

Preface

Thank you, reader, for giving me the chance to present to you this book.

The urgent message this book carries is a request to nurture *empathy* in all the people we can reach.

Why empathy?

The most moving interaction I have had in the last 10 years was with parents of small children fighting Type I diabetes, and the young adults who show so much bravery in their daily activities, constantly pricking their skin and injecting with needles the insulin and glucagon they need to stay alive.

Understanding the actual limitations of state-of-the-art technology was only possible after I talked to these people who really need a better solution. The information I gained with those conversations is not plainly written in the scientific journals or technological reports. You will not easily get it from the doctors or medical companies that have developed the best technologies.

Empathy enabled me to align very fast all my efforts towards the needs of the people who will benefit from the technology my team and I are developing, particularly to inject without needles.

Our world is in desperate need for other solutions to the many problems we face as humans, and I strongly believe you have chances of contributing positively to the whole challenge.

Why now?

Like my best teachers, I want to start with some questions, but please try to think about your answers before reading mine.

-
1. What if we could have a framework, independent of which historical moments we are living, that helps guiding in any direction: technical, economical, commercial, ecological, legal, etc.?
 2. Could we strip down to the bare minimum all those concepts and great books that I have seen to build such timeless framework?
 3. Would such a minimalistic approach be useful for someone out there?
-



Answers:

1. I am presenting you with an updated definition of engineering, knowledge, persuasiveness and empathy.
2. I compiled a nonexhaustive list of advice or tips for the future you may be facing anytime soon. It is this strong feeling that such guide is missing and necessary that motivated me to prioritize my time to work on this book.

3. I believe the answer is yes, based on the feedback given by my collaborators and former and current students. However, the ultimate answer will be if students and professionals can apply in their lives the things they learn from this book.

Who am I writing for?

Have you ever felt that something wrong around you could or should be fixed? For example, reducing the gas emissions of public transportation means, say a passenger bus. Do you feel that you are unprepared, or do you get frustrated that there is no clear path or point from where to start, such as how to get in contact with the bus manufacturer?

Even if you have spent years studying or working – at home or employed – I think that there is nobody who could resolutely say there is a magic formula or a step-by-step guide to solve a given problem. When I say “solve a problem” it may be something small, like solving a simple math problem, but it can also apply to something (really) big, such as trying to solve even a small aspect of the climate crisis.

I see this book as a sort of innovation guide for newbies and experienced professionals. If you are reading this as part of a course it will help those who feel the need to do more than just get another academic grade or degree and want to contribute to solving real-life problems.

This book will . . .

- provide you with my humble “cocktail” of basic ingredients that I think are needed for you to get started solving problems: knowledge, persuasiveness and empathy (KPE);
- clarify the words innovation and entrepreneurship, which you might have heard in different contexts;
- trigger very different ideas or feelings when discussing about soft skills, depending on your personal and professional journey;¹
- fill a knowledge gap: a “how-to-start-innovating guide for newbies” who are facing the twenty-first century;
- teach you new perspectives that expand beyond stories of people who already succeeded many years ago, where I refer to success in the context of achieving solutions and personal growth;
- give you a temporal proximity to “solutions in the making” explained by several innovating engineers and their companies. Their journeys may give some inspiration for your own journey.

¹ The challenge to teach students “how to innovate” for several years gave me the springboard to start writing about this topic.

This book will not . . .

- necessarily be the best starting point if you already have a clear solution and aim to start a company or entrepreneurial activities; however, you can check Section 4.6 and Chapters 5 and 6 for useful tips;
- be one of the following two types of books or articles typically found:
 - (a) containing only anecdotal stories of famous inventors, leaders of companies and politicians, labeled “a success” a long time ago, and
 - (b) very technical, academic or philosophical, which are mostly helpful for specialists in specific activities, such as product development, humanistic studies, business management, etc.;
- replace any of the available literature. It will be complementary to the types of literature listed above, a guide to action to get you started solving problems or at least trying to do so.

Thus, this book is meant for anyone who:

- wants to *know more or teach* about solving problems regardless of background knowledge;
- wants to undertake an innovation effort to improve or create a product or a service, take a scientific challenge, etc.;
- is considering creating or joining a company to become an active agent of change,
 - . . . or is just undecided; that’s also fine;
- learn about other people’s experience in doing all of the above.



Whatever your reason might be, I am very interested in establishing a dialogue with you, the reader. My aim is to improve this first attempt I have made to teach my tricks to new generations of problem solvers.

For this, please join the discussion at www.empathic-engineering.com.

In practice, this book is in the first place meant to be used in or along undergrad science, technology, engineering and mathematics (STEM) programs, i. e., BSc and MSc, but written in a way that can be understood by other people.

The majority of the examples are related to chemical engineering, with a focus on microfluidics and process intensification, because these are my most active areas of research. However, they are discussed at a basic level so that it can be understood by students without any prior chemistry-related knowledge.

Why am I the right person to tell you about this?

My mission with this book is to help STEM students primarily to be entrepreneurial and empathic. If you, as reader, consider to already have some of these qualities, bear with me because I believe we can always have a bit more of both qualities.

I was implicitly trained to innovate as a primary task (engineering, some would say). Yet, even when many study programs include innovation in one way or another,

students focus more on specific (technical) subjects based on knowledge you can find in classical textbooks or biographies – the trend changes slightly after graduation in real life.² Yet, I felt that the newer generations might need something extra that should not overload the already cramped study plans.

To avoid the trap that this book becomes another innovation or management guide,³ I tried to isolate myself as well as I could from what was already written, at least at the beginning. This allowed me to think how my past experiences could help those who, like me, would like to change the world for the better.

