The Art & Science of Technology Transfer

PHYLLIS L. SPESER

WILEY

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This book is dedicated to my father, David, who taught me that marketing and sales is just a matter of walking in the other guy's shoes.

Contents

Acknowledgments

When you come to the end of an exercise like this book there is a moment of sadness and loss. After such a long time, you miss the regularity of writing. But the moment is immediately replaced by relief that the book is done and gratitude for the people who made it possible to finish.

Like every author, I find there are too many to thank by name, so I too will focus on those few who made the difference between quitting and continuing. Tops on my list is my Mom. Not only is she the woman who said "You can do this," she has spent countless hours editing the text. Next is my Dad, who has always been there to teach and support. Susan McDermott of John Wiley & Sons also deserves thanks for being kind when I was late and encouraging when I promised to finish.

I also want to express my gratitude to the citizens of Providence, RI, where I moved in January 2005. I have spent countless hours in restaurants outlining chapters or typing away at my notebook computer. To my amazement, people actually took an interest in what I was doing. They asked me to explain it, offered suggestions, and were supportive. Talk about being blessed! And special thanks to Mayor David N. Cicilline and his economic development team for encouraging us to move here. If you have a high tech company and are not sure where to locate, call me about Providence. I'm a happy camper.

I also want to thank Roland Tibbitts, who developed the first federal Small Business Innovation Research program at the National Science Foundation, and Bob Wrenn, who initiated—and for many years ran—the SBIR program at the Department of Defense. Roland and Bob, you have been an inspiration and friends.

We at Foresight have been fortunate to have awards from U.S. Department of Agriculture, the Department of Education, and the National Science Foundation SBIR programs to study how to do technology transfer better. I also want to thank the Office of Naval Research for supporting beta testing of our methods through their Long Term Scientific Research Broad Agency Announcement and Vinny Schaper, now retired, who was the Navy SBIR program manager who encouraged me to apply. Of course,

I need to add the findings and conclusions and recommendations in this book are mine alone and do not reflect the views of the government.

I also want to thank our customers at Foresight, with a special thanks to the following SBIR program managers: Jim Gallop of EPA, Charles Cleland of USDA, and Larry James of DoE who have encouraged us to experiment with our commercialization support program in order to better help their awardees attain commercial success. If you are a small company and do not know about SBIR, you need to find out. No matter what agency you work with, you will be fortunate to meet some of the finest people in the science, engineering, and technology community. All we can hope is that every federal civil servant is as dedicated to the wise use of the taxpayer's dollar.

A special thanks goes out to my son Arendt, and two of his buddies from Haverford, Joe Bender and Chris Penfield, who worked many vacations at Foresight when we hit overload. I also want to thank my daughter, Ariel. They spent countless hours around the dinner table discussing my research. What I have learned from "my three sons" and my daughter cannot be adequately acknowledged. How many people get to toss ideas around with amazing bright young folks who also love you?

Finally, I want to thank the people of my company, Foresight Science & Technology. Hillary Clinton was famous for saying "It takes a village to raise a child." I can tell you it takes a team to move technology. I have been honored to work with the best, the brightest, and the most fun-loving people in the world.

Phyllis Leah Speser
Providence, RI
October 28, 2005

About the Author

Phyllis Leah Speser is the co-founder and team leader of Foresight Science & Technology (Providence RI), where she is the senior executive for the company and focuses on strategic planning and new product development. Dr. Speser holds a Ph.D. and a J.D., cum laude, from the State University of New York at Buffalo. She has supported commercialization of technologies in all fields, is the developer of the Technology Niche Assessment™ and Virtual Deal Simulation™ methods used by Foresight, She has served as Principal Investigator on numerous federal R&D awards focused on application of artificial intelligence to technology transfer and commercialization. She also has authored many other publications on technology transfer/commercialization and is a frequent speaker at professional society and trade association meetings.

Dr. Speser was the lead lobbyist for the Small Business Innovation Development Act, developer of the Small Business Technology Transfer Research program concept with Roland Tibbetts, and a lobbyist for the Technology Transfer Act of 1989. During her ten years as a lobbyist she was instrumental in enacting legislation protecting archaeological and environmental resources as well as serving as the point person for the science community on the federal budget as Executive Director of the National Coalition for Science and Technoloy.

