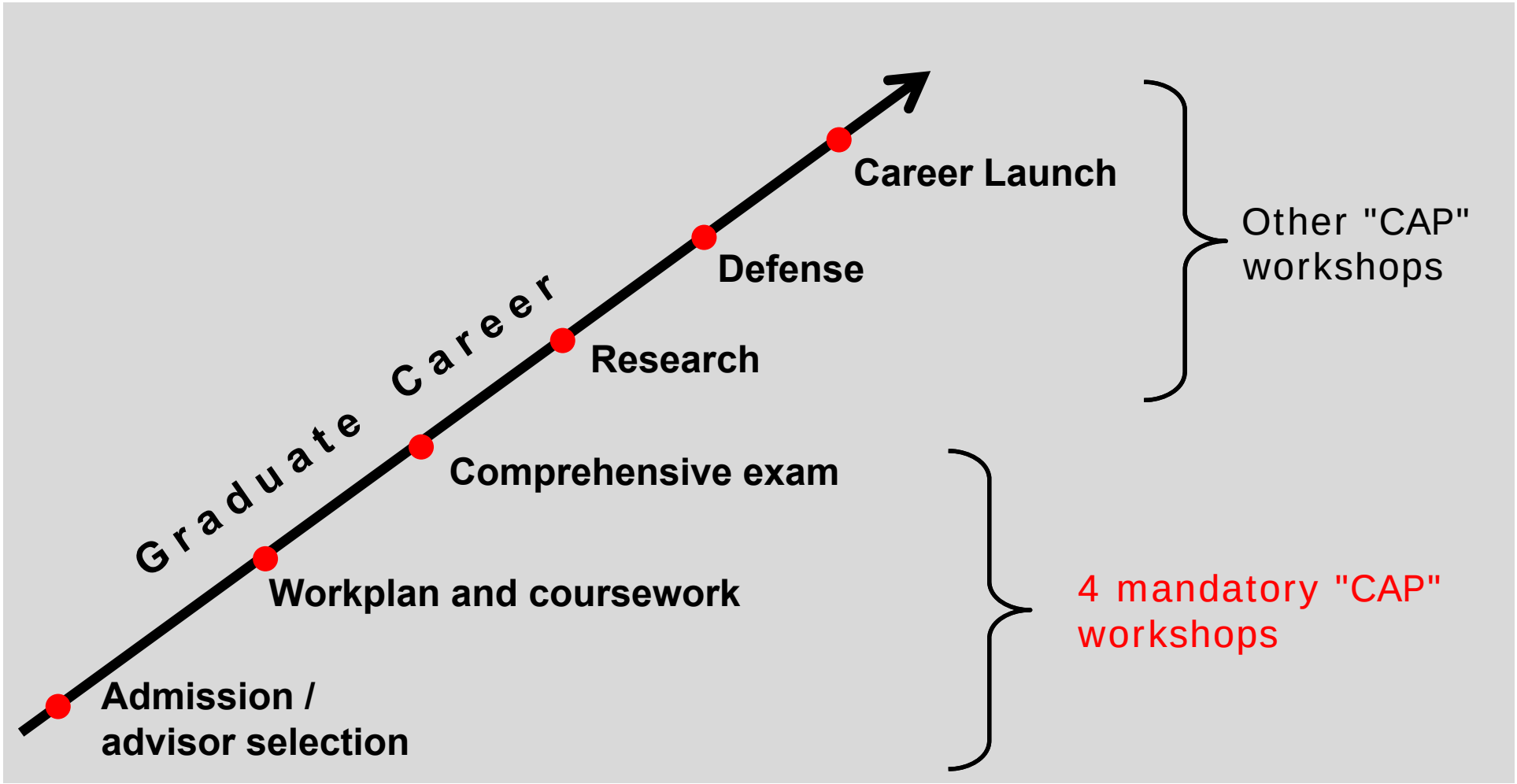
CAP7003E
Doctoral Research Strategies in Engineering
or *"Ensuring a successful doctorate"*

Jean Dansereau Ing. Ph.D.
Département de génie mécanique
Institut de génie biomédical
B-450.19

WORLD-CLASS ENGINEERING

POLYTECHNIQUE MONTRÉAL

The PhD education landscape



Complementary workshop program

MANDATORY FOR PHD STUDENTS. TOWARD THE COMPREHENSIVE EXAMINATION (4 OUT-OF-PROGRAM CREDITS)

- **CAP7003E Doctoral research strategies in engineering (1 cr.)**
- **CAP7005E Handling of scientific and technical information (1 cr.)**
- **CAP7011E Creative approaches to research (1 cr.)**
- **CAP7015E Leading a research project (1 cr.)**

NON-MANDATORY WORKSHOPS

TOWARD DISSEMINATION AND PUBLICATION

- CAP7110E Writing science effectively (1 cr.)
- CAP7120 : Concevoir son projet professionnel (1 cr.) (soon in English)
- Communicating with non-experts (1 cr.)

TOWARD THESIS DEFENSE AND EMPLOYMENT

- CAP7210E Intellectual property and patents (1 cr.)
- CAP7220E Teaching engineering (1 cr.)
- CAP7230E Become a technological entrepreneur (1 cr.)
- Starting a high-tech business (1 cr.)
- Mobilizing human, physical and financial resources (1 cr.)

Recommended at 2nd and 3rd year

Program coordinator: Élise Saint-Jacques

Web : https://www.polymtl.ca/etudes/en/graduate-studies/complementary-training-cap

Why a mandatory complementary program at Polytechnique?

1. To accompany students during the first four semesters of the PhD
   - Know and integrate the expectations (yours, your research director's, your institution's)
   - Understand criteria of success
   - Increase motivation
   - Define your research project and write your research proposition
   - …Toward a successful comprehensive exam

2. Graduate education is evolving. It is recognized, worldwide, that a PhD graduate should demonstrate the acquisition of a wide set of personal and professional skills, in order to address a variety of problems and situations.

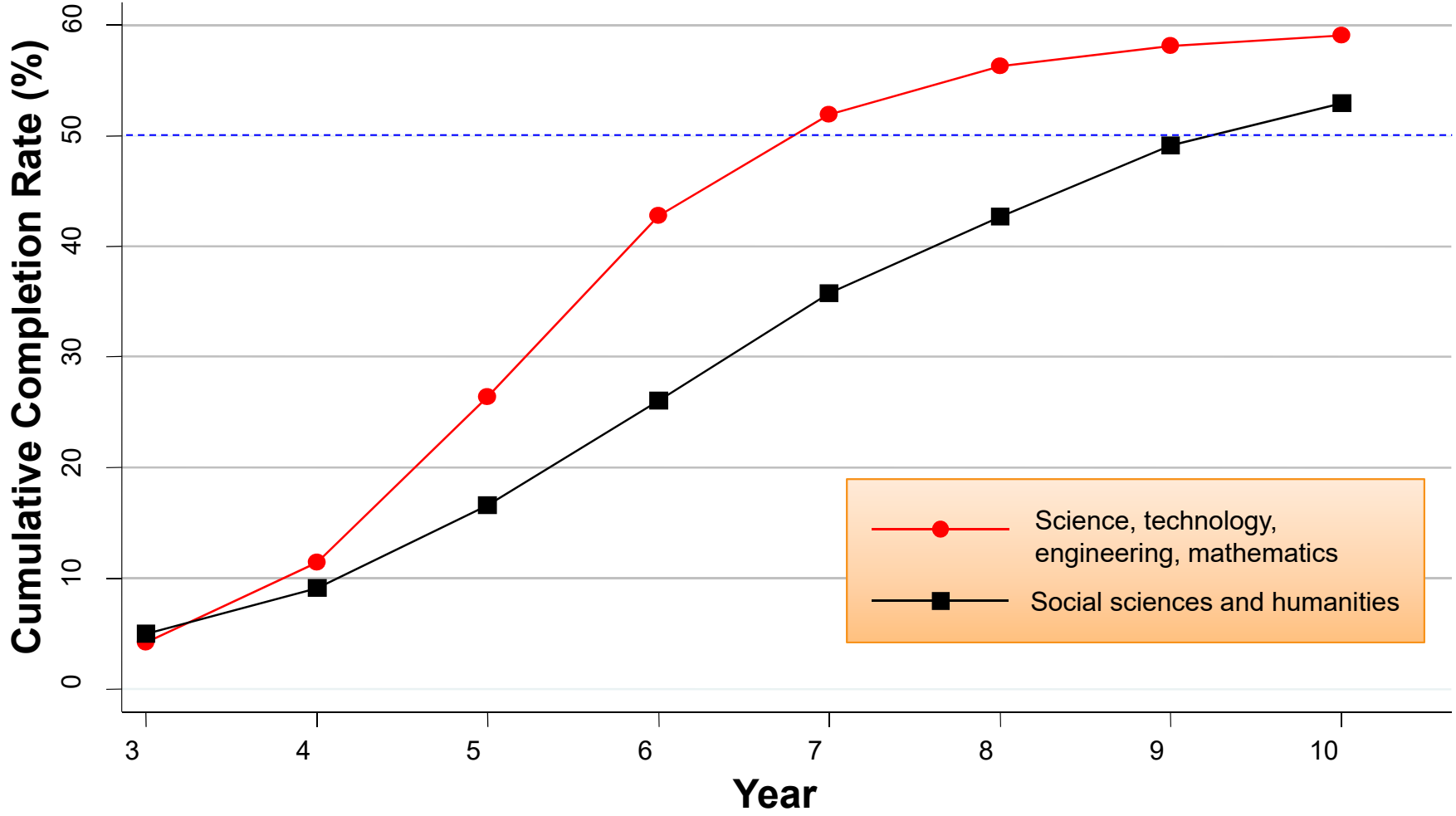
Five competencies expected from PhD graduates

The PhD graduate from Polytechnique Montréal is expected to :

1. Autonomously and expertly lead a scientific research project that makes an original contribution to knowledge or development in the areas of science and technology.
2. Identify, manage and analyze information and resource materials relevant to one's field of research.
3. Clearly communicate, across a wide range of situations, findings from scientific research or knowledge on one's subject area.
4. Respect standards, rules of ethics and fairness, as well as best practices for research.
5. Commit to a process of lifelong learning and improvement.

