

Your instructor: Daive Iannuzzi

# Entrepreneurship for Physicists

**THINK DIFFERENTLY**

- CH 1: MOTIVATION FACTORS
- CH 2: IDEA + CUSTOMER ADDED VALUE
- CH 3: EXPECTATION THEORY/RISK & UNCERTAINTY

**GET GOING**

- CH 4: FOUR PILLARS OF A BUSINESS MODEL
- CH 5: BUSINESS CANVAS AND STRATEGY
- CH 6: ACCOUNTING

**GOOD TO KNOW**

- CH 7: TRUST, PERSUASION, AND PEOPLE
- CH 8: THE TECHNOLOGY TRANSFER OFFICE

**WHAT HAVE WE LEARNED? (CH 9)**



**1. BIRD IN HAND**

- WHO AM I?
- WHAT DO I KNOW?
- WHOM DO I KNOW?

**2. AFFORDABLE LOSS**

- PRICE THAT I AM WILLING TO PAY TO GIVE MYSELF THE OPPORTUNITY TO ACHIEVE MY ENTREPRENEURIAL GOAL

**3. CRAZY QUILT**

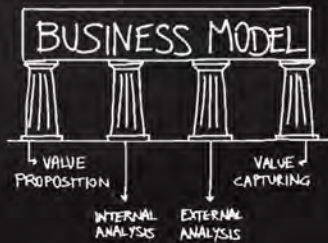
- ...STITCH TOGETHER THE PEOPLE I NEED
- ...OBTAIN THEIR COMMITMENT
- ...AND MULTIPLY MY MEANS

**4. LEMONADE**

- "IF LIFE GIVES YOU LEMON, MAKE LEMONADE!"

**5. PILOT IN THE PLANE**

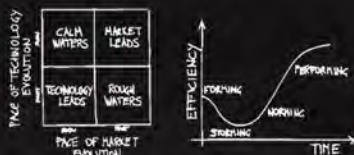
- "IF YOU CAN CONTROL IT, YOU DO NOT NEED TO PREDICT IT!"



**RESOURCES (THINGS YOU HAVE)**

- TANGIBLE
  - HUMAN
  - INTANGIBLE
- OR
- HUMAN
  - SOCIAL
  - FINANCIAL
  - PHYSICAL
  - TECHNICAL
  - ORGANIZATIONAL

**CAPABILITIES (THINGS YOU CAN DO)**



A PRACTICAL GUIDE TO MOVE INVENTIONS  
FROM UNIVERSITY TO MARKET

# Entrepreneurship for Physicists

A practical guide to move inventions from university to market



# Entrepreneurship for Physicists

A practical guide to move inventions from university to market

**Daide Iannuzzi**

*Vrije Universiteit Amsterdam*

Morgan & Claypool Publishers

Copyright © 2017 Morgan & Claypool Publishers

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher, or as expressly permitted by law or under terms agreed with the appropriate rights organization. Multiple copying is permitted in accordance with the terms of licences issued by the Copyright Licensing Agency, the Copyright Clearance Centre and other reproduction rights organisations.

#### Rights & Permissions

To obtain permission to re-use copyrighted material from Morgan & Claypool Publishers, please contact [info@morganclaypool.com](mailto:info@morganclaypool.com).

ISBN 978-1-6817-4668-5 (ebook)

ISBN 978-1-6817-4669-2 (print)

ISBN 978-1-6817-4670-8 (mobi)

DOI 10.1088/978-1-6817-4668-5

Version: 20171001

IOP Concise Physics

ISSN 2053-2571 (online)

ISSN 2054-7307 (print)

A Morgan & Claypool publication as part of IOP Concise Physics

Published by Morgan & Claypool Publishers, 1210 Fifth Avenue, Suite 250, San Rafael, CA, 94901, USA

IOP Publishing, Temple Circus, Temple Way, Bristol BS1 6HG, UK

*To Giacomo and Pietro.*



# Contents

<b>Preface</b>	<b>ix</b>
<b>About the book</b>	<b>x</b>
<b>Acknowledgements</b>	<b>xi</b>
<b>Author biography</b>	<b>xii</b>
<b>Introduction</b>	<b>xiii</b>
<b>1 Motivation factors</b>	<b>1-1</b>
Sense of accomplishment	1-2
One way to be different	1-3
If you are a parent	1-4
Fun	1-5
Money	1-5
A quick look at the literature	1-6
References	1-10
<b>2 The idea</b>	<b>2-1</b>
Technology-push	2-1
From 10× to SCAMPER	2-4
Market-pull	2-5
Reframing	2-7
Want to dance?	2-7
How about patents?	2-7
References	2-9
<b>3 Effectuation theory</b>	<b>3-1</b>
A lesson from prospect theory	3-1
Effectuation theory: introduction	3-2
Bird in the hand	3-3
Affordable loss	3-5
Crazy quilt	3-6
Lemonade	3-8
Pilot in the plane	3-9
Moving to the next step	3-10
References	3-10