Dr. Speser served two terms on the Board of the Technology Transfer Society, is a recipient of the society's Certificate of Appreciation (1991), was Chairman of its Task Force on National Technology Transfer Policy (1989–1991) and a co-author of the Best Paper at its 1987 annual meeting. She was a gubernatorial appointment to the Board of the Washington Technology Center from 1994 to 1997 and is a member of the Bar Association of the District of Columbia, the Licensing Executives Society, and the American Association for Artificial Intelligence and has been listed for years in numerous Who's Who publications. She has been active in public service, including helping to start and serving as the founding chairperson of the Glen Echo Park Foundation (now the Glen Echo Park Partnership for Arts and Culture Inc.) and the Olympic Peninsula Foundation (renamed the Northwest Natural Resource Group in recognition of its expansion to serve the entire Pacific Northwest).

The accomplishment she is most proud of is raising two wonderful children.

Preface

I was educated as a political philosopher and philosopher of law. My graduate work, in the SUNY Buffalo Department of Political Science and Law School, focused on problems of judgment and how we can make reasonable political judgments. I wrote a dissertation on the topic. So why am I writing this book? The short answer is that technology transfer is a problem in applied judgment. Deals are based on two parties agreeing on what is a reasonable exchange. Understanding how they come to this conclusion is an interdisciplinary problem that builds upon insights from the social scientific, economics/business, and legal literature interpreted in light of a healthy dose of practical experience.

The real reason, however, has to do with the contingencies of life. In the mid-90s I was living in Port Townsend, WA. I was "*equity tripping,*" a quaint term used on the Olympic Peninsula for living off the funds gained when a business is sold. In my case, I had done an asset sale of a government relations business in Washington, DC. I had started that business after graduate school, when the opportunity to make a difference seemed more attractive than studying about how others might make a difference.

As a lobbyist I had specialized in science and technology legislation. Among other legislation, I played key roles in the establishment of the Small Business Innovation Research (SBIR) Program government-wide, the Small Business Technology Transfer Research (STTR) Program, and the 1984 amendments to the Stevenson-Wydler Act. So I had a pretty good view of technology transfer from the policy side. I also had done some consulting along the way—things like helping to design university/industry centers and raising seed money for them. That activity gave me some insights into technology transfer from the hands-on side. Those insights were enhanced by work getting government R&D and procurement contracts for university and corporate customers, and licensing technology out of small high tech companies and into Fortune 500 corporations or other small companies.

I had sold my business because I needed a bone marrow transplant for leukemia. I was fortunate enough to have a sister, Louise, who was able to

be my donor. I was transplanted at Fred Hutchinson Cancer Research Center in Seattle. The Hutch is a bone marrow transplant factory and the people there are great. I was lucky in that my two doctors, Fred Applebaum and Mary Flowers, were research scientists. I got to spend many hours talking with them about the dilemmas of balancing the need for R&D funding with the best possible patient service. Part of that discussion addressed the role of technology transfer.

After leaving the Hutch I settled on the Peninsula and had, for the first time in years, the leisure to engage in reflection. Having worked on technology transfer legislation, done a bit of it as a consultant, and experienced its benefits as a bone marrow recipient, it is not surprising I began reflecting on how to do technology transfer better.

Then I got lucky. I was reflecting on the fact that I could market an optical technology as easily as a biomedical one. Why was that? There must be something generic in the technology transfer process that allows practitioners like me to cut across technologies and industries. At first it seemed that I must be following a set of rules, a kind of 1, 2, 3 linear process. Reflecting on just what those steps might be led me to write a proposal to the U.S. Department of Agriculture SBIR program on an expert system for technology transfer. I won a Phase I and Phase II award and built the expert system.

Then I got really lucky. No one wanted to buy the expert system. The software was unwieldy to use, required massive amounts of data, and the algorithms had limited utility since they had to be supplemented for each sector and technology. Clearly the 1, 2, 3 approach had limited utility. After struggling with this problem for about two years, an epiphany occurred.

