent application for the invention, is what counts. Neither you nor anyone else should ever have shown your invention to someone else or talked about it anywhere (not at a conference or your normal group meeting when external guests were present), nor have you ever published it (not even in a conference abstract, press clipping, blog, or email to an external colleague) before the priority date. If you have to show your idea to people (e.g., to raise funds), then you must make sure that all those present have first signed a confidentiality agreement. New is not the same as innovative.
2. **It should be innovative.** No one with a general knowledge of the field of the invention (i.e., who is supposed to know the state of the art in the field and its literature up to the day of you filing your patent application) should be able to derive your technology or process in a straightforward manner given the field's current state; your invention must not be self-evident by any means. Surprising new combinations can be innovative

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and thus eligible for a patent. This aspect is called "novelty." New and innovative are not the same as applicable.

3. **It should be applicable.** Your concept for a product or for a process to produce a product should be concrete enough to be functionally, industrially, and commercially relevant. It may still be in a prototype phase, but a solid proof of concept is needed.

How a patent differs from a normal scientific article

A confidential draft of a future scientific article can form the basis on which a patent attorney can write the patent application (Table 2.10). However, there are some major differences:

- Patents have inventors, not authors, and all inventors must be named on the patent. Anyone else who helped incidentally ("a pair of hands") should not be listed on the patent. Any mistakes in who you name may have major consequences for the validity of the patent.
- You have to define matters exactly in a patent application (see Table 2.11). Your definitions must be precise and complete, whereas you can assume such definitions will be known by the readers of a scientific article.
- You can make claims that you have not yet proven; revisions to the text can be made up to one year after the priority date (see below).
- Claims should be substantial and expected to generate cash within two to three years because a patent application incurs a high fee.
- Every word written in the patent application can have judicial implications. It is therefore crucial to obtain the help of a patent specialist in writing a patent application.

Once your patent application has been filed (see below), you may submit your scientific article to a journal and start talking

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about your ideas at conferences, for example. Most commercial (project) partners will allow a delay of 6 to 12 months for a patent application to be made.

Filing a patent application

Most universities have a transfer and technology liaison (TTL) office with ties to external patent specialists. They will also help you predict the balance of costs (e.g., $100–$20,000 for the initial stage of application, $10,000 or more for final filing and maintaining, and more than $100,000 for defending the patent) and benefits (e.g., royalties; although net revenues over $100,000 per academic patent are rare, there are incidental

TABLE 2.10 What is written in a patent application?

	Patent	Equivalent in scientific article
1	Inventors	Authors
2	Priority date	Earliest claimable filing date (usually the submission date)
3	Technical field of invention	Field of research
4	Background of invention	Problem stated
5	Prior art	State of the art
6	Summary of invention	Summary of findings/results
7	Description of invention	Detailed description of, e.g., materials and methods
8	Claims	Accurate and detailed description of the scope and breadth of the findings/results/applicability

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TABLE 2.11 Patent texts can include many details that may seem irrelevant or trivial to a scientist but necessary to a patent specialist: (a) excerpt from the claims section of a patent on new statistical methods; (b) excerpt from the description of the invention in the same patent