<b>4</b>	<b>The four pillars of a strategic plan</b>	<b>4-1</b>
	Four pillars to start from	4-1
	Value proposition ( <i>which game are you playing?</i> )	4-1
	Internal analysis ( <i>can we play?</i> )	4-5
	External analysis ( <i>can we win?</i> )	4-6
	Value capturing model ( <i>is it worth playing at all?</i> )	4-11
	References	4-13
<b>5</b>	<b>Business canvas</b>	<b>5-1</b>
	The nine elements of the business canvas	5-2
	Entrepreneurship for physicists: business canvas of this book	5-4
	References	5-6
<b>6</b>	<b>Getting the numbers straight</b>	<b>6-1</b>
	Balance sheet	6-2
	Profit-and-loss (P&L) statement	6-3
	Working capital: matching P&L and balance sheet	6-5
	Free cash flow	6-5
	Future estimates	6-6
	Discounted free cash flow	6-6
	Comparing two projects with discounted free cash flow	6-8
	Reference	6-8
<b>7</b>	<b>Random thoughts worth spreading</b>	<b>7-1</b>
	Trust	7-1
	Team efficiency: from Lencioni to Tuckman	7-3
	Cialdini's six principles of persuasion	7-5
	Kotter's eight principles of effective management	7-6
	Team composition: culture and people	7-7
	The pitch	7-10
	References	7-12
<b>8</b>	<b>The role of the technology transfer office</b>	<b>8-1</b>
	TTO and the motivation of the scientist	8-1
	Friction on the Treacy–Wiersema frame and the funnel	8-3
<b>9</b>	<b>Entrepreneurship for non-entrepreneurs</b>	<b>9-1</b>

# Preface

The idea of writing this book came after a homonymous course that I have been teaching to the students of the Master of Physics in Amsterdam and, in a shorter format, to physics PhD students and postdocs of different organizations.

Saying that the course is different from what physicists usually get in class is probably an understatement. There is no equation to understand, no theorem to prove, no  $\hbar$ ; opinions matter, and, for every question, there is often more than one correct answer. For most of the people who attend the course, this aspect is hard to digest. Students are disoriented by the lack of solid foundations. Everything seems to be based on questionable arguments, and it takes a few lectures before they all get acquaintance with what some of them call ‘fluffy stuff’. On the other hand, as the course progresses, the atmosphere gradually change to a point that, at the end of the last lecture, several students confess that coming to my class was a refreshing experience. There is even a small group of crazy students who eventually decide to follow my suggestion and do something they would have never thought themselves able to do: start a business. As usual, however, the success of the course strongly depends on the attitude of the students. They need to keep an open mind approach and accept the different way of thinking that this subject brings with it. For this reason, at the start of my course, I always advise them to be ready to let the physicist part of the brain go, take a leap of faith, and try to enjoy the fact that, in business, the best answer to all questions is: ‘it depends.’ If they do that, they will eventually have some genuine fun.

I have written this book with the same spirit with which I have designed my course. It is first and foremost a book from physicist to physicist, despite the fact that the subject discussed has little to do with physics. In writing it, I have embraced all the doubts and perplexities that we, physicists, have towards everything that is related to business. I have then put all my enthusiasm to highlight the exciting aspects of the entrepreneurial process that brings ideas to market. I have further filled its pages with all the most relevant lessons that I have learned over the last ten years, sharing anecdotes, opinions, and arguments from the literature.

Although I expect that most of you will start reading the book with skepticism and will be tempted to abandon it after the first few chapters, I truly hope that everyone will hold tight and complete the journey, maybe only after taking that leap of faith I was talking about above. I also hope that the more senior colleagues will take this book as a starting point for considering whether it would be worth designing an Entrepreneurship for Physicists course for their students as well. I can guarantee that students are going to love it, and I am convinced that a course of this kind can be very beneficial for them, regardless of the career they will pursue in the future. Finally, I hope that the book will inspire a handful of you to bring an idea to market. If that happens, please, let me know: you will certainly make my day.

# About the book

Physicists are very smart people. Still, when it comes to moving their ideas from university to market, they often lack the basic set of know-hows that could help them succeed in the technology transfer process. To fill this gap, *Entrepreneurship for Physicists: a practical guide to move ideas from university to market* offers a concise analysis of the key ingredients that enable entrepreneurs to bring added value to their customers. After a short discussion on why university physicists should pay more attention to this aspect of their professional life, the book dives into a set of theories, models, and tools that could help an academic scientist transform an idea into customer added value. The reader will be introduced to effectuation theory, internal resource analysis, external landscape analysis, value capture, lean startup method, business canvases, financial projections, and to a series of topics that, albeit often neglected, do play a fundamental role in technology transfer, such as trust, communication, and persuasion. In the last chapter, the book explains how most of the concepts discussed actually find application in the career of scientists in a much broader sense.

# Acknowledgements

I would have never been able to write this book without the inspirational lectures of all of my MBA teachers from TIAS Business School, who introduced the most relevant pieces of the literature to me and offered their own interpretations, models, theories, and hands-on experience. I am particularly indebted to Robert Dew. I am sure that, reading my book and seeing how often I cite his fascinating lectures, you can have a feeling of how influential he has been to me and my classmates. I would also like to thank Carla Koen for the numerous stimulating discussions and for pointing me towards effectuation theory; Peter Gillis, whose lectures inspired a large part of chapter 7; Herbert Paul, for teaching me what strategy is and how to manage it, and for pointing me towards the resource based theory of a firm; Rudy Moenaert, for his enthusiastic and fascinating introduction to marketing and branding; and Frans de Roon, who introduced me to balance sheet, P&L, and cash flow (among other very interesting topics).

I would further like to express my gratitude to Enno Masurel, from the Faculty of Economics of the Vrije Universiteit Amsterdam, with whom we have designed and have been delivering the course Entrepreneurship for Physicists for the students of the Master in Physics of Amsterdam. I am enjoying this collaboration very much, and I am sure that what I have been learning from Enno dwarfs, in any aspect, what Enno may ever learn from me.

This book would have little value if it were not (at least partially) based on what I have learned via direct experience. I am deeply thankful to Hans Brouwer—my business partner in Optics11—who has shared with me all of his pluriennial experience as serial entrepreneur, and to Steven Tan, Nigel Wagstaff, and Bart Klijsen—the technology transfer office people who helped me get Optics11 off the ground—for the patience and professional attitude with which they have always treated my case. I am further thankful to all the people who are incubating their ideas at the Demonstrator Lab, because, in the attempt to support them, I am continuously learning new aspects of the idea-to-market process.