Reading any of the books and internet sources listing anecdotes or examples from innovators may not necessarily show you how to innovate, because it is hard to reproduce situations from other places and contexts – particularly if they happened long ago. However, I found analogies and convergence points between my ideas and the literature, which is a good sign, but I could not find a reasonably compact guide to innovate “right away.”

I want this book to help you while you are actually trying to solve the problem of your choice, now or in the future. To satisfy this desire, I spent some time packing different ideas, stripping them to the bare minimum, so that you can easily remember the basics.

My interest in getting all this out as soon as possible was fueled by the unique circumstances our world has endured since 2020. With the lockdowns imposed around the globe to reduce the impact of COVID-19, I could only imagine how people felt restricted to their rooms or houses, unable to study or feel useful. I tell more about this in Section 6.1.

In particular, my daughter was supposed to experience her first year at university. I started thinking, if I were in her situation, or at least her age, “what would I have done?” Empathizing with her, my students and other people limited by the pandemic, I searched my memory and published work to distil this book for you.

How to read it?

This book is not meant for you to read it in one go. If it is not used in a course, where your teacher will set the order and pace, I envisaged you could use it more like a consulting text or an entertainment non-fiction book. By that, I mean that you may benefit from reading chapters and sections in the proposed order, but you may also start where

² One of my students said to me: “*you have the unique advantage of not only having tried to innovate, but also having grappled with the challenge of trying to teach innovation. This sets your book apart from the in vogue entrepreneurship books.*”

³ There are many great books that serve these purposes! Some of them I duly cite.

you have the most urging question. There is sufficient cross-referencing to bring you from one side to the other.

I am naturally inclined to suggest you to try and start, er . . . , from the beginning! The main reason is that it starts “light” in content, and when it gets more dense, you will get warnings of a “rabbit hole” ahead – thus, enter if you have time, who knows what you might learn inside. The benefits of entering such holes tend to be evident in the long term.

Anyway, the chapters are:

1. Chapter 1, I am short of time! <i>Everyone</i>	— page 1
2. Chapter 2, Where to start engineering? <i>Students/teachers</i>	— page 3
3. Chapter 3, Give me facts . . . <i>Everyone</i>	— page 37
4. Chapter 4, Where did I read this? <i>Teachers and professionals</i>	— page 62
5. Chapter 5, Got it! Now what? <i>Everyone</i>	— page 87
6. Chapter 6, IEEE: interviewing empathic entrepreneurial engineers. <i>Everyone</i>	— page 118

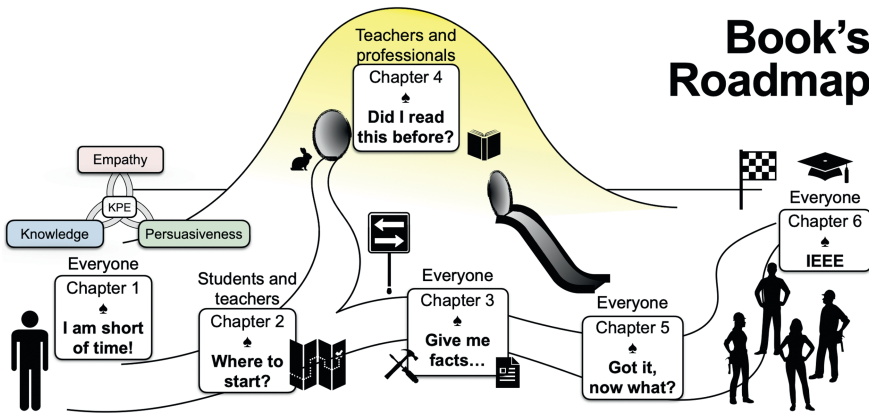


Figure 1: Suggested guide to read this book. Chapter 1 is so short that it would be a pity not to read it. Chapter 2 is still easy to grasp, while Chapter 3 gives more details and useful tools. Chapter 4 is a bit tougher to digest, and I put a rabbit hole to represent that it can get deep into some aspects. However, if you are in a rush, skip it for now, and go on to Chapter 5. Lastly, Chapter 6 gives snapshots of personal journeys through interviewing empathic entrepreneurial engineers.

I trust the reader will identify a logic structure in the choice of chapter titles, which I briefly explain now.

I know how difficult it is to keep our attention or focus on a single task or objective these days: everyone seems to have very limited time for anything. I condensed the most important elements of this book to fit in Chapter 1, which is only one page, not counting its Figure. I give here what you really must know to start solving problems

with “my ingredients” composing the KPE framework. I hope just glancing at it will trigger your curiosity and you will go further.

Chapter 2 gives a bit of guidance and expands on the basic elements given in Chapter 1, with basic tools that can help in the journey. Of great relevance, I provide my own definitions of what engineering should be today, or at least in the near future. In Chapter 3, my ambition is to give you a few examples, mainly from my own experience. This chapter may be updated or grow with the passage of time, e. g. newer editions.

Chapter 4 is for those who want to have more references to dive into or check what others have done in the past. Here I want to clarify the question “*Where did I read this before?*” citing most of the relevant books or articles I used, and that can help the interested reader go on further. I may have missed relevant publications. Therefore, send me a message if you can, suggesting any you believe should be included.

Chapter 5 will have a coaching character by providing tips aligned with the KPE framework that help in making steps to connect effectively to other people and grow professionally on your own. In Chapter 6, my views are analyzed through the lens of other innovators I know.

Along the way in the book, you will also find notes, assignments and cases with a strong link with real-life scenarios, besides personal experiences of colleagues and myself. The answers or extra evidence backing up the statements in the main text can be found in the appendices at the end of the book. I did this with the intention of clarifying the more abstract ideas discussed along the book’s narrative line.

These side steps in the story will help you apply knowledge for solutions, identify points of attention for your own self-assessment and find sources of inspiration.