RSC 2: HOW TO WRITE A PHD PROPOSAL

Writing a PhD proposal is a really challenging, yet very rewarding task because you get to write your own project. It probably takes a good two weeks of solid effort and this normally comes during the busy time when writing a master's thesis! Of course it is easier to be told what research to do by someone else, but being able to pick one's own topic is ultimate freedom. Obviously, this requires that you know what you really want, have the curiosity to find a solution to a problem you see, and find out what is already known – or not known – about your chosen challenge. Reading and talking to people, listening to your own desires and being open to our global problems is a good start. Concerning our field – environmental and water engineering there is an abundance of problems reported in the press, and if any of this resonates with you then it is an easy start. I do require research proposals when recruiting PhDs (or Postdocs) because I do want to be able to assess this engagement, the ability to structure and articulate and match the passion of junior researchers with the work they will do with me – and the pre-invest in this work is of course a pretty good indicator if a researcher is actually burning for research or just wants a salary.

- **TOPIC:** First and foremost, figure out what you really want – assume all wishes being granted. While it is healthy to know what one wants, being very clear about it can also be described as 'manifestation' and there is belief that this will lead to wishes actually being fulfilled. If you are engaged with the topic, then you are simply more willing to give what it takes and often the stars do align for you. What achievements would you be proud of? What do you want to be famous for? What skills do you have? What skills do you still need? Role models are good to look at, but of course ultimately it is about you being yourself and finding the right place for you.
- **AUDIENCE:** Who are you writing this proposal for? Firstly, a potential supervisor, so make sure there is a match once you know what you want (see RSC2). What will excite this potential supervisor if they see your CV and your proposal? Secondly, you will need funding to follow your dreams. You need to identify potential funding sources, see what they are likely to fund and what their requirements are. Someone who is about to commit to a PhD can be expected to have some advanced internet search skills to identify funding options. There is nothing more frustrating than failing on formality (missing the deadline or not supplying a requested document because you think it isn't necessary). Funding is competitive and following guidelines is a basic requirement. If you do not ask you will not receive! Thirdly, with a supervisor and funding, now this is your roadmap to satisfying your curiosity and developing your career (with getting a PhD eventually, building a track record of skills and publications).

As you set out to the task of writing your PhD proposal, it is always a good idea to start with a 'blank sheet of paper' and a good structure, bullet points at first, focus on the three main things you want to say in each section, figure out what you need to do to be able to complete the task (find information, draw visuals, etc), this is a very iterative process and full text is very simple to write later.

- **STRUCTURE:** At IAMT we work with a PhD having four main results chapters, that can be arranged in parallel, in series or any combination thereof to cover the story of the overall PhD. Each chapter will be a publication and then there are other chapters like intro, background, conclusions, etc. Bear this in mind in the proposal and plan the workplan accordingly. The structure of the proposal should be logical.
- **TITLE PAGE**: The basics, your name, the topic/title, the place you plan to do your PhD, the supervisor(s).
- **PROBLEM/IDEA**: It is good to capture attention with your idea, the problem you would like to solve (be realistic), focused with a clear purpose and justification. Most good research is incremental, rather than transformative, while novel and relevant insights must be gained. A cool graphical abstract that shows your creativity can summarize it. Spend time figuring out which problem you will solve with your work.

> *'If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions'*
> *(Albert Einstein)*

- **NOVELTY**: highlight what you will contribute that differentiates your work from everything that is already going on. Just another location, yet another pollutant or the same theme but with yet another of a trillion possible material combinations is really not convincing. Think about what you will add to knowledge, understanding, engineering, models, what may surprise or a new interdisciplinary approach, what is

unique and original about your idea/approach. A lot of really good ideas are transferred from other fields or results of good brainstorming. The more you read the more open you become to ideas. Inspiration often happens when doing other things – hiking, swimming, traveling, playing music, dancing, etc. – be in a place where you are open to receive and carry a notebook so you can remember your ideas later!

'We cannot solve our problems with the same thinking we used when we created them'
(Albert Einstein)

- **LITERATURE**: For a proposal the literature research is inevitably the starting point. You need to know what is going on in a field and it is a good idea to read broadly, Wikipedia, magazines, Nature/Science, textbooks and of course research articles. Avoid unverified websites and find a place where you can read uninterrupted for a few hours (switch your devices off). Talk to experts, listen to needs in the industry, but prepare, do not waste time of busy people and say thank you. Structure the main literature topics to balance both depth (theory, state-of-the-art, models) and breadth (broader context, where this fits in the overall field, competing technologies, etc). Research gaps ought to transpire from your literature and this leads to the research questions you wish to address. Be careful to use good schematics and visuals (your own no copy and paste and reprints) such that you do not overload a reader with plain text.
- **RESEARCH QUESTIONS**: A PhD has three research questions for the overall story, while each chapter also has three specific research questions. There are good and bad research questions, as a brief summary they need to be i) focused, ii) researchable, iii) feasible, iv) specific, v) complex, vi) relevant, and vii) original. Research questions should be both connected and focused on your research problem.
- **METHODS & FEASIBILITY**: The methods need to match your problem and the research questions. Which experiments will you need to do to answer your research questions? What equipment is required, what analytical tools – what is available at IAMT, what is not? Where can you access tools that are not available? What skills do you need that you do not yet have? Will the detection limits of your analytical tools match what you are planning and will this work for your sample matrices? What are the main risks and potential challenges? At IAMT the website gives a very good idea about equipment, while usually previous papers describe methods. You can use what is there, but expect to also set up a new method or tool, this is an integral part of the training, so don't expect that all is just ready and waiting for you.
- **RESULTS:** There is no results section in your proposal! If you want to show your anticipated progress compared to existing data, this belongs to the literature. However, it is a really good idea to think about what results you expect as this allows you to plan which experiments (with how many variables or parameters) you will need. In work that is typical at IAMT, a publication requires on average 50 experiments that may be a day long and produce 10 samples that need analyzing. This excludes experiments required for method development, but this clearly limits the number of parameters that you can investigate which emphasizes the need for focus and good planning.
- **WORKPLAN:** This is the heart of your proposal as here is where you plan and commit. Under promise, overdeliver, but excite and challenge your limits. The workplan is what makes you finish on time – assuming you deliver on your deadlines – no matter what. Yes, you will underestimate the time taken for tasks and yes you will experience delays. In the end, you will need to make up for lost time, so work with your workplan and take deadlines seriously, even though four years seems to be an incredibly long time. A good workplan is one page long, well organized in a readable table with detailed tasks of the chapters. Workplan is well aligned with the chapters, research questions and the methods. This is your roadmap!
- **BUDGET:** A budget is more important in a funding application than in a PhD, yet it is incredibly healthy to know what research costs and where such funds will come from. Why should (usually some taxpayer) invest in your work and what will you return to society? Work at IAMT is extremely expensive, we have state-of-the-art labs and analytical tools, this is a huge privilege, to not waste resources we plan our work well. Some scholarship providers give an allowance for research (e.g. DAAD) which of course covers only a small fraction of our costs. We do not normally charge bench fees and there are no major tuition fees. This means scholarship (or salary) and the actual research materials are the main costs, as well as conference travel or research stays (such activities can be funded through other schemes).

At IAMT we have a lot of templates, a lot of support with research skills and there is a continuous exchange of ideas, feedback and strategy to develop good stories and publications. Naturally supervision starts when researchers start at IAMT, not before. As such we do not usually contribute scientifically to PhD research proposals upfront, even though the idea may result from some postings that we publish, direct feedback and discussions for funding applications. Note that any ideas that are not yours need to be credited and shared.