Finally, I would like to thank the two key partners this initiative has hinged on: my Publisher, who bravely embraced the idea of a book on entrepreneurship for an audience of physicists, and my family, who supported me through the entire process.

# Author biography

## **Daide Iannuzzi**

---



Daide Iannuzzi (PhD, University of Pavia, Italy, 2002; MBA, TIAS Business School, 2015) is a professor in experimental physics at the Vrije Universiteit Amsterdam and the Scientific Director of the Demonstrator Lab—Amsterdam Physics Research and Innovation Laboratory, in Amsterdam. Parallel to his academic career, he has developed an in-depth knowledge of the technology transfer process that brings scientific ideas to market, both via direct experience as an entrepreneur himself and via the support he has been offering, over the years, to numerous other startupper.

# Introduction

**Entrepreneur** /,ʌntɹəprəˈnɜ:(r)/ *noun* a person who makes money by starting [...] a business [1].

Madison Nicole Robinson is a teenager girl from Galveston Island—a narrow piece of land that stretches into the Texas Gulf, some 80 km south from Houston. When she was still a child, she used to spend most of her free time at the beach with her family. Like many other kids of her age, in those long days, she would often sit down with a piece of paper and a bunch of colored pencils to draw whatever would pass through her mind. It was on one of those days that, in 2006, she came up with an intriguing idea: why not use some of the colorful sea creatures she had drawn many times before as the background of a new line of beach sandals? Madison was only 8 years old. Encouraged by her father, who saw a lot of potential in his daughter and her newly designed shoes, and supported by some family friends, the little girl spent four years of hard work going from a kid’s sketch to a trade show product. Then, in July 2012, she wrote a solicitation letter to the famous fashion retailer Nordstrom. In response to that letter, Nordstrom decided to put Madison’s beach shoes in not less than 64 of its shops. A few months later, American journalist Adrienne Burke picked the story up and put it on the front page of yahoo.com [2]. The article went viral, and so did Madison’s flip flops. Today, Madison is considered a role model for young entrepreneurs, and, even if one may argue whether she would have been that successful without the support of her family, it is quite impressive to read that, when she was 16, her company had already sold more than 100 000 pairs of shoes [3].

A few years before that, on a day like many others, a kid named Fraser Doherty [4], from Edinburgh, Scotland, was on his way to pay a visit to his grandmother. Even though he was only 13, Fraser was determined to start his company and live the life of an entrepreneur. After trying out a couple of ideas, however, he had not been able to find the right product to build his company around. When he arrived at his grandmother’s house, he found her in the kitchen, preparing jam according to her secret recipe. It was in that precise second that Fraser had what he recalls as his ‘eureka moment’ [4]. After convincing his grandmother to teach him the recipe, he started to produce it in his own kitchen and sell it door-to-door in his neighborhood. Encouraged by the excellent results obtained in this first series of tests, he soon decided to move his sale activity to farmers’ markets. Yet, something did not sound right. The global jam industry was in continuous decline, and even renowned brands seemed to suffer. Why was that? After a bit of research, Fraser realized that the problem with jam was the large amount of added sugar that all commercial preserves apparently had. He thus modified his grandmother’s recipe to make it a 100% fruit jam, and started to pitch it to British supermarket chain Waitrose. After a couple of failed attempts and new starts, Fraser’s SuperJam finally entered the local grocery store, where, in the first day alone, it sold more than what all the other jam brands combined would sell in one month. It is not difficult to imagine how the story developed after that. Suffice to say that, at the moment of writing, Fraser is 24, and his company supplies more than 2000 supermarkets worldwide [5].

Madison and Fraser are not alone. There is a long list of entrepreneurship champions who became successful well before the age of 20. Juliette Brindak, for instance, was 10 years old when she created a social network for tween and teenager girls that, six years later, was valued to be a \$15 million business [6, 7]; Bella Weems founded her million dollar revenue jewelry when she was 14 [8]; and Farrah Gray, who is currently considered an icon of the entrepreneurial world, was only 6 when he started to sell homemade body lotions [9]. One could go on and on, listing names of teenagers who were able to start up their firm and make a living (and something more) with it. While it is clear that their success probably stems from a rare combination of personal skills and fortunate circumstances, when I look at these chaps, I cannot refrain from asking: why did it take me 39 years of my life to start a company?

I believe that there are at least four good reasons why people do not embrace an entrepreneurial career: lack of awareness (people do not know about the opportunities that this kind of career may offer), lack of motivation (people do not see the benefits of moving towards this kind of career), lack of resources (people believe that they do not have the resources to move towards this kind of career), and lack of know-how (people believe that they do not know what to do to move towards this kind of career). The goal of this book is to address all of these four issues for people like you, namely, physicists who are studying or working in an academic environment.

In this context, it is important to stress that I do not expect to be so convincing that, after reading this book, you will abandon your academic career to fully immerse yourself in your new startup. Actually, it would probably not be the wisest thing to do either. What I argue, however, is that, if you want, at least at the beginning of the technology transfer process, you can live two parallel lives, a bit along the lines of Dr Jekyll and Mr Hyde: the life of the researcher during the working day and the life of the entrepreneur in the time that is left. In other words, becoming an entrepreneur is an exercise that, at first, you can do while (rather than instead of) being an academic researcher. Furthermore, and maybe more importantly, even if you do not have any intention to start a company, you can still dedicate some time to look at how the entrepreneurial process works. In doing so, you may find a lot of useful tips that can be applied to a much more general context. What I mean is: adapting an entrepreneurial way of working to our professional life may prove to be, at times, a sensible thing to do even in situations that have nothing to do with the startup process.