Source : Competencies, competency elements and resources to mobilize for the DESS, professional master's, research-based master's and doctorate. (https://share.polymtl.ca/alfresco/service/api/node/content/workspace/SpacesStore/5a78b62e-ab73-42a2-8e76-cf6db8e72434?a=false&guest=true

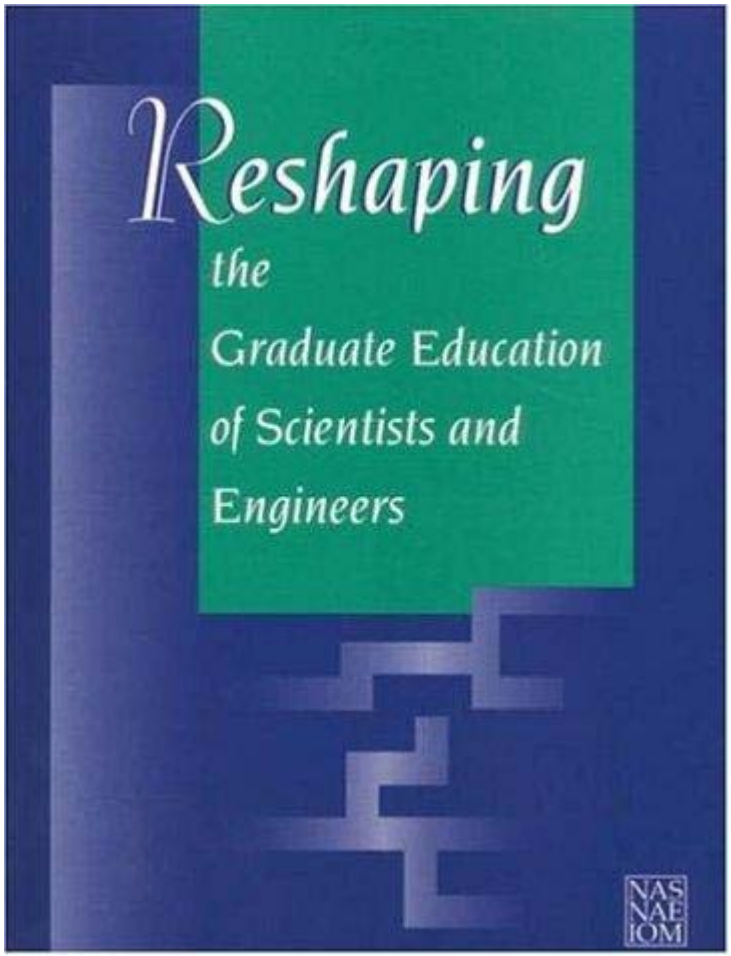
Ph.D. completion rate



NOTE: 10-Year completion rates include all cohorts entering 1992-93 through 1994-95

Council of Graduate Schools, Completion and Attrition Program Data (www.phdcompletion.org)

Reshaping the graduate education of scientists and engineers



"The process of graduate education is highly effective in preparing students whose careers will focus on academic research. It must continue this excellence to maintain the strength of our national science and technology enterprise. But graduate education must also serve better the needs of those careers will not center on research."

National Academy of Engineering
National Academy of Science
1995

Acquisition of non-disciplinary skills is essential!

Canadian Research Funding Agencies (2007):

- Interpersonal skills / communication
- Critical and creative thinking
- Efficiency
- Integrity, ethical behavior
- Teaching and transfer of knowledge
- Leadership
- Management of research
- Mobilizing knowledge and application of knowledge

Responsibilities and resources – Moodle and more

A few things you must know...

You are starting your PhD at Polytechnique Montréal: avoid surprises and if you have'nt done it yet, read the whole document Graduate studies - general regulations.

Recently arrived at Polytechnique? You are advised to read the Guide for new students produced by the Polytechnique Student Service: a wealth of information to optimize your chances of success.

In order to engage your reflection in the context of the present workshop, Ensuring a successful doctorate, your are also invited to read the document Competencies, competency elements and resources to mobilize for the DESS, professional master's, research-based master's and doctorate [pdf], which will help you to better understand the expectations associated with the PhD diploma.

Lastly, most of the rules and policies that govern your doctoral path at Polytechnique Montreal can be found at this page: http://www.polymtl.ca/es/en/documents-officiels/index.php

Wishing you all the succes in your PhD!

Information for newcommers to Quebec

TIMELINE FOR THE FOUR MANDATORY CAP WORKSHOPS

WHAT THE DOCUMENT "DOCTORAL STUDY PLAN" SAYS:

These 4 credits for non-program workshops must be completed no later than the 4th semester. These 4 credits are not included in the 90 credits of the Ph.D.

- CAP7003E Doctoral research strategies in engineering : **imposed** at the 1st semester
- CAP7005E Handling of scientific and technical information : preferably at the 1st or 2nd semester
- CAP7011E Creative approaches to research : preferably at the 2nd or 3rd semester
- CAP7015E Leading a research project : preferably at the 3rd semester

FLEXIBILITY ACCORDING TO YOUR SITUATION

The semester at which the workshops CAP7005E, CAP7011E and CAP7015E are followed is flexible. The recommendations made on the Study Plan are indicative, and simply reflect the relevance of the content according to the progression of the student. Register early in the course choice modification period in order to have a place at the desired semester. If a student cannot enroll in a particular semester, or if the desired workshop conflicts with another activity, the workshop may be followed in the next semester. The four mandatory workshops are offered at every semester (including summer), in French and in English

NOTATION OF THE COMPREHENSIVE EXAM

The 4 mandatory workshops are designed to help the student prepare for the comprehensive exam. Although the situation is not ideal, a student may register for the exam, even if the four required workshops are not completed. If he or she passes the exams before completing the four mandatory CAP workshops, the score “Iv-incomplete” will be noted for the comprehensive exam. This score will be replaced by “P-pass” when, in addition to having passed the comprehensive exam, the student will also have completed the four mandatory CAP workshops.

Reference : Règlement des études supérieures. Article 73 Exigences du programme; Article 75.5 Ateliers complémentaires liés à l’examen général de synthèse et Article 75.6 Notation de l’examen de synthèse.
Official documents (in French) : https://www.polymtl.ca/renseignements-generaux/documents-officiels/5-affaires-academiques-et-vie-etudiante
Selection of translated documents : https: //www.polymtl.ca/renseignements-generaux/en/official-documents

CAP7003E

Doctoral Research Strategies in Engineering

or *"Ensuring a successful doctorate"*

Syllabus

CAP7003E - Objectives

The primary objective of this workshop is to clarify what is a successful doctorate at Polytechnique and to bring doctoral candidates to articulate the success criteria.

More specifically, at the end of the workshop, the doctoral candidates will be able to:

- Describe the process, milestones, and components of a doctoral research project;
- Identify the expectations and quality criteria for setting up a research project;
- Identify and describe methods and strategies for carrying out an engineering research project including project definition, planning, work breakdown structure, schedule, milestones, deliverables and risk mitigation;
- Produce a first version of his own research proposal in engineering;
- Conduct critical analyzes and proposal evaluations of research projects in engineering from doctoral colleagues;
- Synthesize critical information to improve his own research proposal;
- Identify the professional aspects inherent to the carrier of a researcher.

CAP7003E – Work Plan

Session 1 – A successful doctorate at Polytechnique: What are we talking about?

Objectives of doctoral research and of an engineering research project. General process governing a research project. Quality criteria and characteristics of doctoral research: strategies and resource mobilization. Expertise. Original and significant contributions. Collaboration and research partnership. Research results and impacts. Objectives and content of a thesis.

Session 2 – Doctoral journey, milestones, and expectations

Transition from research topic to research project. Major steps of a research project: organization and structure of the project. Emergence of the project and publication strategy. Phase of realization. Application: development of a first version of your research proposal and methodology of implementation.

Session 3 – Leading a research project

Processes associated with basic research, applied research, technological development and innovation. Conduct and management of a research project: definition, planning, execution and completion. Work breakdown structure. Organization of time, schedule. Milestones. Deliverables. Management of risks, risk mitigation. Human Resources and Industrial Partnerships. Cost planning. Application: critical evaluations of research proposals of doctoral colleagues.

Session 4 – Strategy for success during and after the doctoral program

Potential pitfalls related to a research project; strategies to avoid them. Management of time. Management of intellectual property. Research ethics Research ecosystem. Career management and expected skills of an engineering researcher. Application: self-assessment and review of your first version of your research proposal.

Assignments and grading

Grading is on a pass/fail basis.

Presence and full participation to all four sessions is required to obtain the credit.

Under exceptional circumstances, students might be allowed by the instructor to miss one class, but students missing more than one class will have to abandon the whole workshop.

All assignments should be submitted on time to obtain the credit.

Main assignments:

- Questionnaires in preparation for workshop session 1 and 2.

  Submit answers on the Moodle site before class
- Research proposal (details will be provided in class)

PPT presentations are available after each session!