(a) What is claimed	
Claim 3	The method of claim 2, wherein the plant is a species selected from the group consisting of: *Agrostis*, *Allium*, *Antirrhinum*, *Apium*, *Arabidopsis*, *Arachis*, *Asparagus*, *Atropa*, *Avena*, *Bambusa*, *Brassica*, *Bromus*, *Browaalia*, *Camellia*, *Cannabis*, *Capsicum*, *Cicer*, *Chenopodium*, *Chichorium*, *Citrus*, *Coffea*, *Coix*, *Cucumis*, *Curcubita*, *Cynodon*, *Dactylis*, *Datura*, *Daucus*, *Digitalis*, *Dioscorea*, *Elaeis*, *Eleusine*, *Festuca*, *Fragaria*, *Geranium*, *Glycine*, *Helianthus*, *Heterocallis*, *Hevea*, *Hordeum*, *Hyoscyanus*, *Ipomoea*, *Lactuca*, *Lens*, *Lilium*, *Linum*, *Lolium*, *Lotus*, *Lycopersicon*, *Majorana*, *Malus*, *Mangifera*, *Manihot*, *Medicago*, *Nemesia*, *Nicotiana*, *Onobrychis*, *Oryza*, *Panicum*, *Pelargonium*, *Pennisetum*, *Petunia*, *Pisum*, *Phaseolus*, *Phleum*, *Poa*, *Prunus*, *Ranunculus*, *Raphanus*, Ribes, *Ricinus*, *Rubus*, *Saccharum*, *Salpiglossis*, *Secale*, *Senecio*, *Setria*, *Sinapis*, *Soanum*, *Sorhum*, *Stenotaphrum*, *Theobroma*, *Trifolium*, *Trigonella*, *Triticum*, *Vicia*, *Vigna*, *Vitis*, Zea, the *Olyreae*, and the *Pharoideae*.
(b) Description of the invention	
Soft- and hardware	A set of instructions (embodied in one or more programs) encoding the statistical models of the invention is then executed by the computational device to identify correlations between phenotypic values and haplotypes. Typically, the integrated system also includes **a user input device, such as a keyboard, a mouse, a touchscreen**, or the like, for, e.g., selecting files, retrieving data, etc., and **an output device (e.g., a monitor, a printer, etc.)** for viewing or recovering the product of the statistical analysis.

Source: Beavis WD, Jansen RC. Patents PCT/US2000/034971, WO2001049104A2, WO2001049104A3, priority date 1999/12/30; available at https://patents.google.com/patent/WO2001049104A3/en.

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success stories of millions of dollars even in academia). Revenues may be assigned to the funding agency, your university or research group, or even to you personally.

A first step in thinking about a patent application is to check widely and thoroughly: mine the literature and internet, use every search option from PubMed to Google to Google Scholar, and look into patent databases such as Espacenet (see "TRY THIS"). If you find any papers, reports, or patents that describe innovations similar to yours, then the route of patent profiling becomes much less attractive – and you can save the expenditure. From the moment that you decide to involve specialists, it's an expensive business going forward.

The next step is to find and contract a patent specialist, who will do a similar search before even starting to write an application. When the application has been written, the patent specialist will file your application either at your national patent authority such at the Netherlands Patent Office or the Intellectual Property Office (IPO) in the United Kingdom. Your application can also be filed at more "international" authorities such as the European Patent Office (EPO), the US Patent and Trademark Office (USPTO), or the Patent Cooperation Treaty (PCT) for one "worldwide" application that you need to convert later into individual patent applications per country. The day of filing a first patent application on the invention is called the "priority date" – within 12 months subsequent applications can claim the priority date of the first application. The patent application can be filed in any country where you see a market and therefore require a patent, but you need to decide to proceed well before 30 months from the priority date. Your patent application will be reviewed by the national patent authorities (for which an expensive fee is charged). After several rounds of revisions, if you are lucky, your final version will be approved, and the patent will be registered and published (i.e., patent has been granted). Note that a patent may be granted in one country while it is still pending in another.

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Also note that anyone can review your patent once it is published and take you to court to dispute the novelty, self-evident nature, or applicability of your concept or product. You will also have to protect your patent, i.e., look for any infringement to your patent and start a court case to call a halt to its use (and you will incur legal fees). Costs for patent maintenance generally increase rapidly after a "low cost" initiation phase of two to three years; if the budget balance is less favorable than anticipated, you can retract the patent by no longer paying the maintenance costs. You should realize that a good termination strategy for your patent is as important as the

TABLE 2.12 Example of what the mandatory patent process may look like at your university

	(a) Patenting process
1	Complete internal invention disclosure form (IDF)
2	Is it patentable: prior art scan?
3	Is it commercially interesting: market analysis?
4	Report to board of university for approval
5	Write patent application
6	File as US patent application (patent pending)
7	Collect more evidence to substantiate the claims
8	Revise patent application (before end of priority year)
9	National patent granted (patent published)
	(b) Develop or terminate the patent
1	File as PCT patent application
2	Lobby to interest commercial parties
3	Negotiate to license or sell
4	Terminate patenting process in case of lack of interest
5	Cash and share royalties and sales in case of success

Note: Color indicates who is primarily responsible: you (black shading), legal officer (gray shading), or external bodies (white shading).