The epiphany was this: Optimizing requires a single solution, hence the massive data problems and limited utility of the algorithms. But if we give up optimizing for *satisficing,* for a "good enough" solution, we can accept constrained data and analysis so long as our outcome provides an acceptable solution, however defined. That permitted a more generalizable methodology. My goal now became to find a satisfactory, rather than an optimal solution. Because the analysis could terminate with an acceptable solution rather than an optimal one, there could be, and likely was, more than one solution—just like in technology transfer.

Once I knew what I was looking for, I quickly discovered I was on a well trodden path. The trailblazer was Herbert Simon, who called his approach *bounded rationality*[1] Bounded rationality is a judgment process

[1] Herbert Simon, "Alternative Visions of Rationality," in Hal Arkes and Kenneth Hammond, eds., *Judgment and Decision Making,* (Cambridge University Press: 1992), pp. 104–106.

in which incomplete data and analysis can be utilized so long as the decision criteria and process can be described and shown to lead us to attain our objectives and goals. Because the set is bounded, it can be expanded or contracted over time, as new knowledge and experience justifies.

This book presents my reflections on my experience and on the social scientific and business literature I have read. I have used these reflections to create the model presented in this book and to draw from it the lessons on how to be more efficient and effective when doing technology transfer. Aristotle said somewhere that philosophy is not studied with benefit by the young as they have nothing yet to reflect upon. Fortunately, I have been doing technology transfer for about 30 years so I do have something to think about. Having said that, I am reminded that Samuel Coleridge once said the willing suspension of disbelief constitutes poetic justice. As this book is, of course, not poetry, *caveat emptor.*

Phyllis Speser
Providence, RI
October 2005

Introduction

This is a book about marketing technology. It explains how to get technology out of laboratories and into practical applications. It focuses on how to find and do deals since deals are, after all, what technology transfer is all about.

Research indicates that novices grasp concepts best when they have tools that help them gain insight into how experts cognitively grasp and pattern a situation. One such tool is emulating the expert, which, of course, is what occurs in apprenticeships. The novice replicates the expert's behavior in order to gain insight into the underlying cognitive pattern. It is the reason why so much mathematics is taught with the aid of doing the problems at the end of each chapter.

Let's try a mind experiment. Suppose you wanted to sell a technology (see Exhibit I.1). That means you probably want to be market driven. Why? A study of more than 300 Dutch firms from multiple industries found that to commercialize technology you must be market oriented. Market orientation is the key to product advantage which, although mediated by good launch tactics, is the most important variable leading to new-product performance and, through it, organizational performance.[1]

We will use an easy-to-grasp example: this book. After all, what is this book if not a commercialization of intellectual assets the author has built up over the years as a researcher and practitioner in the field? I will present the conceptual structure that is the core intellectual asset (IA). By embodying my model in this book, it becomes an expression. By being embodied in a physical medium, literally touchable, it becomes an object. Like other objects, we can meaningfully discuss who can touch it and under what conditions and in what contexts. The creative expression embodied in a physical medium becomes property due to the magic of a legally enforceable prohibition on replicating that expression. We call this

[1] F. Lanerak, E. Hultink, H. Robben, "The Impact of Market Orientation, Product Advantage, and Launch Proficiency on New Product Performance and Organizational Performance," *Journal of the Product Development Management Association* 21, no. 2 (March 2004): 89.

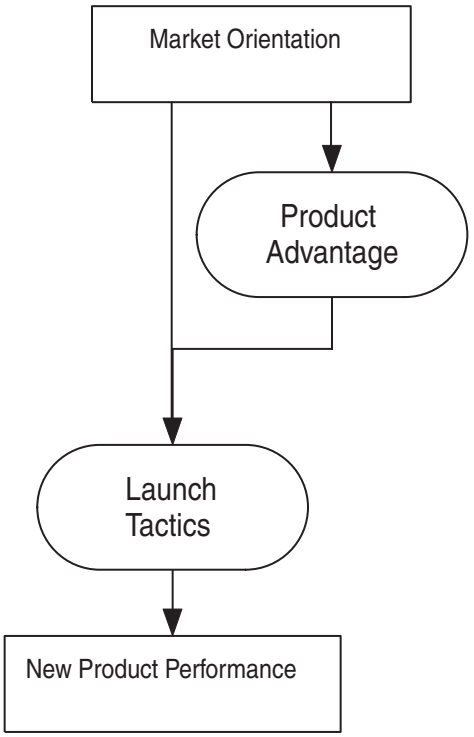

EXHIBIT I.1 Selling a Technology

legally enforceable right *copyright,* which is a kind of intellectual property (IP).