Evaluations and availabilities

Questionnaires 1 and 2 (homework 1 and 2) :
- examined but not annotated (used to prepare the coming session)!

Assignment 3 has 3 parts:

- **Part I:** submission of a 1st draft of your research proposal;
- **Part II:** evaluation of 3 research proposals produced by your colleagues;
- **Part III:** your improved research proposal using comments received from your colleagues and notions seen in class; this version will be annotated by the professor.

My availabilities:

- **On Monday PM : B-450.19**
- **By email, to make an appointment : jean.dansereau@polymtl.ca**

Introductions

Name, background, department, field of research.

Session 1

A successful doctorate at Polytechnique: What are we talking about?

ANOTHER IMPORTANT FINDING

Most Ph.D. students do not understand well the "rules of the game" and what is expected of them

"When students know the performance that is expected of them and the standards they will be judged on, they become more engaged in their intellectual and skills development, are better able to self-assess and correct deficiencies, and are better able to demonstrate what they know and can do."

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Introductory question

What is your primary motivation for completing a Ph.D.?

What career do you want to pursue?

What is your primary motivation for completing a Ph.D.?

Interest for research

- Intellectual challenge
- Work on an interesting project
- Mastering complex tools
- Carry innovation
- Going to the end of a problem
- Increase knowledge
- Realize a passion

Career

- Professor / teacher in university
- Researcher
- R&D in public or private sector
- Inventor
- Consultant
- International opportunities

Maturing / developing

- Develop analytical thinking
- Building a network
- Achieve beyond expectations
- Acquire specific skills

Personal

- Remain a student
- Moving to a new country
- Manage your own time
- Be free to work on what you want

Question #1

What are the differences between a Ph.D. and other university degrees (bachelor, master)?

(Teams: Green number on your badge)

Answer #1

What are the differences between a Ph.D. and other university degrees (bachelor, master)?

Transformation from *user of knowledge* to *creator of knowledge*

What are the differences between a Ph.D. and other university degrees (bachelor, master, …)?

- Master's students implement while PhD **make original contributions**
- The **definition of the research** project is an essential and important aspect of a Ph.D. program, not in a master
- For PhD students, it is required to **publish**
- Something new has to be done
- PhD students
  - Work **autonomously**
  - Focus on a very specialized subject
  - Become **experts** in their field
  - Will get better jobs, at a higher level
  - Tackle intellectually challenging tasks
  - Have bigger impact on society

"The heart of the Ph.D. experience is the psychological transition from a state of being instructed on what is known to a state of personally discovering things that were not previously known"

- UNESCO, 2004

Metamorphosis from user …
…to creator of knowledge

Before entering the Ph.D. program		After completing a Ph.D.
Learning to use or reconfigure existing knowledge	→	Learning to create, by yourself, original knowledge.
Applying known theories, approaches and tools that are already validated	→	Venturing into unfamiliar terrain, identifying a promising solution, exploring it, and validating its content.
Progressing into a precise frame with pre-established timelines, according to well-defined rules, and under the supervision of faculty.	→	Progressing into uncertainty with no predetermined timeline; establishing a relationship with the advisor; surpassing the advisor in a specific niche.

Adapted from Jean Nicolas, CAP7001 Classnotes

Metamorphosis from user …
…to creator of knowledge

According to EPFL (2006)

Before the Ph.D.

"In previous stages of their education, students had to show their mastery of the content of an object world and the appropriate methods for examining it, essentially by digesting knowledge that had been didactically prepared for them. They learned how to put it to use."

EPFL, Practical guide for PhD candidates at EPFL (2006)

Metamorphosis from user …
…to creator of knowledge

According to EPFL (2006)

At the Ph.D. level

"PhD candidates are now expected to do research on their own. They are no longer supposed to act within a frame of knowledge that is given but to strive for an active synthesis, which includes what is already known but also what has yet to be found."

"Studying for a PhD means to become an active producer of new scientific knowledge and technological artefacts. It is easy to see why this can be such a frightening experience at times.»

EPFL, Practical guide for PhD candidates at EPFL (2006)

Goals of Ph.D. Research

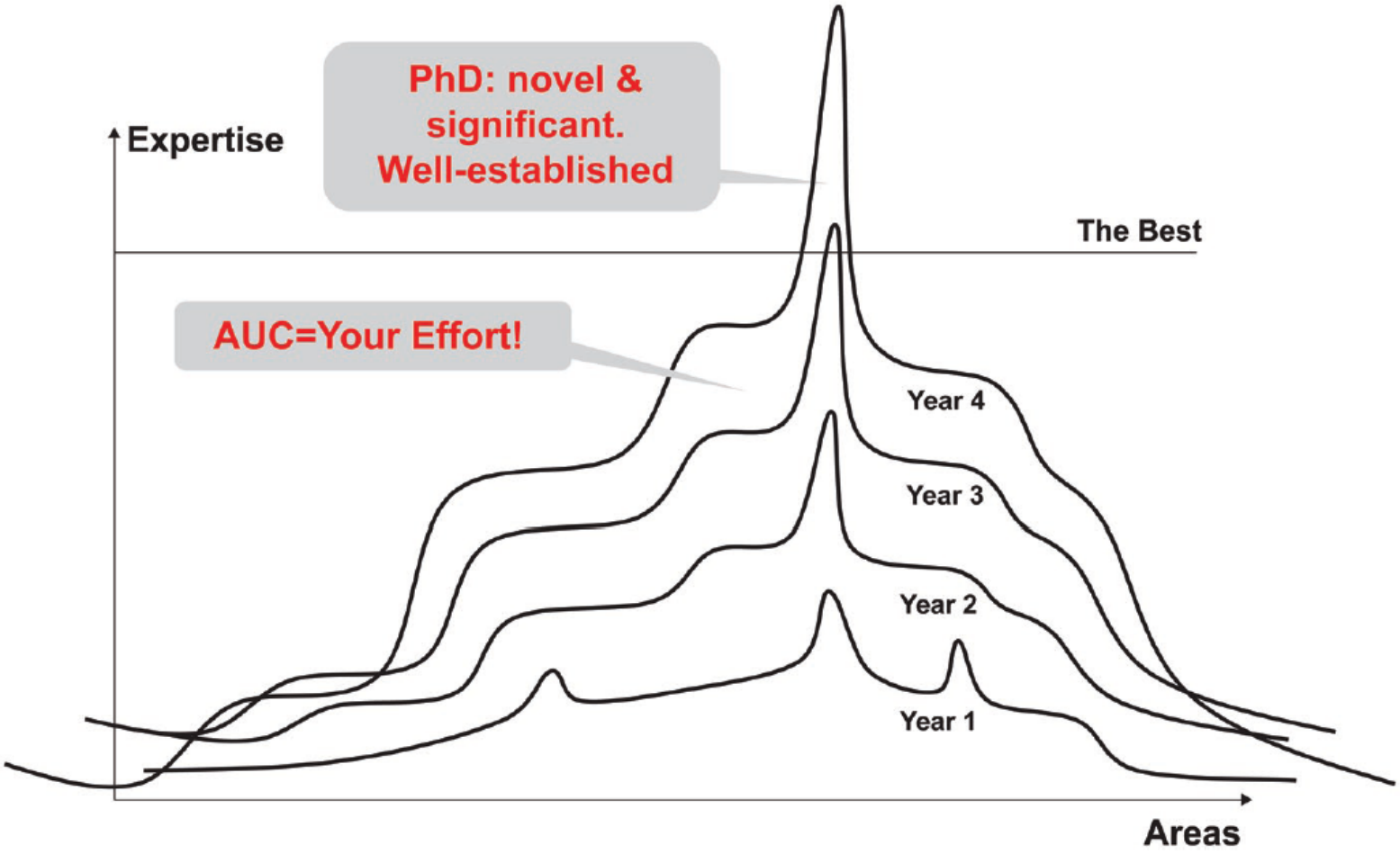


FIGURE 2.1: Progress in four years of Ph.D. study.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