The book is organized as follows (see below figure 0.1). In chapter 1, you will be invited to reflect on the motivation factors that may induce an academic researcher to follow an entrepreneurial pattern. Chapter 2 analyzes the first important step in an academic entrepreneurship process, when the scientist starts to appreciate the differences and analogies between scientific ideas and business ideas. In the third chapter, following a widely recognized model known as *effectuation theory*, we will discuss how entrepreneurs think about, create, and manage business opportunities. Particular emphasis will be given to the difference between risk and uncertainty, and to how this theory can mitigate a few key show-stoppers that often inhibit academic scientists from bringing their ideas to market. Chapter 4 is dedicated to the description of four pillars that every business plan relies on: value proposition (with a short introduction to the *lean startup method*), internal analysis (with a

discussion of the *resource based theory of a firm*), external analysis (with an analysis of the difference between *sustained* and *temporary competitive advantage*), and value capture model (with a reflection on the complexity of the sale process). All the points discussed above are then used in chapter 5 within the framework offered by the *business canvas model*—a practical tool that allows one to put an entire business plan on one sheet of paper. Chapter 6 provides a quick introduction to the main financial sheets that any entrepreneur must be familiar with: balance sheet, profit and loss statement, and free cash flow. In chapter 7, the focus is moved towards a series of seminal papers and good-to-know concepts that may help academic entrepreneurs boost their teamwork skills. Chapter 8 is dedicated to the role of technology transfer offices. In chapter 9, the topics discussed in the previous chapters are reviewed under a different perspective to stress how all that has been said can be more broadly applied to the career of an academic scientist well beyond the entrepreneurial process.

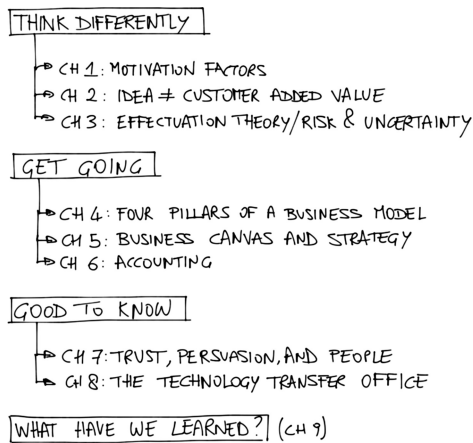


Figure 0.1. List of the main topics discussed in the book.

## References

- [1] Hornby A S 2011 *Oxford Advanced Learner's Dictionary of Current English* 8th edn (Oxford: Oxford University Press)
- [2] [https://www.yahoo.com/news/blogs/profit-minded/15-old-entrepreneur-got-her-product-nords-trom-233738356.html?soc\\_src=social-sh&soc\\_trk=tw](https://www.yahoo.com/news/blogs/profit-minded/15-old-entrepreneur-got-her-product-nords-trom-233738356.html?soc_src=social-sh&soc_trk=tw)
- [3] <https://smallbusiness.yahoo.com/advisor/blogs/profit-minded/from-fishflops-to-fifth-avenue--teen-entrepreneur-expands-192431319.html>
- [4] Doherty F 2011 *SuperBusiness: How I started SuperJam from my Gran's Kitchen* (Chichester: Capstone)
- [5] <http://www.fraserdoherty.com/pages/biography>
- [6] <https://missoandfriends.com/our-team-juliette-brindak/>
- [7] <http://www.telegraph.co.uk/technology/internet/10667632/Digital-natives-25-internet-success-stories-aged-25-and-under.html>
- [8] <https://www.origamiowl.com/ourstory>
- [9] <http://www.farahgray.com/about/>



## Entrepreneurship for Physicists

A practical guide to move inventions from university to market

**Daide Iannuzzi**

---

# Chapter 1

## Motivation factors

It is Friday evening. As you glance at the oscilloscope, you suddenly see a sharp spike. After checking its amplitude and its decay time, you have no doubts: your setup is finally doing what it is supposed to do. Impatient, you jump on the knobs to gather what seems to be the very first series of a beautiful set of data. At the end of the series, you change a few parameters, and start a new run. Outside is getting darker, but you are so focused that there is nothing that can distract you...except for one thing: at seven o'clock, your partner calls you to check whether you remember that your friends are coming to dinner that night. Pretending that you did actually remember, with a reassuring tone you confirm that you are about to go home. A couple of minutes later, however, you are still there, waiting for the new spike to come in. The phone goes off again. It must be your partner checking whether you actually left the lab. This is getting dangerous. You switch off the lights, close the door, and rush out of the building, with that mixed feeling of exhaustion and excitement that will accompany you for the rest of the night. You can already see the publication that will follow that successful experiment, the congratulations of your colleagues, and the applause that you will receive on the last slide of your presentation at the next conference. As the fresh air outside clears your thoughts, you suddenly realize that, actually, that instrument could have many more applications than those you have devised it for. Maybe some people would even pay some money to get one! You should go to the technology transfer office to see what they think about this idea. They might even offer you the opportunity to start a business around it. Wouldn't that be exciting? Wait a minute, though. That will delay your publication, because they will suggest that you make a patent out of your invention. And starting a business would take a lot of your time. It would entail a non-negligible financial risk and it would distract you from real science. Better to forget about it. Why should you bother, after all?

Drawing from my own experience (and from what I see when I interact with other entrepreneurs), in this chapter I will try to convince you that there is a bunch of good

reasons why, in situations like the one described above, you should think twice before giving up the opportunity in front of you. Let us start from one that a lot of people do resonate with.