Now the research tells us to succeed at commercialization we need a market orientation. So who needs to know about technology transfer? Who will put their hands on this book and read it? Who is the audience? More generically, who is the end user? Answering the question, "Who needs it?" is the key to developing a market orientation. We want to know who will gain utility from reading this book. For those people, this book will be an asset, that is, an object with a value. Since the object will have value, at least in theory, I should be able to make some money by capturing some portion of that value. How much value I can capture is a matter of how much of the value the end user has to retain to make it worthwhile to acquire the book. But, I am getting ahead of myself.

One way to answer, "Who needs it?" is ask who does activities in which this book would be useful. In other words, market orientation occurs when a technology push-perspective (I have this knowledge about how to commercialize technology) is converted to a market pull-perspective (these

folks want to know how to commercialize technology). If I can make this transition, a deal is possible. I can sell books.

As we will discuss, identifying relevant folks is a matter of mapping the performance, ease of use, and price of a technology against needs of potential end users. From this perspective, technology transfer is providing "*just-in-time knowledge*™" to those who need it. If I find the people who need the intellectual assets, then I will find the customers.

Technology transfer is the transfer of a technology from one person to another across organizational lines. Almost always, *technology* transfer involves early stage technologies that are just emerging from R&D or offer a substitute for technology recently introduced into a market niche. In technology *transfer,* the intellectual asset package that constitutes the technology is literally handed from one party to another. This transaction is called a deal. The deal commonly involves money, but as with any contract, it really does not matter what is being traded in exchange for the intellectual asset package.

Now, if technology transfer involves doing deals, then one market niche for this book should be people who do deals involving technologies. We can segment these professionals into at least four groups by where they work: university and non-profit technology transfer offices, government lab technology transfer offices, corporate licensing offices, and consulting groups, like my own company Foresight Science & Technology. On the other side of the deal equation we again have at least five segments based on the arena in which people work: corporate in-licensing offices, government R&D and procurement activities, venture capitalists and other investors, consulting firms that find and integrate technologies for customers (another activity of Foresight), and firms that buy or license in technology in order to further develop it and then sell it.

We can examine each of these customer segments in more detail to discover why they might be interested in this book. Since they are probably buying the book to learn something, it makes sense to understand their current knowledge and know-how in technology transfer. That way we can offer them something new. What we need to understand is their requirements for knowledge and know-how so we can design our book to map to their needs.

One reason for segmenting the market, as part of gaining a market orientation is that each segment will have more or less different requirements. For example, a major motivation for university technology transfer is to get faculty discoveries into practical use in order to stimulate social and economic benefit on the one hand, and on the other hand, to create honorific and monetary rewards for faculty and the university. Money is far more important for corporate out-licensing. General social and economic

benefits are usually not success criteria for corporate offices. So it is likely that universities will be far more interested in learning how to do small deals that break even than corporate folks, as they have to create faculty satisfaction as well as make money. In other words, the requirements of end users reflect the activities they conduct and their motivation for those activities and thus shape what they will look for in a technology.

Comparing the training offerings of different associations highlights this difference. The Association of University Technology Managers (AUTM), which represents university technology transfer professionals, has courses like Basic Licensing, Start-Up Businesses, and Technology Operations and Organization Licensing Skills.[2] The major emphasis of training for university offices is how to move the technology out, sometimes in the context of bringing in research funding from industry. The Licensing Executives Society (LES), which represents corporate professionals, has courses like Licensing Fundaments, Intermediate, and Advanced but adds courses in intellectual asset management and business development.[3] For corporations, moving it out is important, but also important is bringing technology in and managing for profit. The Federal Laboratory Consortium, which represents labs run by the U.S. government, has courses analogous to those of universities, i.e. tech-out, with a subsidiary emphasis on forming research partnerships that bring in external funds and resources.[4]

In addition to activities and motivations, other factors influence end-user responses when they are confronted with new technology. As we shall see, especially important are the competencies and experiences of the practitioners of the activity. Obviously, experienced practitioners will seek more advanced material than novices. Lawyers will seek different material than marketing folks. Understanding who our end-users are, and what they do, helps us determine if our technology, in this case, this book, will likely be perceived as useful.