Goals of Ph.D. Research

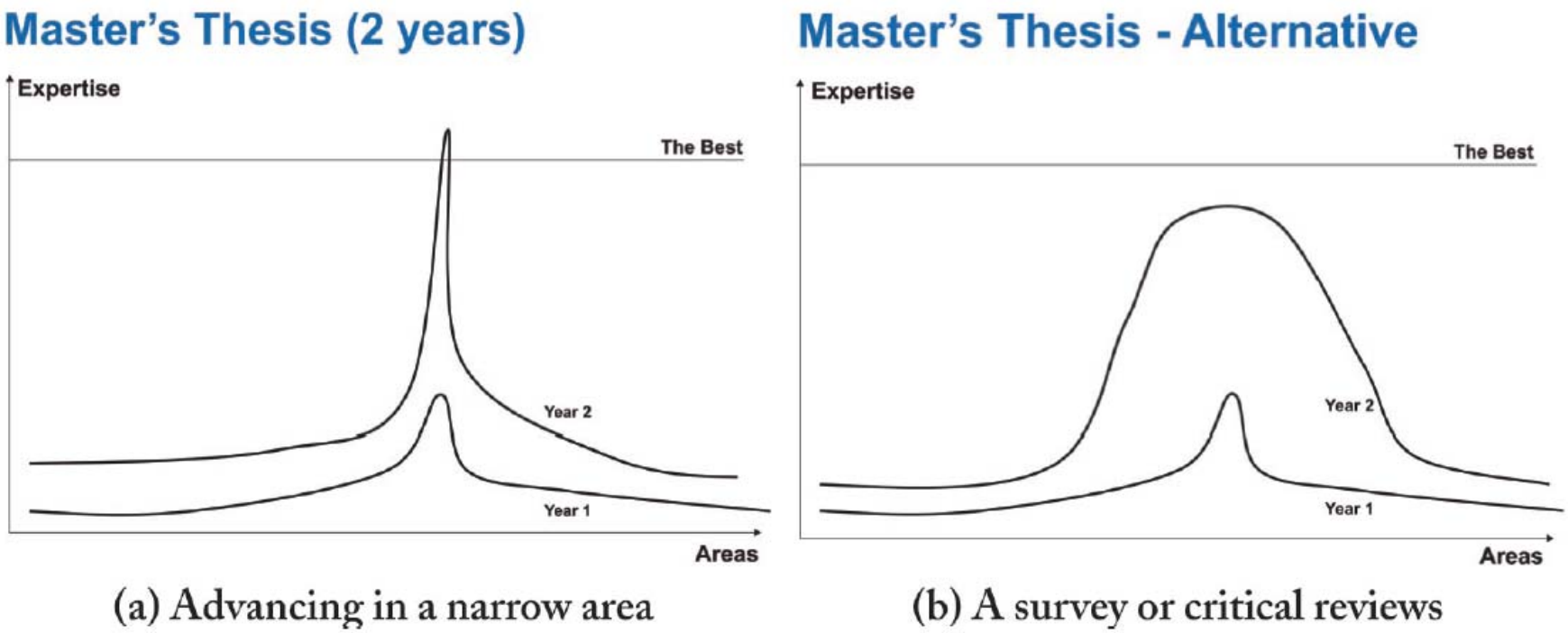


FIGURE 2.2: Progress in two years of Master's study.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

Goals of Ph.D. Research

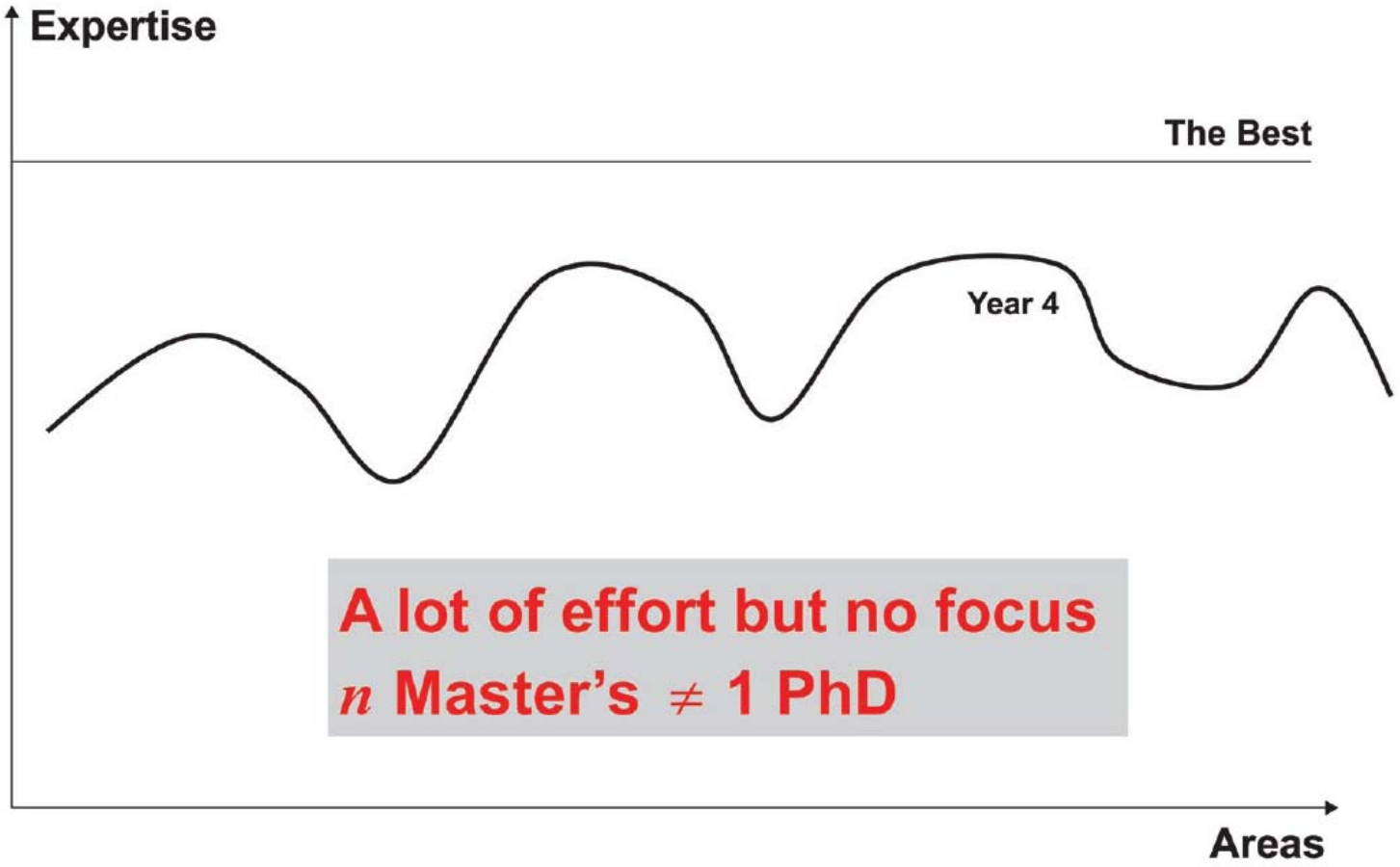


FIGURE 2.3: What to avoid in a Ph.D. study: cover many areas shallowly.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

Goals of Ph.D. Research

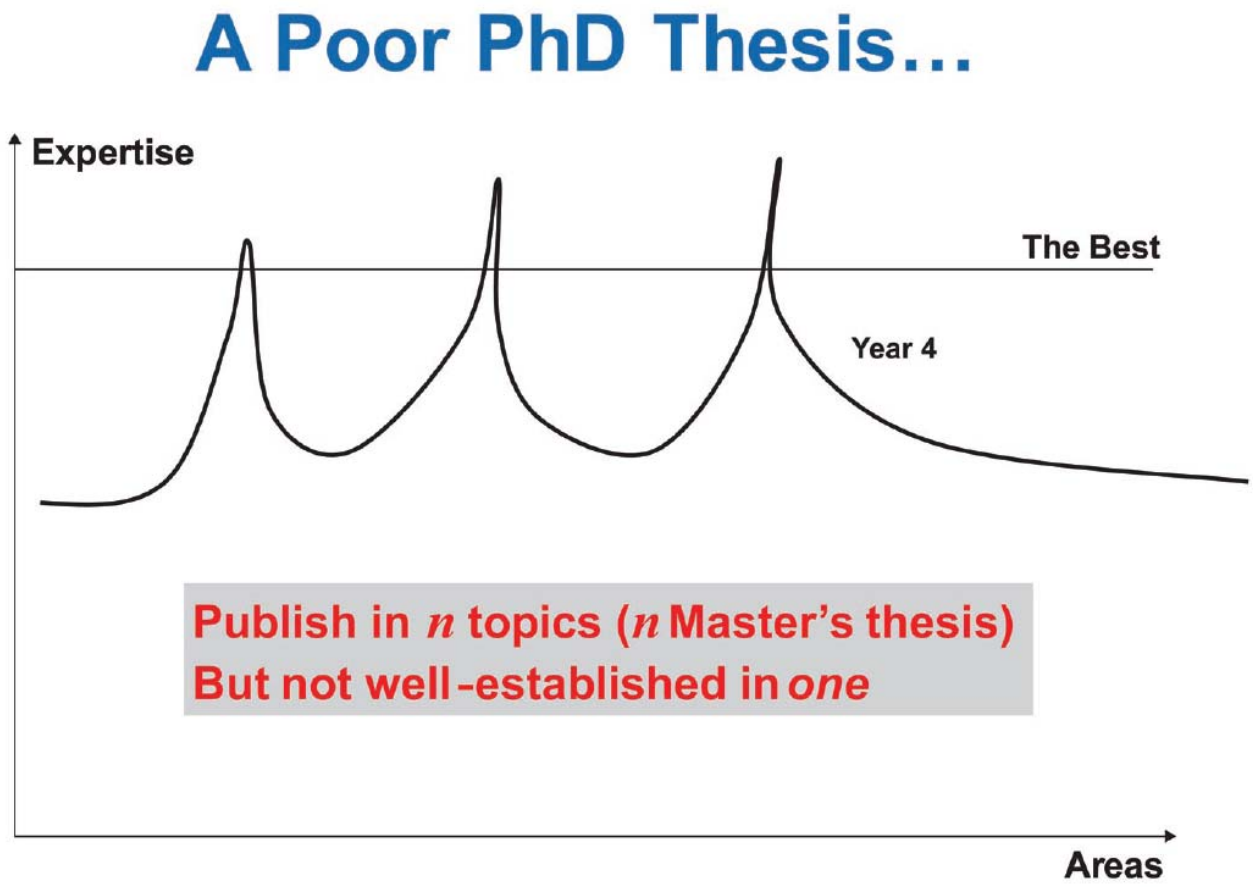


FIGURE 2.4: What to avoid in a Ph.D. study: publishing in several topics but not well established in any one of the topic areas.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