## **Sense of accomplishment**

When I give a speech on entrepreneurship, I always start from telling the audience about the day I came up with the idea that eventually allowed me to start my company. A student of mine had just entered my office to explain to me a technical problem we were facing in a quantum mechanical experiment. To solve that problem, I proposed to him that he change his approach, and to explain what I meant, I drew the cross section of the new sensor I wanted him to work on. It was August 2005. As the student walked out happy, I made a list of other fields that the device could be applied to, and soon realized that I was faced with a golden opportunity to initiate a technology transfer process.

It took me six years (and a lot of mistakes) to bring that technology to a point where it could be of interest to other users. When I reached that point, I was introduced to serial entrepreneur Hans Brouwer, and, together, we decided to launch a company that could facilitate the introduction of my invention to market: Optics11.

Optics11 now counts some 20 employees and, with its products, it enables scientists all around Europe, China, Australia, North America, and the Middle East to do things that they could not do before. Isn't that great?

Yes, from my perspective, it is great! And that is exactly the point that I want to make. At the moment of writing, Optics11 is not a big company and it did not make me rich. Still, I can guarantee that the sense of accomplishment that I have been experiencing while interacting with Optics11's customers has no equal. There is no scientific paper, conference presentation, or successful experiment that has been able to give me the same kind of feeling. None of the works that I have done during my academic career gave me the same buzz that I had the day I closed the first sale with a German colleague, who still thanks me, any time we meet, for making him aware of our technology. I never felt so useful as the day a customer called me to say that, thanks to the instrument that Optics11's people have developed, he could finally write up a work he was struggling with; or when I read that another group, which I do not even know, has published a paper in which they make use of one of Optics11's products. And every time our marketing team, coming back from a demo, confirms that once again the potential users are impressed by what we can do, I cannot avoid smiling, as I cannot avoid smiling when I walk into the offices and laboratories of Optics11 and see how many jobs have been created from that initial spark that was ignited, in my office, in 2005.

So, here is a very good reason why you should start a company: you have the possibility to see *your* ideas spreading all around the world and creating new jobs, as yet another person is about to take the benefit of what *you* have invented, developed, and brought all the way to market. And that gives an immense sense of accomplishment.

But why would this set of achievements give a different feeling with respect to what we are used to with our academic results, you may ask? I believe that the answer to this question lies in the difference between *passion* and *pride*. Academic researchers are mostly driven by the passion for their job. Passion can withstand isolation. You can be a lonely researcher, turning the knobs of an old piece of equipment in the basement of a building in the middle of nowhere, and still feel the passion for what you are doing. When it comes to bringing your ideas to market, however, passion itself is not sufficient anymore. The real driver that makes you go outside the comfortable walls of your laboratory is the pride of delivering something special to another person. In other words, as suggested by Roberto Verganti, ‘Passion is about what you do. Pride is about what you deliver.’ [1] Keep this detail in mind when, in the next chapters, we look into some aspects of the entrepreneurial process.

## **One way to be different**

I do not consider myself as a ‘top scientist’. Yes, I have given some contributions to science, putting passion and a lot of hours into it. But I am perfectly aware of the fact that there is a very large number of researchers who have done and will continue doing much, much better than me. Yet, helped by a great deal of luck, I was able to collect some of the most prestigious grants that a European scientist can receive, and make a career that many other scientists, who may be better than me, would be very happy to have. So, what was the trick? How could I gain my bit of notoriety in such a competitive environment, where I clearly underperform with respect to the tip of the top? I believe that my unique selling point is my proven ability of combining fundamental physics and technology transfer. That is what makes me different; and, if you are going to follow a similar path, you will have an opportunity to claim that you are different as well.

I can imagine that for some researchers this argument may sound irritating. Funding agencies, universities, and research institutes have been recently adapting their selection criteria to the pressure that governments put on the societal impact of public research activities. Most researchers, especially those who work on very fundamental topics, do not like it; people like me are often seen as those who surrendered to this logic and are now nurturing this overall trend. To avoid any misunderstanding on this issue, I want to make clear a couple of things. First of all, not every physicist has to become an entrepreneur. Some of us would never be good at it (although I think this is really a very small minority) and some others prefer to work on subjects that do not offer that many opportunities for technology transfer, and one can certainly not blame them for that. Secondly, I agree that funding agencies should be extremely careful with cutting more fundamental, blue sky research. Extrapolating to the extreme, I think we all agree (maybe with the exception of some politicians) that it would be very sad to live in a world where research is only focused on technological applications, with no space for art, history, or philosophy, to name a few (if we take the wrong but common assumption that art, history, and philosophy never give opportunities for technology transfer).

Furthermore, history has taught us that the most important technological breakthroughs often find their roots in the most fundamental pieces of research. Therefore, if you are among the people who were irritated by my previous statements about being different, please, reconsider: I am with you. Yet, we have to recognize that entrepreneurship is one of the engines of our society, and promoting it in the academic environment via the right tools is not necessarily such a bad thing to do. Shall we really always condemn an academic scientist who wants to try to build an entrepreneurial career via a technology transfer process? Actually, does not it actually make sense to forge a physics department where the more fundamental researchers work side by side with colleagues who have some interest in, and possibly some experience with technology transfer?

As for those who were not irritated by my previous arguments and do actually get the added value of developing entrepreneurial skills, I would like to reiterate an undeniable fact: the best way to develop entrepreneurial skills and to make sure that other people see that you have developed those skills is to start a company. Even if your company nosedives and goes bankrupt after a few months, you will be able to prove that you saw the opportunity, took the initiative, and went through the whole process. And this is going to be a major asset of yours, which will stand out in your next job application or, if you stay in the academic environment, every time you apply for a grant.