One place training is useful is where new people are entering a field. What was striking when I did the original market research leading to this book is that in every customer segment there was a demand for more training and education about how to do technology transfer. Why? Labor shortages! According to the U.S. Department of Labor's *Occupational*

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[2] Association of University Technology Managers, "AUTM Events," n.d., http://www.autm.net/index_ie.html (accessed September 12, 2004).

[3] Licensing Executives Society, "LES Education programs," n.d., http://www.usa-canada.les.org/education/ (accessed September 12, 2004).

[4] Federal Laboratory Consortium for Technology Transfer, "T2 Education and Training," February 18, 2004, http://www.federallabs.org/servlet/FLCItemDisplayServlet?wItemID=2003–08–11–14–31–46–062-Item&wRgn=National&wUser=eportney (accessed September 12, 2004).

Handbook, marketing is a growth industry and in this rising tide, early-stage technology marketing is just one of the boats rising.[5]

Labor shortages suggest a new market niche: higher education. A quick Web search reveals the National Collegiate Inventors and Innovators Alliance, an association for entrepreneurship programs at universities and colleges. The members list is extensive—a good preliminary indicator of market opportunity.[6] As with the professional niche, we can segment the customers. For example, students in entrepreneurship programs likely will have somewhat different needs from students in engineering management, MBA programs, and technology transfer programs.

We end up with a market that has two niches plus a bunch of customer segments within each niche. Thus, we may have a dilemma as a technology that is designed to meet the needs in one segment or niche may not meet needs as well in another segment or niche. One way to focus on the best opportunities is to look at competition. It makes little sense to try to meet a need if the market is already locked up by competitors, or soon will be. A search of Amazon and Barnes and Noble revealed there appear to be few textbooks. There are lots of how-to books and some specialized studies, but it is hard to find a generic textbook.

Hey, hit me over the head with a market opportunity! So, this book is designed to exploit a gap in the market that is inadequately served: textbooks. But it is written in such a way as to be useful for technology transfer professionals who want to step back and think about what they do in order to work more efficiently and effectively.

Think about it. What you want is to sell your IP into a market where you can grab significant market share quickly, and thus attain takeoff. Then you want to leverage that initial market niche to penetrate follow-on niches. University courses are great for books like this one. Each time a professor specs the book for a class, you sell multiple copies. Because of the cost of redoing a course each year, you are likely to get multiple years

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[5] See U.S. Department of Labor, "Advertising, Marketing, Promotions, Public Relations, and Sales Managers," *Organizational Handbook* (February 27, 2004), http://bls.gov/oco/ocos020.htm (accessed September 8, 2004); U.S. Department of Labor, "Market and Survey Researchers," *Organizational Handbook* (May 18, 2004), http://bls.gov/oco/ocos013.htm (accessed September 8, 2004); U.S. Department of Labor, "Demonstrators, Product Promoters, and Models," *Organizational Handbook* (February 27, 2004), http://bls.gov/oco/ocos020.htm (accessed September 8, 2004); and U.S. Department of Labor, "Management, Scientific, and Technical Consulting Services," *Organizational Handbook* (February 27, 2004), http://bls.gov/oco/cg/cgs037.htm (accessed September 8, 2004).

[6] For the NCIIA membership list see http://apps.nciia.net/WebObjects/NciiaResources.woa/wa/Members/ByLetter?l=A (accessed September 12, 2004).

of purchasing once the professor does adopt your textbook. Heck, you can teach and have your own students buy it if sales are slow.

Educational use has another benefit. The first sales are always hardest to get. Once you penetrate one market, you can use it as a springboard to others. So, if I can get this book adopted as a text, it will have the credibility it needs to make it more likely that other professionals will buy it. But that means when you design the technology, in this case this book, it is necessary to do it in such a manner as to meet needs in both market niches—schools and professional continuing education.

Obviously, adapting the knowledge I have to meet the needs of my targeted readers will be critical for selling this book. Common sense says meet the most widely held need where there is not too much competing technology. So now we have the focus of this book: how to find customers and do deals; the tech-out side of the equation. This is an activity done across the board, whereas tech-in is primarily of interest in the corporate sector and, to a lesser extent, in government agencies with defense, space, or other mission foci.