Goals of Ph.D. Research

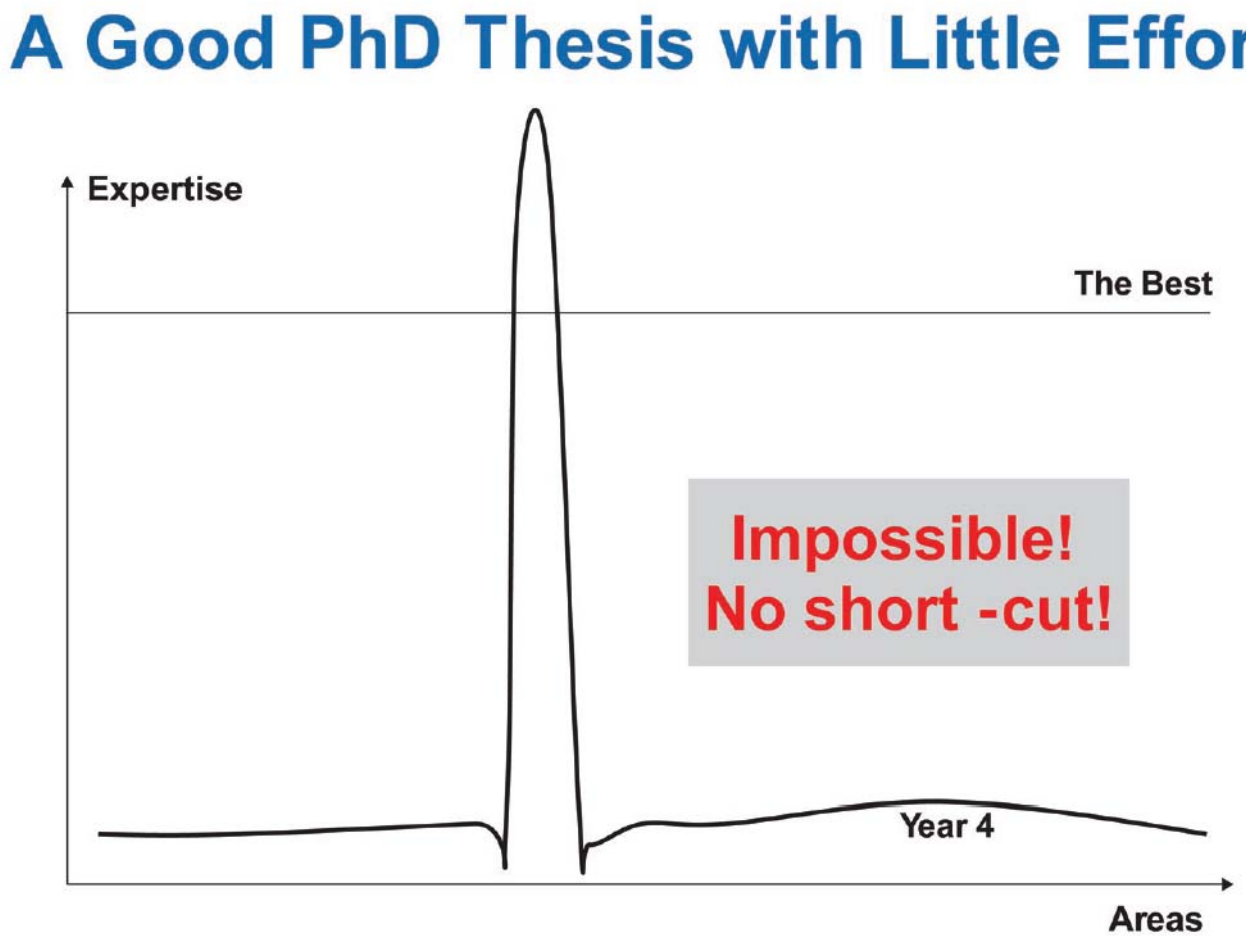


FIGURE 2.5: An impossible situation in Ph.D. study.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

Goals of Ph.D. Research

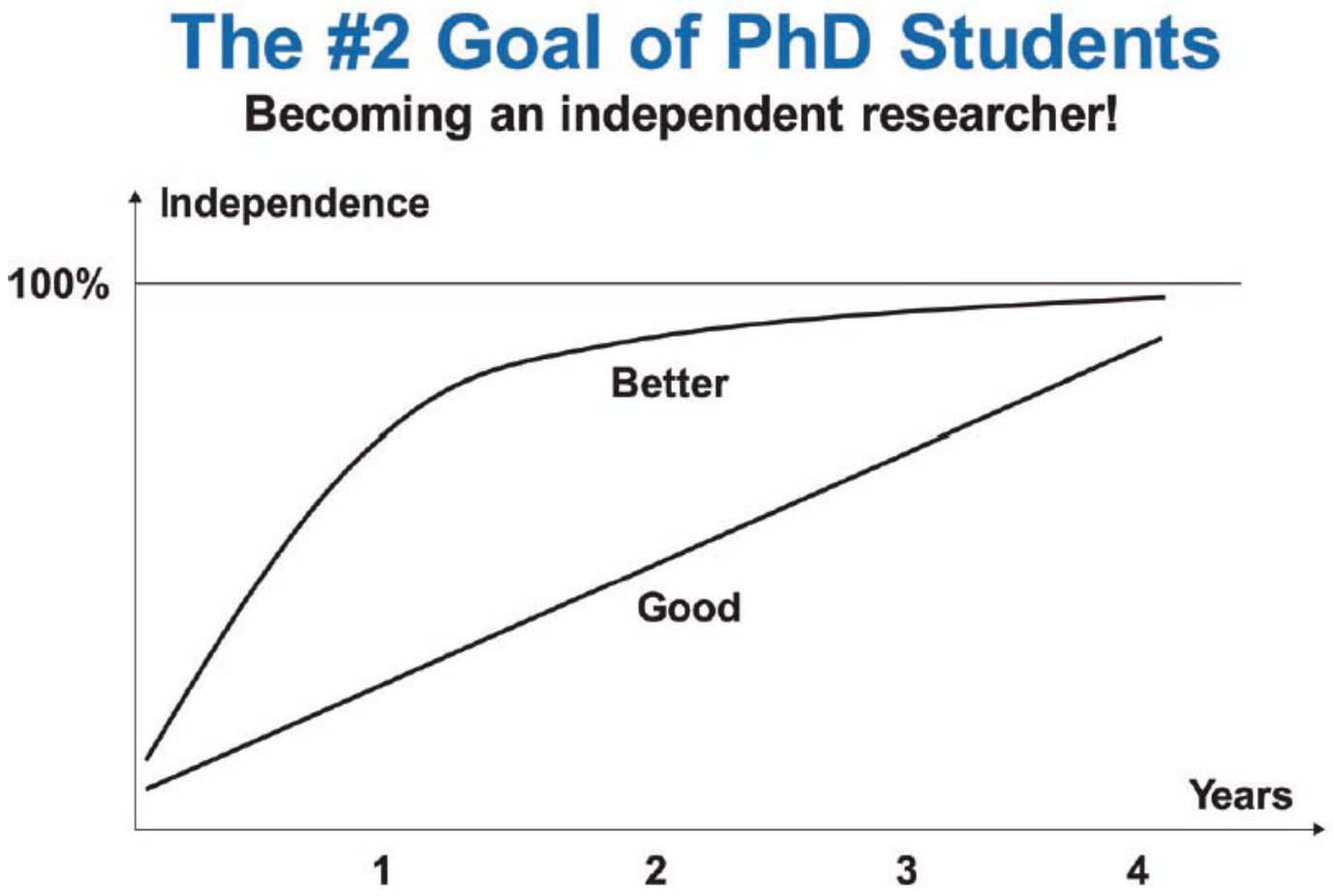


FIGURE 2.6: The "independence curve" for a Ph.D. student.

C.X. Ling, Q. Yang, "Crafting your research future: A guide to successful master's and Ph.D. degrees in science and engineering", Morgan and Claypool Publishers (2012).

The purpose of a dissertation

- To train students to be professionals in the discipline
- To learn how to and demonstrate the ability to:
  - Conduct independent and original research – identify/define problems and generate questions, review the literature, apply appropriate methods, analyze data/text, discuss findings, produce publishable results
  - Engage in a sustained piece of research or argument
  - Think and write critically and coherently : Write to be read!
  - Be a professional in and contribute to the discipline
- To show mastery of the field
- To prepare for a career and get a job
- It is a capstone on the graduate education and research experience, a rite of passage from student to professional

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The purpose of a dissertation

TABLE 9.1.
The Purpose of an Engineering Dissertation

To teach the student to think about process and how to write; to learn to define a problem, summarize the current state of the art and gain a little global perspective on the problem, place the problem in a broader context, propose a solution, perform research, and obtain significant results; to develop mastery of a particular area to the point where the student can contribute to the field; to demonstrate thinking and writing skills, and professional engineering competencies; to document the student's research and provide a tutorial for the next student; to provide evidence for the scholarship the student has achieved during graduate school; to communicate the student's results to his or her colleagues and the rest of the world; is an instructional tool

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The purpose of a dissertation

TABLE 10.1.

The Purpose of a Mathematics Dissertation

To produce a fully formed professional, independent mathematician, or mathematics researcher; to make sure students have acquired the stills necessary to learn and carry on professional activity as mathematicians; to gain some experience in solving problems; to give students practice writing papers and organizing their thoughts; to learn how to come up with good problems, do research, and write mathematics; to demonstrate that the student can do original, independent research of some significance in some area of mathematics; to certify that the person is qualified to have a Ph.D., that he or she can do certain kinds of things, is able to do research after graduate school, and get certain kinds of jobs.