It is further important to recognize that, if you decide to put one of your ideas into the market, there will soon be a group of people (your marketeers and sales people) whose job and salary depend on how well they can sell that idea to others. And that will make your invention spread at a speed that you have never witnessed before.

## **If you are a parent**

Researchers seem to agree that children who are born in a family of entrepreneurs are more prone to undertake an entrepreneurial career [2]. As one may expect, part of this phenomenon can be ascribed to pre-birth factors [2]. As far as post-birth factors are concerned, it has been recently demonstrated that the obvious elements that one may consider as most relevant, such as business ownership inheritance, access to cheaper capital, access to network and human capital, or transfer of know-how and skills, only contribute a small part of the phenomenon. Apparently, what induces the children of an entrepreneur to become entrepreneurs themselves is the ‘taste for entrepreneurship’ [3] that parents communicate ‘through role modeling’ [3].

I did not know about this phenomenon and its explanation before I started my company. Yet, I am glad to see that my kids may now appreciate that entrepreneurship is not something they should be scared of. By telling them about my entrepreneurial experience, I am showing them that even people who are as risk averse as me can find pleasure and satisfaction by venturing out, without the risk of jeopardizing their life—as long as every step is taken with due care, of course. I think they may say: ‘If daddy has done it, I can certainly do it too!’ And I think this is a healthy message that will help them in their life.

If you are a parent and you want to start a company, this is good news. If you are not a parent, you may still be intrigued by the idea that your colleagues, one day,

may find in you a source of inspiration. And that will contribute to the sense of accomplishment and to the career booster I was talking about a few pages back.

## **Fun**

A couple of years ago, my elder son, Pietro, asked me if we could go to Rotterdam to see the latest show by stand-up comedian Gabriel Iglesias, also known as *Fluffy*. Pietro is a big fan of this guy, who, apparently, these days is one of the best. I thought it was a good opportunity to have some quality time with my son, and, therefore, I was very happy to buy the tickets. Still, I was not really expecting much from the show itself. I was wrong. That guy is hilarious. I laughed till I cried, literally. When I came back home, I rushed to my wife to tell her how much fun it was. To make her understand what a wonderful evening we had, I went on repeating some of Fluffy's jokes. She did not laugh at all! I was able to get nothing more than a compassionate smile. That is to say: I cannot explain the experience of fun. People may feel my enthusiasm, try to understand my enjoyment, but they will never, ever be able to live it through me.

The reason I am telling you this story is because I would like to convince you that starting a company does bring a lot of fun. Unfortunately, I am not able to. Therefore, if you do not believe me on my word, you have to try it yourself. You will not regret it.

## **Money**

Let's face it, at times, physicists have a hard time recognizing that there is an actual value in activities that are not related to pure science. We somehow assume that the only place where good things can happen is our laboratory, the computer where we are running our simulations, or the piece of paper where we are elaborating our next theoretical model. You can thus imagine how my colleagues were looking at me when, in 2013, a few months after my promotion to full professor, I announced that I had enrolled in business school. Skepticism was the most polite of the reactions; disgust the most common one. One day, I was at the copy machine, printing out the next exam for my electromagnetism course, when a friend from the atomic physics group approached me:

'I heard that you are going to business school,' he said. 'That is a clever move. Because, you know how it goes: in physics, if you are smart, you get the Nobel Prize; in business, if you are smart, you become rich!'

This comment nicely reflects the common belief that business, after all, is all about money. For this reason, if you start a business, some people will look at you differently. They will think that you are in it just to become rich. Starting a company will give you the opportunity to put yourself in a better financial position, and they will judge you for taking that opportunity instead of staying devoted, full time, body and soul, to science. Is it really true that academic scientists start a business for money, though?

Let us go back to the comment of my colleague. Even though I have always been aware of the fact that I have no chance of winning the Nobel Prize, I must say that,

when I enrolled in business school, ‘becoming rich’ was not part of my program either (whatever ‘rich’ may mean). And the same applies to the first period after starting Optics11. Becoming rich was for me a remote and uninteresting possibility, dwarfed by the long list of other, noble reasons to have my company. Still, I was quite intrigued to know that, if everything did go well, my effort could lead to some form of monetary compensation. In other words, even if becoming richer was not the goal of starting my business, I was sympathizing with the idea that money might become a pleasant consequence.

As time was passing, this not-very-romantic aspect of the technology transfer process started to silently creep inside my latent greediness. When I finally realized that it was time to let my company go with its executive team, I was genuinely surprised to discover that, actually, I was not that disappointed to give up control and intellectual ownership. My attitude towards money had changed so much that for me Optics11 had become, first and foremost, a financial investment. To protect my financial investment, the best thing to do was to let others make the company grow, which, eventually, is what counts.

I have seen several colleagues following a similar path. No academic physicist starts his/her business with the goal of making money, let alone becoming rich. None of them sells his/her soul to the evil of profit. Still, all of them do sympathize with the idea that, in starting a business, they have some chance, in the long term, to harvest a financial return on what they are about to invest in. As the possibility of collecting that return on investment becomes more realistic, most of them realize that, after all, it is not that bad to be a bit more money driven—an attitude that, incidentally, will help them let things go when it will be time to do it.

In the light of the discussion above, one may ask whether academic scientists would start a business if they did not have any financial interest in it. After all, money is only a collateral aspect of the process, and it appears not to be a motivation factor. My simple answer to this question, based on my experience and on what I have seen around, is no. That remote possibility to harvest monetary compensation at the end of the process is what, according to Frederick Herzberg’s dual factor theory (see, for instance, [4]), one would call a *hygiene factor*—an aspect of the job that, by itself, cannot motivate someone to do something, but that it must be put in place to avoid dissatisfaction with the task assigned.