Of course, writing a book that will sell sounds great, but before you opened the cover to read these words, somehow you had to be made aware of the book and convinced it was worthwhile buying. Then, you needed a place to buy it. Meeting these challenges is called marketing and sales. Launch tactics address this topic.

Before ending this introduction, I should say a few quick words about my publisher. As an author, a technology developer, I had a dual challenge. On the one hand, I had to write a book you would buy. On the other hand, since I am not a publisher, I needed to find a publisher, who would acquire my IP and then manufacture and resell it to you. (We call this party a commercialization partner or a target.) This structure is pretty common in technology transfer. On the one hand is the end user; on the other hand is the partner (a licensee, strategic alliance partner, investor, etc.). Usually both are needed to succeed.

If you know how to sell to the end-user, you can almost always sell to the partner. The reason is simple. If a potential partner is in business, if you can make money for them, they have an incentive to do the deal.[7] All you need to do is find someone selling to your end users (or wanting to sell to them), who has the ability to do what is necessary to sell to the end users, and who has a gap in their offerings that you fill. In my case, Wiley was the obvious target. They have a well respected series on intellectual property. Their books are bought for both university courses

[7] If the target is a government agency or nonprofit, the incentive is almost always a superior way of meeting a mission.

and professional continuing education. They do not have a marketing-technology book.

Technology, end users (buyers), competitive product, good launch tactics, appropriate partner. All we need to get this book into the market are two deals: the first one with the partner, the second one with you. And if you are reading this, well, thanks. That counts toward the royalty payments.

Throughout this book I have used Web sources for information as much as possible. My intent was to demonstrate that, with publicly accessible sources, you can do an amazing amount of research. The down side of using the Web is that sometimes information disappears as the page is taken down or moved. (That is the reason we always list the date we access a site in footnotes.) It is important to compensate for the Web's fluidity by capturing the data when you find it.

It is vital to recognize that Web information can be inaccurate and unreliable. Always consider the source creating it and maintaining it. Cross-check information by seeking multiple sources for the same information. Whenever possible confirm the information from the Web with interview data or other more reliable secondary sources (such as a referred journal accessed through a fee-for-service Web site). Use the Web to make your hypotheses and other sources to sustain or falsify your hypotheses.

Finally, please note that the copyright for all the graphics in the book is owned by Foresight Science & Technology and all are used here with permission.

So much for the introduction. Let us begin.

The Art & Science of Technology Transfer

PART One
The Game of Technology Transfer

CHAPTER 1

The Pieces

INTRODUCTION

In this part we introduce you to the cognitive framework for understanding and doing technology transfer. We use a game metaphor, as that is the easiest way to understand the model. As with other games, there are pieces and there is a board. In this chapter we introduce some of the key pieces. In the next chapter we explain the board. In Chapter 3, we discuss strategy.

Technology is simply an aid for conducting an activity which is repeated time and time again. It may be a tool, a technique, a material, etc. Because humans engage in activities that are repeated over and over again, it makes sense to build tools and other useful aids so we can do this activity more effectively and efficiently.

Consider a game in which the object is to move a technology out of the hands of one player into the hands of another in such a way as each player is better off after the technology has moved than before. In plain English: You win when you do a good deal. You lose if you do a bad one or do not get one at all. Since you have two ways to lose and only one to win, all other things being equal, simply relying on luck should lead to a loss.

Now, what makes technology-based aids different from those developed on the basis of experience or Eureka bursts of inspiration is that we can explain why we built the tool the way we did. Technology occurs where thought precedes action and is applied to the improvement of that action. In modern times, this thought is usually a scientific or engineering finding that explains why if you do X, you will get Y with some degree of confidence.

It is these aids we are trying to move from one player to another. Our game board is a geophysical-temporal space on which are laid out a series of channels. Players move messages, goods (including technology), and themselves through these channels. The channels run between nodes or arenas where the players live and work. If a channel does not exist, the players are allowed to construct one.

Players, messages, and goods can only be moved where relationships exist. Relationships exist where the players develop predictable patterns of behavior that is patterns that have some probability of occurring. These patterns involve interactions between two or more players.