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The purpose of a dissertation

TABLE 8.1.
The Purpose of a Physics Dissertation

To obtain professional training for the future; to learn and to demonstrate the ability to conduct projects independently; to learn how the field functions; to demonstrate expertise in student's area, mastery of the subject matter, and the ability think critically and put student's project work in the context of the field; to convince the committee that the student is able to do certain things independently; to demonstrate the completion of formal academic requirements; is a capstone on the student's research project and training; an opportunity to provide a coherent presentation of the body of work the student has done as a graduate student; a union card to become a member of the research community

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Completing a doctorate is first and foremost a change in mindset where openness, initiative, creativity, rigor, autonomy, and tolerance to risk and uncertainty take considerable importance.

Adapted from J. Nicolas, CAP7001 classnotes

Question #2

What is an original contribution?

What is a significant contribution?

(Teams: blue number on your badge)

What is an original contribution?

Original contribution

- Has never been done
- May be a patent
- Is inspired/creative
- Opens new horizons
- Is publishable
- New technique
- Breaks paradigms
- Tackles an unsolved problem
- Disproof established ideas or knowledge

Significant contribution

- Research that is cited
- Tackles problems that is of concern for many people
- Has concrete use
- Is publishable
- Has a commercial or industrial impact
- Has an impact on people's lives
- Is new (new theories)

The nature of an ORIGINAL contribution

- Something that has not been done, found, known, proved, said or seen before that results from:
  - Asking or identifying new questions, topics, or areas of exploration
  - Applying new ideas, methods, approaches, or analyses to an old question, problem, issue, idea, source, thinker, or text
  - Developing or applying new theories, theorems, theoretical descriptions, or theoretical frameworks
  - Inventing, developing, or applying new methods, approaches, computations, techniques, or technologies
  - Creating, finding, or using new data, data sets, archives, information, materials, or sources
  - Applying old ideas, methods, approaches, or analyses to new data, material, or source
  - Developing or applying new analyses, analytic approaches, frameworks, techniques, models, or statistical procedures
  - Coming up with new ideas, connections, inferences, insights, interpretations, observations, perspectives
  - Producing new conclusions, answers, findings or proofs
  - Combining or synthesizing things (experiments, facts, knowledge, models of inquiry, problems, sources, technologies, theoretical constructs) from other fields or disciplines
- Is publishable
- Adds to knowledge
- Changes the way people think
- Moves the field forward/advances the state of the art

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The nature of an ORIGINAL contribution

TABLE 9.2.

The Nature of an Original Contribution in Engineering

Something that has not been done before; comes from the student not the advisor; new and innovative theories, methods, or applications; solving a solved problem by a better, cheaper, or easier method; successfully solving new or existing problems; developing new algorithms, models, or computational methods; inventing new devices; creating new things; making something work better or differently; taking a method or a result from another field and applying it to an engineering problem; making a conceptual contribution; elucidating a topic; advancing the knowledge base or the state of the art

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The nature of an SIGNIFICANT contribution

TABLE 9.3.

The Nature of a Significant Contribution in Engineering

A nontrivial, useful breakthrough that will have an impact; putting a folk theorem into a solid theoretical framework; combining existing techniques; coming up with a clever solution to a very important problem; solving a long-standing problem; developing a product that gets adopted by an interested company; having implications or leading to applications in other fields and areas; stimulating further work; opening up a new field

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

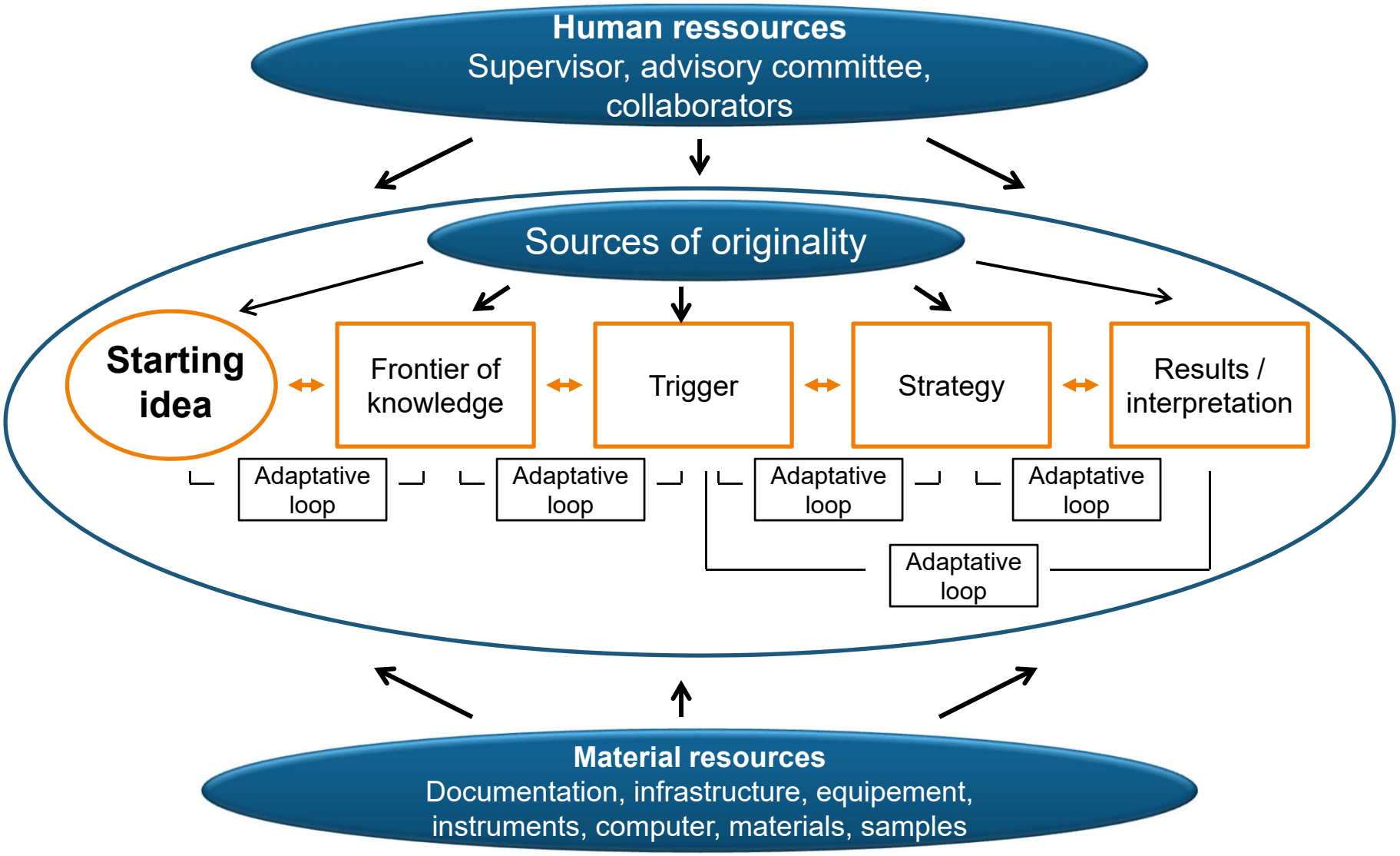
Finding an original idea

Source for the starting idea

Thesis advisor	A theme Some publications A question An hypothesis A problem	A thesis A contract A patent A grant proposal
Ph.D. candidate	An interesting topic The continuation of a master's project A scientific question of technological challenge An interesting project in progress in the research group	
An external person or organization	A company A research center A ministry A call for projects/proposals/bids	

Adapted from Jean Nicolas, CAP7001 classnotes

Finding "originality" as the thesis progresses



Adapted from Jean Nicolas, CAP7001 Classnotes

Risk and potential impact

- **Incremental research**
  - Low risk, low impact
- **Trendy research**
  - Moderate risk, moderate impact, highly competitive
- **The "long-shot", disruptive approach**
  - Very high risk, huge potential impact, little or no competition

THE KEY: Tackling a problem that YOU can solve

Different fields, different cultures for framing the thesis

Research is driven by:

- **An hypothesis**
- **A question**
- **Objectives**

The original idea is embodied in the writing of a research hypothesis, a research question or a general research objective!

Question #3

What do you expect from your thesis advisor?

What are, in your opinion, the expectations of your research advisor?

(Teams: Red number on your badge)

Answer #3

What do you expect from your thesis advisor?

What are, in your opinion, the expectations of your research advisor from yourself?

The quality of the interactions between the Ph.D. student and his/her advisor is one of the most important factors in ensuring a successful doctorate

What do you expect from your thesis advisor?

Funding
- Financial support
- Participation to conferences

Support
- Material resources
- Human resources
- Availability
- Helps me networking

Direction and coaching
- Continuous follow-up
- Is not too directive
- Gives feedbacks and critical assessments, shares opinions
- Recommends readings

Expertise
- Is confident
- Advises me and puts be back on track when necessary
- Understands the difficulties
- Has a vision of my subject
- Masters the field
- Knows the limits of knowledge and current state of the art

Protects me

Is a mentor
- Is fair and accurate
- Challenges me (on results, conclusions)
- Is interested in my work
- Stimulate progress, guides my progression
- Listens

Team work
- Maintains coherence between co-advisors
- Fosters interactions within the research team
- Encourages communication
- Explains the projects and the interactions between them to all team members

Attitude
- Cares about my future
- Openness, leaves room for initiative
- Does not oppose to acquiring complementary competences (teaching, languages,…)
- Leaves freedom to grasp opportunities

Availability

What are, in your opinion, the expectations of your advisor from yourself?