One may thus say that, in an academic startup process, money is a hygiene factor that, with time, will transform into a motivation factor. The prospect of becoming richer is a little bit like the prospect of writing a scientific paper. We do not start a research project just to write a paper, but we would never start a research project if we knew, *a priori*, that that work could not be published. As the results start to come in, the prospect of writing a nice paper becomes more and more real, motivating us to stay late in the lab and collect better data. Can we really blame scientists for doing that?

## **A quick look at the literature**

In the first theory of the entrepreneur that is known to the literature, dating back to no later than 1755, Richard Cantillon defined the entrepreneur as ‘someone who

engages in exchanges for profit; specifically, he or she is someone who exercises business judgement in the fact of uncertainty’ [5]. Some 230 years later, in an attempt to summarize the existing literature on the economic theory of entrepreneurship, Robert E Hebert and Albert N Link proposed to define an entrepreneur as ‘someone who specialized in taking responsibility for and making judgmental decisions that affect the location, the form, and the use of goods, resources or institutions’ [6]—a definition that, as recognized by the authors themselves, closely recalls the one put forth six years earlier by Mark Casson, who suggested that an entrepreneur is ‘someone who specializes in taking judgmental decisions about the coordination of scarce resources’ [7]. As stressed by Jeffery S McMullen and Dean A Shepherd, however, ‘a decision is a necessary but insufficient condition for the occurrence of entrepreneurship. [...] entrepreneurship requires one not just to decide but to decide to act’ [8]. Likewise, in another widely accepted definition reported in 2000 by Scott Shane and Sankaran Venkataraman, entrepreneurs are defined as people who go through a process whereby ‘opportunities to create future goods and services are discovered, evaluated, and exploited’ [9].

To emphasize the importance of acting, in 2006 McMullen and Shepherd proposed that the entrepreneurial process is actually a two-step process [8] (see figure 1.1). In the first stage, the entrepreneur recognizes that there exists a third-person opportunity emerging from a technological change. In the second stage, he/she evaluates whether that third-person opportunity is actually a first-person opportunity. If he/she assesses that the third-person opportunity is worth bearing the associated uncertainty, he/she will take action to exploit that opportunity. The authors further stressed that, in both stages, there are two pivotal instances that will determine the difference between a person who will see the third person opportunity and take action and a person who will either not see the third-person opportunity at all or not transform it into a first-person opportunity. These two instances are *knowledge* and *motivation*. In McMullen and Shepherd’s words: ‘[...] the willingness to bear the perceived uncertainty associated with an entrepreneurial act is representative of a belief–desire configuration, in which belief of what to do is a function of knowledge and desire of why to do it is a function of motivation’ [8].

It is important to stress that *knowledge*, in this context, does not necessarily refer only to *technological knowledge*, which will be anyway discussed in chapter 2. As we

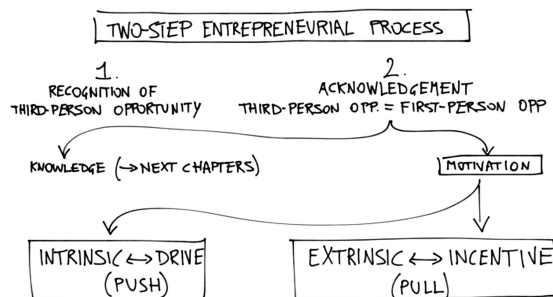


Figure 1.1. The two-step entrepreneurial process as indicated by [7–11].

will see in chapter 3, in fact, entrepreneurs rely on their entire range of assets, including network, personal traits, know-how, and ability to gather information and to cope with uncertainty.

As for *motivation*, which is the topic of this chapter, as early as 1934, Joseph A Schumpeter identified a series of traits that would push an entrepreneur to take action, including ‘self-centeredness [...], the dream and the will to found a private kingdom [...], the will to conquer [...], and the joy of creating [...]' [9]. Since then, the literature has tried to gain more insight into the reasons why some people take action faced with an opportunity and others do not, but, despite the enormous progress, the results seem to remain, at best, incomplete. In a paper of 2011, for instance, Alan Carsrud and Malin Brännback do not hesitate to say that ‘motivation [...] remains largely underresearched [...] despite its critical importance to predicting and explaining entrepreneurial behaviors’ [11]. So, what can we really say about the motivation factors that push an entrepreneur to start his/her firm?

In the first place, as one would intuitively expect, motivation factors come into two flavors (see figure 1.1): *intrinsic* motivation factors and *extrinsic* motivation factors (see [11] and references therein). Intrinsic motivation factors are associated with the entrepreneur’s personal ambitions to achieve a goal, whereas extrinsic motivation factors are triggered by external conditions. In fact, the literature typically distinguishes between *drive* theories, which describe the entrepreneurial process as triggered by an internal need, and *incentive* theories, which describe the entrepreneurial process as triggered by external rewards [11]. Typically, drive theories are more focused on the negative factors that may *push* a person to look at entrepreneurship as an opportunity to mitigate a situation of distress, whereas incentive theories essentially look at the positive factors that would *pull* an entrepreneur to start his/her company [11]. Push factors include ‘risk of unemployment, family pressure, dissatisfaction with one’s present situation [...], a bad situation in the labor market, and the lack of interesting offers and job positions’ [12], while pull factors encompass, for instance, ‘self-realization and personal satisfaction, [...] the need for autonomy [...], the need for achievement [...], the acquisition of priceless experience, the opportunity to realize one’s potential and be satisfied with one’s work, and the endeavor to achieve high earnings and the accumulation of wealth’ [12] (see [12,13] and references therein).