Rules govern how you can bring players, messages, and goods into relationships by defining what constitutes coherence between attributes of those entities. By defining what constitutes coherence, that is, a permissible relationship, the rules also de facto define what is impermissible. The rules can change over time. By changing a coherence between attributes into an incoherence, players can block the movement of their opponents' players, messages, and goods.

Relationships can be described via equations. These equations use terms like "*constrains*" (–>), "*equals*" (=), or "*approximately equals*" (≈) to describe how an attribute of one entity coheres with the attributes of another entity. For example, an equation can express the equivalence in value between a technology that is being offered to other parties and what other parties are seeking to exchange for technologies.

When players interested in a deal agree the values are equal (or close enough to equal), technologies can be moved from one party to another. This part of the book explains the game. The rest of the book is about how to win this game.

THE PROBLEM WITH MODELS ABOUT HUMAN BEHAVIOR

Like Monopoly™, this game purports to reflect certain aspects of reality. However, social science requires abstracting essential features out of the flux of everyday life. Just what is essential depends on what is being studied. Here we are studying human behavior.

Social scientists will tell you building models about human behavior is fraught with problems because the object of study is active, dynamic, and intelligent. There is a famous debate concerning the anthropologist Margaret Mead, who studied the differences between adolescent sexual behavior in South Pacific and Western cultures. The debate centers on whether Mead was subject to a hoax pulled by the Samoans she interviewed.[1]

According to Derek Freeman, two of the people Mead relied upon, Fa'apua'a and Fofoa, were kidding when they said they spent their nights

[1] See Bender, Humphries, and Michal, "The Margaret Mead and Derek Freeman Debate," n.d., http://members.fortunecity.com/dikigoros/meaddebate.htm (accessed September 11, 2004).

with boys. Freeman said Fa'apua'a told him that she never thought Mead would have believed them because it is a Samoan custom to joke and exaggerate about sexual behavior. For our purposes it does not really matter what was the truth. We just need to be aware that asking people about what they are doing or thinking does not necessarily lead us to the truth.

Unfortunately watching people may not be any better. Observation does allow us to develop statistical probabilities for behavior. But without an understanding of what motivates people, we have no way of knowing with any certainty if the behavior will continue. For example, in a study of workers at the Western Electric Company's Hawthorne plant in Chicago, various factors were changed to see if they had an impact on productivity. The factors were things like pay, light levels, and rest breaks. Curiously, every change brought productivity increases. Then, over time, in each instance the productivity increase dissipated. Finally the researchers came to the conclusion that it was not the factors being manipulated that led to the increase in productivity. Rather, it was the workers' awareness that they were being studied. As the studies wound down, so did the productivity gains.[2]

A third path is called *participant observation*. In this method, the scientist uses a carefully structured research protocol to analyze a situation in which the researcher is also a participant. The idea is that by participating, you share in the intersubjectivity of human experience and thereby are able to combine both the "*ask them*" and the "*watch them*" approaches. The problem is the tendency to "go native" and lose objectivity. Even if this problem can be avoided, by becoming a participant, the researcher can never be sure his or her presence has not skewed behavior and views from what they would be in the researcher's absence. It is the social scientific equivalent of the Heisenberg uncertainty principle.[3]

What this brief digression demonstrates is that any scientific method for collecting data on which to build a model has problems. So, I hope the reader will be sympathetic when I acknowledge this model is based on none of these approaches. Instead my approach is philosophic in the Platonic sense. This model is based on contemplation: reflection on my experiences, reflection on what I have read, and thinking about how to systematize the data.

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[2] See Stephen W. Draper, "The Hawthorne Effect and Other Expectancy Effects: A Note," June 1, 2004, http://www.psy.gla.ac.uk/~steve/hawth.html (accessed September 12, 2004).

[3] See Sociology.org, "Participant Observation: Overview," n.d., http://www.sociology.org.uk/mpop.htm (accessed September 12, 2004).

CONSTRUCTS

Following Max Weber, I have created constructs or ideal types, which are then explored to create the model.[4] Constructs are objects (entities, model elements) that carry attributes and can be placed into relationships.[5] The attributes define (when instantiated) entities. The relationships use these attributes to link one contract or entity to other constructs. The constructs have no intrinsic merit. They merely are more or less useful, depending on how well they help us understand the phenomenon being modeled.