- **Contribution to the project and to the group**
  - Supervise less experienced graduate students
  - Show initiative
  - Be focused and self-motivated
  - Do not hide, give updates
- **Skills and knowledge**
  - Get good grades in courses
  - Work autonomously
  - Accept advice
  - Be curious
  - Maintain broad scientific, technical culture
- **To graduate**
- **Scientific thinking**
  - Be creative
  - Be rigorous and methodic
  - Be thorough
  - Obtain significant results
  - Communicate significant results
- **Professionalism**
  - Be hardworking, put time
  - Be able to face crisis
  - Be persistent
  - Be productive
  - Be faithful
  - Be a team worker
  - Respect deadlines
  - Use resources appropriately

You must develop a constructive relationship with your advisor… and the rest of the team

BE EXPLICIT!!!

- Agree on mutual expectations
- Agree on methods of interactions (meetings, writings, etc.)
- Express your needs

- You must be responsible and professional
- You are “changing” rapidly, so are your needs

- You will most likely be evolving within a team

ETH Zurich Survival guide
(http://www.aveth.ethz.ch/sg/AVETH_survival_guide_2012.pdf)

What does your supervisor expect from you ?	What should you expect from your supervisor ?
✓ To be **independent.** ✓ To do not always ask what am I going to do next ? ✓ To have ideas and **proposals**. ✓ To show **original thought**. ✓ To be of scientific stringency.	✓ To be supervised. ✓ To be supervised regularly as opposed to whenever it is convenient for your supervisor or once you have nearly completed your dissertation. ✓ To make (written) comments not only on the details of the work but also on the overall progress of the study.

Jean Nicolas, adapted from ETH Survival Guide

ETH Zurich Survival guide
(http://www.aveth.ethz.ch/sg/AVETH_survival_guide_2012.pdf)

What does your supervisor expect from you ?	What should you expect from your supervisor ?
✓ To produce **written work before meeting with him.**	✓ To read your work **in advance** of a meeting.
✓ **To have regular meeting with you** ✓ **To be honest** when reporting on your progress ✓ **To follow her/his advice** when you ask for it. ✓ **To surprise her/him** and become an expert in your field.	✓ **To be available when needed.** ✓ **To be rather an advisor** than a judge**.** ✓ **To be constructively critical.** ✓ **To have a good knowledge of the research area.**

Jean Nicolas, adapted from ETH Survival Guide

Six areas a student should manage with is advisor

"It is recommended that the student should:

1. Attempt at the outset to **ascertain the supervisor's own views** of the staff-student relationship.
2. Agree with the supervisor the **routine aspects** of the relationship (and take responsibility for their implementation).
3. Produce **written lists of queries prior to** meetings with the supervisor.
4. Keep **written notes of meetings** with the supervisor and submit copies.
5. Agree with the supervisor on the **nature and timing of progress reports** to be submitted.
6. Agree with the supervisor on the **nature and timing of draft chapters** to be submitted."

Excerpt from: John A. Shapr, John Peters, and Keith Howard, The management of a student research project – Third edition, Gower Publishing Company, Burlington (2002

In summary

Most advisors expect Ph.D. students to display a high level of autonomy and to work in a collaborative mode.

Qualities of a dissertation

Despite the importance of the dissertation for obtaining the Ph.D., the mystique in which it is typically shrouded, and the weightiness of the task of completing one, the purpose of a dissertation in doctoral education, what it means to make an original and a significant contribution, and faculty's standards or expectations for quality are rarely made explicit to graduate students. Indeed, here is a sample of questions from David and Parker's study (as cited in Katz, 1997) that graduate students often ask and the answers they often receive:

> Question: What are the quality standards?
> Answer: High!
>
> Question: How long should a dissertation be?
> Answer: Long enough to cover the topic.
>
> Question: How exhaustive should the literature review be?
> Answer: Exhaustive. (p. 11)

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Question #4

What are the criteria for a quality doctorate?

or

How will you know that you are ready to defend your thesis?

(Teams: Green number on your badge)

Criteria for success

Advisor's criteria

- x seminars, y lectures, z articles, w patents
- Building a prototype, instrument, sensor, …
- Creating code, developing an algorithm
- Creating a new database
- Inventing a new method

University requirements

- 0-15 course credits
- Study plan
- Comprehensive examination
- Writing and submitting a thesis
- Defending a thesis

Your criteria

- Completing the study program in X years
- Obtaining prizes and awards
- Balancing academic success and personal/family life
- Building a professional network
- Building a strong portfolio (scientific, professional, personal)
- Completing an internship (industry, academic laboratory)
- Developing professional skills
- Learning languages

Characteristics of Good and Poor Dissertations

Good/Passing		Poor/Failing	
Winter, Griffiths, Green (2000)	Mullins and Kiley (2002)	Winter, Griffiths, Green (2000)	Mullins and Kiley (2002)
Coherence	Cohesiveness and clarity	Lack of coherence	Lack of coherence
Intellectual grasp	Critical reflection	Lack of originality	Work that is not original
Originality	Originality of presentation	Methodological weakness	Mixed or confused theor-etical and methodological perspectives
Presentation	Professionalism (mature comments, accuracy of logic)	Lack of intellectual grasp	Lack of confidence
Engagement with the literature	Well-structured arguments	Poor engagement with the literature	Researching the wrong problem
Grasp of methodology		Lack of generalizability	Not being able to explain end of the thesis what had actually been done
		Poor presentation	

Adapted from Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Universal qualities of a dissertation

The OUTSTANDING ENGINEERING dissertation

WRITING AND PRESENTATION

- Well written
- Clearly states the problem and why it is new and important
- Writing demonstrates clear thinking
- Sets out ideas clearly and concisely
- Presents a convincing argument
- Includes many details

Breadth and depth
Originality
Significance

CONTENT and OUTPUT

- Is original, significant, insightful and creative – puts things together in unique ways
- Shows intellectual effort, depth, and tenacity
- Takes knowledge to a new level;
- Is based on mathematical or physical science
- Addresses a new problem, large class of problem, or a problem that has been of great interest to the field
- Is thoroughly researched
- Invents new methods or devices
- Results in an elegant solution or a general method that applies to a broad class of problems
- Obtains results that are of interest to the larger community
- Results in several publications in top-ranked journals in different areas
- Opens new areas of research

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Universal qualities of a dissertation

The VERY GOOD ENGINEERING dissertation

WRITING AND PRESENTATION

- Well written
- clear

CONTENT and OUTPUT

- Very solid
- Comprehensive and coherent
- Original but not very significant
- Lacks the sparkle of elegance
- Is lacking in one of the key components (theory, methods, data analysis)
- Problem is not broad, interesting or significant
- Has solid theory, methods and data analysis
- Data and results are described in detail
- Misses several opportunities
- Has some obvious loose ends
- Makes a modest contribution to the field

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Universal qualities of a dissertation

The "almost" ACCEPTABLE ENGINEERING dissertation

WRITING AND PRESENTATION

- Difficult to understand
- May need strong editorial work
- Introduction is sloppy
- Does not place the work in context

CONTENT and OUTPUT

- Good work but feels incomplete
- Demonstrates the student can do research but does not demonstrate true mastery of the area
- Project is narrow in scope
- Is original but not very significant
- Does not make the case for why the research is new and important
- Is not particularly interesting or creative
- Shows lack of understanding of how referenced papers fit together
- The theory and methods are marginal
- The experiments are not exciting or do not work
- Connections are missed, not fully explored or made in a tenuous way
- Has some applications
- Is a small, weak contribution

…could often be returned with major corrections…

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

Matrix of components of the dissertation used for different disciplines

Disciplines	Components					
Biology, physics, engineering, economics, psychology, sociology	Introduction	Literature review	Theory	Methods	Results/data analysis	Discussion and conclusion
Mathematics	Introduction/ problem statement	Discussion of the literature	Statement of results/theorems	Approach to the problem (techniques)	Proof of results	Conclusion/ future directions

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation

TABLE 5.2.
Some Dimensions of the Different Components of the Generic Dissertation

Introduction	Literature review	Theory	Methods	Results/analysis	Discussion/ conclusion
• Problem statement • Research question • Motivation • Context • Summary • Importance • Road map	• Comprehensive • Up to date • Command of the literature • Contextualization of problem • Selective • Synthetic • Analytic • Thematic	• Appropriate • Logical • Understood • Alignment with question and methods • Strengths and limitations	• Appropriate • Detailed • Alignment with question and theory • How used • Advantages and disadvantages	• Appropriate • Alignment with question (and hypotheses) • Sophistication • Iterative • Amount and quality of data/ information • Presentation • Interpretation • Insights • Limitations	• Summary • Refers back to introduction • Ties everything together • Larger perspective • Strengths and weaknesses • Implications and applications • Future directions

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation and their characteristics at different quality levels

The next 5 slides have to be seen as a guide to be used to evaluate if your thesis is *"Outstanding"* or "*Acceptable*" , and this, for the different components of your Ph.D. thesis !!!