If we narrow the analysis to academic entrepreneurs, we are faced with a general lack of systematic investigations on the motivation factors that may induce faculty members, postdocs, PhD students, or even younger members of the academic community to embrace an entrepreneurial career (see [13,14] and references therein). Most academic entrepreneurs seem to be pulled into the startup process by incentive motivation factors, including technology diffusion, further technology development, personal financial gain, career enrichment, job creation, and skill enhancement [13,14]. Some academic entrepreneurs believe that starting a company is part of the public service that academics bring to society, in that it allows them to further develop a technology that, eventually, can have impact on society [13], while a study carried out among Italian researchers showed that PhD students may be pushed into the entrepreneurial path by a lack of career perspectives in the academic sector [15]—a



condition that probably applies to a good fraction of the younger readers of this book. Alice Lam further proposed to divide academic entrepreneurship motivation factors into three main categories (see figure 1.2): *ribbon*, which refers to the desire for peer recognition via publications, invitation to conferences, citations, and awards; *puzzle*, which stems from the opportunity to use one’s creativity skills throughout the technology transfer process; and *gold*, which emerges from the possibility to improve one’s financial position [16]. In a study conducted in 2011, she concluded that ‘there is no one single type of entrepreneurial scientists driven by a common motive’ [16], although one can separate between *reluctant commercializers*, who are exclusively driven by the ribbon, *strategic commercializers*, who are driven by a combination of ribbon and puzzle, and *the committed commercializers*, who are driven by a combination of puzzle and gold.

Of course, in general, a person will start an entrepreneurial career only if the prospective benefits outweigh the prospective costs [17], or, in other words, if the perceived utility of taking action is higher than the perceived utility of not doing it—a topic that will be discussed more thoroughly in chapter 3.

For a physicist used to analyzing complex theories or experimental results, the findings of this short literature review may sound a bit thin. The papers described do put a bit of order in the topic and are certainly useful for the policy maker, who could use these studies to stimulate the entrepreneurial spirit of the community they operate in. Yet, all of the motivation factors listed above are quite obvious in hindsight and may not really help the reader in getting any more excited about the prospect of starting a company. Even worse, you may now be faced with the dilemma of asking yourself which of the motivation factors listed above apply to you, if any. Still, I hope that with this review you can at least overcome one of the main hurdles that a lot of our colleagues experience when they are confronted with the opportunity to start a company, namely, the lack of awareness. From now on, in fact, you cannot neglect that a lot of people like you have found a very diverse range of very convincing motivation factors that pushed or pulled them into the entrepreneurial world. And if you still do not find your drive or incentive in the lists reported above, just keep in mind what Murray B Low and Ian C MacMillan said in 1988: ‘It seems that any attempt to profile the typical entrepreneur is inherently futile’ [18].

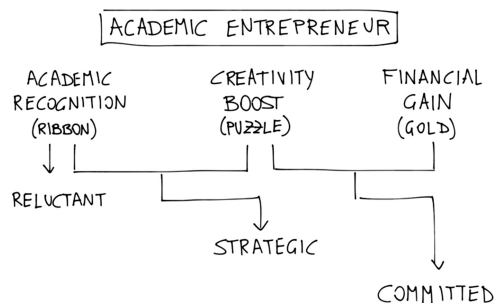


Figure 1.2. Motivation factors for academic entrepreneurs as reported in [16].

## References

- [1] Verganti R 2009 *Design-Driven Innovation* (Boston, MA: Harvard Business Press)
- [2] Laspita S, Breugst N, Hebllich S and Patzelt H 2010 Intergenerational transmission of entrepreneurial intentions *J. Bus. Venturing* **27** 414 (and references therein)
- [3] Lindquist M J, Sol J and van Praag M 2015 Why do entrepreneurial parents have entrepreneurial children? *J. Labour Econ.* **33** 269
- [4] Huczynski A A and Buchanan D A 2013 *Organizational Behavior* 8th edn (London: Pearson)
- [5] As quoted by [8]
- [6] Hebert R F and Link A N 1988 *The Entrepreneur: Mainstream Views & Radical Critiques* 2nd edn (New York: Praeger)
- [7] Casson M 1982 *The Entrepreneur: an Economic Theory* (Oxford: Martin Robertson)
- [8] McMullen J S and Shepherd D A 2006 Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur *Acad. Manage. Rev.* **31** 132
- [9] Shane S and Venkataraman S 2000 The promise of entrepreneurship as a field of research *Acad. Manage. Rev.* **25** 217
- [10] As quoted by [7]; see ed Schumpeter J A 1934 *The Theory of Economic Development: an Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* (Boston, MA: Harvard University Press)
- [11] Carsrud A and Brännback M 2011 Entrepreneurial motivations: what do we still need to know? *J. Small Bus. Manage.* **49** 9
- [12] Staniewski M and Awruk K 2015 Motivating factors and barriers in the commencement of one's own business for potential entrepreneurs *Econ. Res.-Ekonomiska Istraživanja* **28** 583
- [13] Hayter C S 2011 In search of the profit-maximizing actor: motivations and definitions of success from nascent academic entrepreneurs *J. Technol. Trans.* **36** 340
- [14] Hayter C S 2015 Public or private entrepreneurship? Revisiting motivations and definitions of success among academic entrepreneurs *J. Technol. Trans.* **40** 1003
- [15] Rizzo U 2015 Why do scientists create academic spinoffs? The influence of the context *J. Technol. Trans.* **40** 198
- [16] Lam A 2011 What motivates academic scientists to engage in commercialization: 'gold', 'ribbon' or 'puzzle' *Res. Policy* **40** 1354
- [17] Levesque M, Shepherd D and Douglas E 2002 Employment or self-employment: a dynamic utility maximizing model *J. Bus. Venturing* **17** 189
- [18] Low M B and MacMillan I C 1988 Entrepreneurship: past research and future challenges *J. Manage.* **14** 139