Critical Acclaim for *Crafting Your Research Future*

*“Ling and Yang summarize the practical aspects of the expectations for the modern graduate student. They will all benefit.”*

—Randy Goebel, Professor of University of Alberta

*“It will be tremendously useful to post-docs and graduate students alike (and perhaps even some junior faculty!)”*

—Adrian M. Owen, Professor and Canada Excellence Research Chair, Western University

*“Want to have a successful research career? This is a nice guide and companion!”*

—Jiawei Han, Abel Bliss Professor, University of Illinois at Urbana-Champaign

Crafting Your Research Future
A Guide to Successful Master's and Ph.D. Degrees in Science & Engineering
Charles X. Ling and Qiang Yang

ISBN: 978-3-031-79350-9 paperback

ISBN: 978-3-031-79351-6 ebook

DOI: 10.1007/978-3-031-79351-6

A Publication in the Springer series

*SYNTHESIS LECTURES ON ENGINEERING*

Lecture #18

Series Editor: Steven F. Barrett

**Series ISSN**

ISSN 1939-5221 print

ISSN 1939-523X electronic

# Crafting Your Research Future

## *A Guide to Successful Master's and Ph.D. Degrees in Science & Engineering*

**Charles X. Ling**
University of Western Ontario, Ontario, Canada

**Qiang Yang**
Hong Kong University of Science and Technology, Hong Kong, China

*SYNTHESIS LECTURES ON ENGINEERING #18*

## ABSTRACT

What is it like to be a researcher or a scientist? For young people, including graduate students and junior faculty members in universities, how can they identify good ideas for research? How do they conduct solid research to verify and realize their new ideas? How can they formulate their ideas and research results into high-quality articles, and publish them in highly competitive journals and conferences? What are effective ways to supervise graduate students so that they can establish themselves quickly in their research careers? In this book, Ling and Yang answer these questions in a step-by-step manner with specific and concrete examples from their first-hand research experience.

## KEYWORDS:

Research Methodology, Research Career Guidebook, Guidebook for Graduate Students, Ph.D. and Masters Research, Writing and Publishing Papers, Writing Ph.D. Thesis, Science and Engineering Career.

# Contents

# Author Biographies

# Acknowledgments

First of all, we thank the thousands of graduate students and researchers who attended our seminars on how to conduct solid research and how to write and publish top-quality papers. To these students: your enthusiasm for research, your questions, and your suggestions helped us tremendously in preparing and finishing this book. It is our wish to motivate and support more young researchers in their path toward a successful research career.

From Charles Ling: I wish to dedicate this book to my parents Zongyun Ling and Ruqian Cao. They were both life-long, awarding-winning, high-school teachers. They gave me so much inspiration and guidance throughout my youth, which laid the foundation of my research life from my graduate study to a full research career. This book summarizes over 20 years of experience as a researcher, which represents a direct outcome of my parents' love, care, and life-long education for me. I wrote parts of this book on the bedside of my father when he stayed in the hospital for several months in 2011. The book is for you!

From Qiang Yang: I dedicate this book to my parents, Professors Haishou Yang and Xiuying Li, who were professors in China's Peking University and Tsinghua University, respectively, where they worked all their lives until retirement. My parents inspired me to pursue a research career in Astrophysics and then Computer Science. Through their own exemplary research careers, they showed me the "garden of research," which is "full of beautiful flowers waiting to be picked" (to quote from my father). To them: my deepest love and appreciation!

Many colleagues, friends, and students read the early drafts of the book, and made many detailed suggestions and comments. Brian Srivastava, a very capable Ph.D. student at Western, provided detailed and thorough suggestions and comments in early draft of the book. Lili Zhao, a research assistant in Hong Kong University of Science and Technology (HKUST), made detailed edits. Luiz Fernando Capretz, Jimmy Huang, Huan Liu, Aijun An, Steve Barrett, Wei Fan, Jenna Butler, Randy Goebel, Eileen Ni, and many others gave us suggestions on various parts of the book. Adrian Owen, Stephen Sims, C.B. Dean and Jiawei Han gave us encouragement after reading parts of the book. Many of our former Ph.D. students, especially Victor Sheng and Weizhu Chen, gave us comments and suggestions. To all: our special gratitude!

# Preface

When we were children, we were often asked, “What do you want to be when you grow up?” Our answer, and dream, was: “I want to become a scientist!” Indeed, we have many giants to look up to: from Newton to Einstein, to Nobel Laureates (such as Richard Feynman). However, when we really went through the process of becoming scientists, we found that the road was not all that straightforward; it was full of misconceptions that took many instances of trial and error to find out. True, there are numerous online articles and commentaries, telling young people how to become a successful researcher and scientist, but most are scattered and some are biased. There has not been a central place where one can find advice targeted to answering such questions about the first and most important stepping stone toward becoming a researcher: graduate study.

This situation will hopefully be changed with the publishing of this book, “Crafting Your Research Future.” Summarizing more than 20 years of experience in research and practice, we have put together an accessible introductory book for aspiring researchers in science and technology.

We strive to make this book accessible to a general audience such that it could be used by readers interested in general areas of science and technology. At the same time, we try to be as specific and concrete as possible, to show you step by step, how research is conducted. We also include several case studies and many specific examples.

The book also summarizes over a decade of seminars and talks at over 50 universities and institutes across the world on the topics: how to do research and how to write and publish research papers. In all our talks and seminars, the attendance has been overwhelming, with hundreds of students and faculty filling the lecture hall. Questions and answer periods stretched beyond the talk. Each seminar gives us a chance to improve our presentation, and this book is the latest in this effort.

Here is a brief overview of the book.

Chapter 1 sets the general stage for the book, by discussing what research is, and what researchers are.

Chapter 2 discusses the goals of research and lays down the basic steps toward a research career.

Chapter 3 answers the question of how to get started by looking for a suitable supervisor, reading relevant literature and getting new ideas. It advocates a principled method with three key steps to guide any research effort.

Chapter 4 presents a general methodology on how to evaluate potential directions in order to find one that is high impact, and how to conduct solid and thorough research. It goes into details on the differences between empirical, theoretical, and multidisciplinary research.

Chapter 5 discusses how to write and publish high quality papers in competitive journals and conferences. It also provides perspectives from reviewers of journal and conference articles, and provides tips on how to handle reviewers' comments.

Chapter 6 presents a collection of commonly met misconceptions and pitfalls, and offers useful tips on paper writing.

Chapter 7 discusses how to plan, organize and write a Ph.D. thesis, and how to defend a Ph.D. thesis. It presents two typical approaches: top down and bottom up.

Chapter 8 gives readers a detailed picture on life after Ph.D. by depicting a realistic picture of the life of a professor. This chapter also discusses important issues such as technology transfer.

Both authors have been university professors for over 20 years, and have supervised many Master's and Ph.D. students. Some of our Ph.D. students are now professors in universities in the US, Canada, China, and other countries. Some are researchers in research institutes and research labs at Google, IBM, and other companies. Some are running start-up companies successfully.

We have put a lot of effort into helping our students to choose thesis topics, do solid research, and to publish top-quality papers. Often co-authoring papers with students in our research, we have published over 300 peer-reviewed journal and conference papers. We have also been Associate Editors and Editor in Chief of several top-ranked journals in the computer science field, such as IEEE[1] Transactions on Knowledge and Data Engineering and ACM[2] Transactions on Intelligent Systems and Technology.

A more detailed biography of the authors can be found at the end of the book.

[1] IEEE: Institute of Electrical and Electronics Engineers

[2] ACM: The Association for Computing Machinery