The components of a Ph.D. dissertation and their characteristics at different quality levels

	Outstanding	Acceptable
Introduction	▪ Well written ▪ Brief, interesting, and compelling ▪ Motivates the work ▪ Has a hook ▪ Provides a clear statement of the problem ▪ Explains why the problem is important and significant ▪ Place the problem in context ▪ Presents an overview of the theory, methods, results, and conclusions ▪ Lays out the study's implications ▪ Provides a road map of the dissertation	▪ Not well written or well organized ▪ Lacks or provides minimal motivation for the work ▪ Makes a case for a small problem ▪ Does not do a good job of explaining why the problem is important ▪ Provides minimum or poor context for the problem ▪ Presents minimal overview of the work

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation and their characteristics at different quality levels

	Outstanding	Acceptable
Literature review	▪ Comprehensive, thorough, complete, coherent, concise, and up to date ▪ Shows critical and analytical thinking about the literature ▪ Synthesizes the literature ▪ Integrates literature from other fields ▪ Displays understanding of the history and context of the problem ▪ Identifies problems and limitations ▪ Is selective – discriminates between important and unimportant works ▪ Identifies and organizes analysis around themes or conceptual categories ▪ Adds own insights ▪ Uses the literature to build an argument and advance the field ▪ Is like a good review article ▪ Makes reader look at literature differently	▪ Provides adequate coverage of the literature Demonstrates that student has read and understood the literature ▪ Lacks critical analysis and synthesis ▪ Is not selective-does not distinguish between more and less-relevant works ▪ Misses some important works ▪ Cites some works that are not relevant ▪ Is an undifferentiated list, “This person said this, this person said that” ▪ Does not put problem in context

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation and their characteristics at different quality levels

	Outstanding	Acceptable
Methods/ approach	▪ Original, clear, creative, and innovative ▪ Provides thorough and comprehensive description ▪ Identifies strengths and weakness / advantages and disadvantages ▪ Flows from question and theory ▪ Uses state-of-the-art tools, techniques, or approaches ▪ Applies or develops new methods, approaches, techniques, tools, devices, or instruments ▪ Use multiple methods	▪ Appropriate for the problem ▪ Uses standard or less sophisticated methods correctly ▪ Provides minimum or sufficient documentation ▪ Shows basis competence

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation and their characteristics at different quality levels

	Outstanding	Acceptable
Results / data analysis	▪ Original, insightful ▪ Uses advanced, powerful, cutting edge techniques ▪ Analysis is sophisticated, robust, and precise ▪ Is aligned with question and theory ▪ Sees complex patterns in the data ▪ Iteratively explores questions raised by analyses ▪ Results are usable, meaningful, and unambiguous ▪ Presents data clearly and cleverly ▪ Makes proper inferences ▪ Provides plausible interpretations ▪ Discusses limitations ▪ Refutes or disproves prior theories or findings	▪ Analysis is objective, routine, and correct ▪ Aligns with question and theory ▪ Produces small amount of thin data ▪ Results are correct but not robust ▪ Includes extraneous information and material ▪ Has difficulty making sense of data ▪ Interpretation is too simplistic

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

The components of a Ph.D. dissertation and their characteristics at different quality levels

	Outstanding	Acceptable
Discussion and conclusion	▪ Short, clear, and concise ▪ Interesting, surprising, and insightful ▪ Summarizes the work ▪ Refers back to the introduction ▪ Ties everything together ▪ Explains what has been accomplished ▪ Underscores and explains major points and findings ▪ Discusses strengths, weaknesses, and limitations ▪ Identifies contributions, implications, applications, and significance ▪ Places the work in wider context ▪ Raises new questions and discusses future directions	▪ Summarizes what has been accomplished ▪ Repeats or recasts the results or major points ▪ Does not address the significance or implications of the research ▪ Does not place the work in context ▪ Identifies a few, nonspecific next steps

Barbara E. Lovitts, Making the implicit explicit: Creating performance expectations for the dissertation, Stylus Publishing, Sterling, Virginia, 2007.

When to stop???

1. **You have worked hard to define the objectives of your project, to cut it out, to set up a timetable and to follow it, to evaluate and mitigate the risks (plan B) and to manage your project and the changes: so you have clearly and systematically defined the perimeter of your project. So you know when to stop! Respect your perimeter!**

2. **Ask yourself: Have I met the criteria and competencies set by the institution and the objectives of my project to obtain a doctorate? If so, you should stop!**

3. **Of course, discuss all this with your research director: It is very preferable that the decision to stop is common!**

4. **This is not the time to be distracted by: "We could write another paper before your defense?" ... But it's still your decision to accept or refuse!**

CAP7003E – Work Plan

Session 1 – A successful doctorate at Polytechnique: What are we talking about?

Objectives of doctoral research and of an engineering research project. General process governing a research project. Quality criteria and characteristics of doctoral research: strategies and resource mobilization. Expertise. Original and significant contributions. Collaboration and research partnership. Research results and impacts. Objectives and content of a thesis.

Session 2 – Doctoral journey, milestones, and expectations

Transition from research topic to research project. Major steps of a research project: organization and structure of the project. Emergence of the project and publication strategy. Phase of realization. Application: development of a first version of your research proposal and methodology of implementation.

Session 3 – Leading a research project

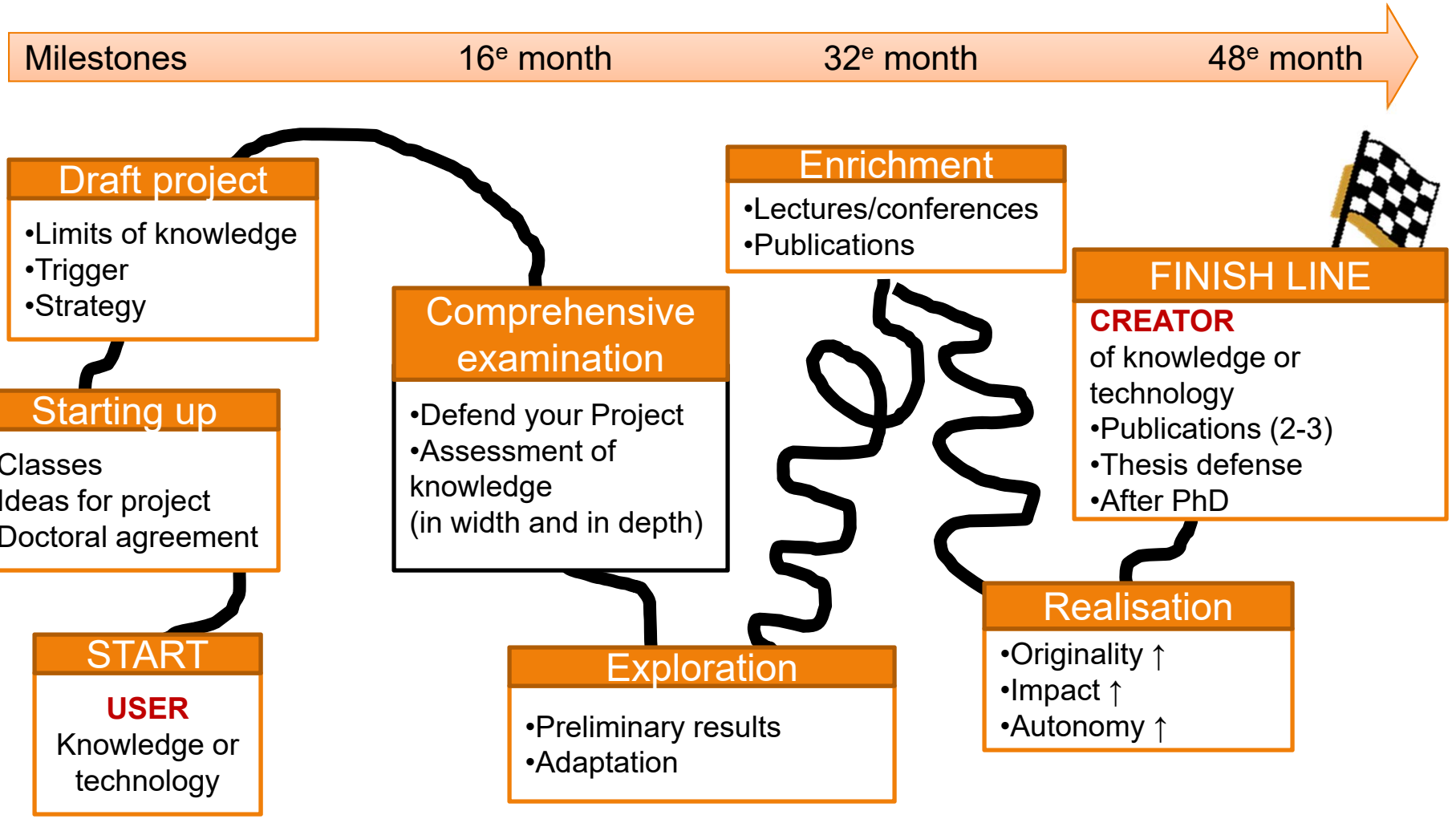
Processes associated with basic research, applied research, technological development and innovation. Conduct and management of a research project: definition, planning, execution and completion. Work breakdown structure. Organization of time, schedule. Milestones. Deliverables. Management of risks, risk mitigation. Human Resources and Industrial Partnerships. Cost planning. Application: critical evaluations of research proposals of doctoral colleagues.

Session 4 – Strategy for success during and after the doctoral program

Potential pitfalls related to a research project; strategies to avoid them. Management of time. Management of intellectual property. Research ethics Research ecosystem. Career management and expected skills of an engineering researcher. Application: self-assessment and review of your first version of your research proposal.

Typical doctoral path

…on a tentative basis



Features of North American PhD Programs

- No central, federal regulatory system
- Doctoral education is extremely decentralized
- Professors design the programs within the policies of their fields of study and the requirements of the institution
- Programs are somewhat structured, with some required course work and a few benchmarks towards dissertation completion
- Programs allow ample students' autonomy and room for self-directed inquiry
- Programs are embedded in departments responsible for both undergraduate and graduate education – teaching possibilities and pedagogical thinking
- PhD programs seek to transform students into independent researchers

Elizabeth Rudd, Improving PhD Quality in the "Small Worlds." EUA Workshop: Building a research environment for doctoral education, Wageningen University, Holland, April 15, 2010