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development strategy; otherwise, the costs may rise hugely without you having any prospect of a return on your investment.

Will a patent make your group rich – or poor?

You're a researcher and may have no business or commercial interest. The success or failure of a patent to raise a return on investments nevertheless depends to a large extent on the energy and effort you are willing to put into it. Check some of these requirements:

- You are prepared to visit potential commercial parties, nationally or internationally.
- You can inspire and convince third parties to invest in further (applied) research to develop a prototype into a marketable product.
- You know how to deal with people who are used to being leaders, e.g., your director, dean, president, and investors.
- You are interested in helping to write the patent application and are on top of negotiating licenses or selling the patent.
- You are happy to show up for court cases if the patent is disputed.
- You have a talented, entrepreneurial PhD student or postdoc who is skilled and has the time and ambition to start a business of their own (with you as a great mentor and shareholder).
- You would look forward to designing marketing material, recruiting staff, and hiring external knowledge-transfer specialists (and many more tasks) should you decide to start your own company.

The hard truth is that most patents cost more money than they will ever generate. It is generally assumed that no more than 1:300 or 1:3,000 patents will be profitable in the end. It's all

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part of the game (while not exactly the same, very few scientific articles are really "successful" either).

Some researchers have adopted strategies and tactics from the business world (e.g., protection based on multiple patents is harder to break than protection based on one patent) and have raised a source of income for themselves, their group, and their university. They can fund their research activities over many years without having to compete for funds from "normal" agencies. Other scientists are named as an inventor on a patent jointly with industry partners, and the nature of the patent is protective; i.e., the claims in the patent protect a broad field in which the company is or might become active (e.g., all crops listed in Table 2.11a). Or the description is so detailed that the use of even obvious tools or methods has been included (e.g., a mouse and keyword to be able to run software, as in Table 2.11b).

A PROFESSOR'S ANECDOTE

Patent and business by accident

I injured my eye in a terrible accident, and it required immediate treatment by a specialist in the ophthalmology department of a university medical center. And so two professors met for the first time, one the patient and the other the clinician. At our next meeting we discussed our research interests, and a surprising interdisciplinary collaboration was born. This is how science can work! We formed a team, the professor of ophthalmology with a postdoc and the professor of biochemistry with a PhD student, and we made great progress, deciding to apply for a patent for our joint innovation and to make a business out of it. The team participated in several venture capital contests. These were very helpful because the postdoc and PhD student learned about the

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business and economic side of the invention, which is completely different from the scientific side: customers, markets, competition, and how to engineer a basic idea into a real and easily producible product. At each contest we performed better than the last, and finally we won the Dutch Venture Challenge and the Green Talents competition run by the German Federal Ministry of Education and Research (BMBF), and we won an innovation prize from Novartis. The postdoc and my (by then former) PhD candidate started up the business. This is how an accident could be turned into an unexpected patent and new business!

TRY THIS!

You've got an idea

- Check the scientific literature; Google for trend reports, white-papers, and position papers written for or by ministries of economic affairs. Has anyone anywhere published something that might jeopardize the newness of your invention?

Check for patents in your field of research

- Check patents.google.com to "read the full text of patents from around the world." Insert your keywords.
- Check patent databases, e.g., on worldwide.espacenet.com/advancedSearch, and insert your keywords. Or go to www.epoline.org.
- Esp@cenet contains 60 million patents from many countries, including information about their application status – filed, active, or ended.
- Epoline of the European Union contains all published European and worldwide patent applications, including information on their status.

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- Also check www.wipo.int/pct/en/ for all the nations covered by the Patent Cooperation Treaty (PCT).

File your patent in multiple countries

- In which countries do you see a market now or in the future? In the Netherlands, Japan, or China? Motivate your answer.
- Can you file your application in your own language or English in these countries? Or should your application be translated partially or entirely into Dutch, Japanese, or Chinese? Discuss this with your patent officer.

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