Science is premised on the assumption that with the right knowledge, we can form predictions of the form "if X then Y" with a reasonable level of confidence. If we can do that, then we can combine this knowledge of X and Y with other knowledge and know-how and end up with technologies of the form "do X and Z will result" with some level of confidence.

Assuming we want Z, then the ability to use X to get Z is useful. For example, I supported initial commercialization of a barnacle protein-based technology for Tufts University, based on a breakthrough by David Kaplan. The university's invention disclosure states:

> *The proteins involved in barnacle adhesion are useful in devising high-strength protein-based adhesives capable of curing under water, coating for prosthetic implants to serve as an interface between the prosthetic and the bone or other tissue, and methods of preventing biofouling of underwater surfaces. DNA and amino acid sequences of the adhesion proteins are provided and isolated nucleic acid sequences as well as microorganisms comprising such vectors and capable of expressing a barnacle adhesion protein are also provided.*[6]

As the above summary highlights, if we know specific proteins are involved in barnacle adhesion, (our "if X then Y") then we can use that

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[4] For an overview of Weber's ideal type, see Coser, "Ideal Types," 1997, http://www2.pfeiffer.edu/~lridener/DSS/Weber/Weberw3.html (accessed September 25, 2004). Note that for our purposes, we need not worry if our constructs are rooted in the current historical period and in modern socioeconomic systems since that is where technology transfer occurs.

[5] The entity, attribute, relationship approach has its root in Peter Chen's Entity-Relationship approach for unifying network and relational data base views. For an overview see University of Texas, "The Entity-Relationship Model," February 29, 2004, http://www.utexas.edu/its/windows/database/datamodeling/dm/erintro.html (accessed September 25, 2004). The E-R basis is important because ultimately we want a way to model technology transfer that is programmable. As we shall see, the E-R approach is one leg. It allows us to collect and store relevant data. The other leg is how we analyze, and thus make useful, the data. The methodology for that is coherence, which is discussed in the following paragraphs.

[6] Tufts.biz, "Novel Kinase and Mechanisms of Curing of Barnacle Adhesives," September 11, 2002, http://www.tufts.biz/cgi-bin/tech_search.cgi?full_report=1&case=37 (accessed September 11, 2004).

knowledge to invent a set of technologies (our if "X then Z" where X is our knowledge of the protein, and Z is some desired end, such as making glue, making a coating, or making antifouling paint). To make glues, we combine our knowledge of the amino acid sequence (X) with tools for synthesizing sequences. To make antifouling additives we combine our knowledge of those same sequences with knowledge of how to cut them or inhibit their formation and with tools for making those enzymes and chemicals. Assuming we want either under-water curing glues or antifouling coatings, knowing the amino acid sequences is useful. In other words, we can design "*how-to's*" if we have a reliable and replicable understanding of "*what-is*."

Carrying this instrumental orientation back to our model, if we want to build a technology for technology transfer, one beauty of constructs is that they can be sustained or falsified empirically. You can go out and test to see if the attributes and relationships actually exist in the phenomenon being modeled, to see if they accurately reflect "what-is." A sustained construct is called valid—that is, to the extent we have tested, it is a fair abstraction of "what-is." If we create valid constructs, we should be able to improve the "how-to" involved in technology transfer.

PORTRAYING CONSTRUCTS

Before continuing, I need to take care of a housekeeping chore. I am going to use graphics to portray constructs. The graphic in Exhibit 1.1 is the legend for understanding the portrayals.

Note that to be included in a construct, an attribute must be capable of being measured. At least a yes/no, 0/1 scale must be conceivable. For us, technology transfer is a quantitative interdisciplinary social scientific field.

Also note that defining a relationship is never enough. There must be a special-temporal path, which, following the marketing and communication literatures, we call a *channel* through which the relationship can be formed and endure. While the ideas behind inventions and creations are critical, we always have to remember technology is embodied ideas. It is as physical as the people who sign the deal.

DEALS

We start with the basic assumption of transactions in market economies: Deals take place where the goods bought are (at least roughly) equal to what is given to obtain them insofar as the parties to the deal are concerned.

In technology transfer, the goods being sold are intellectual property—

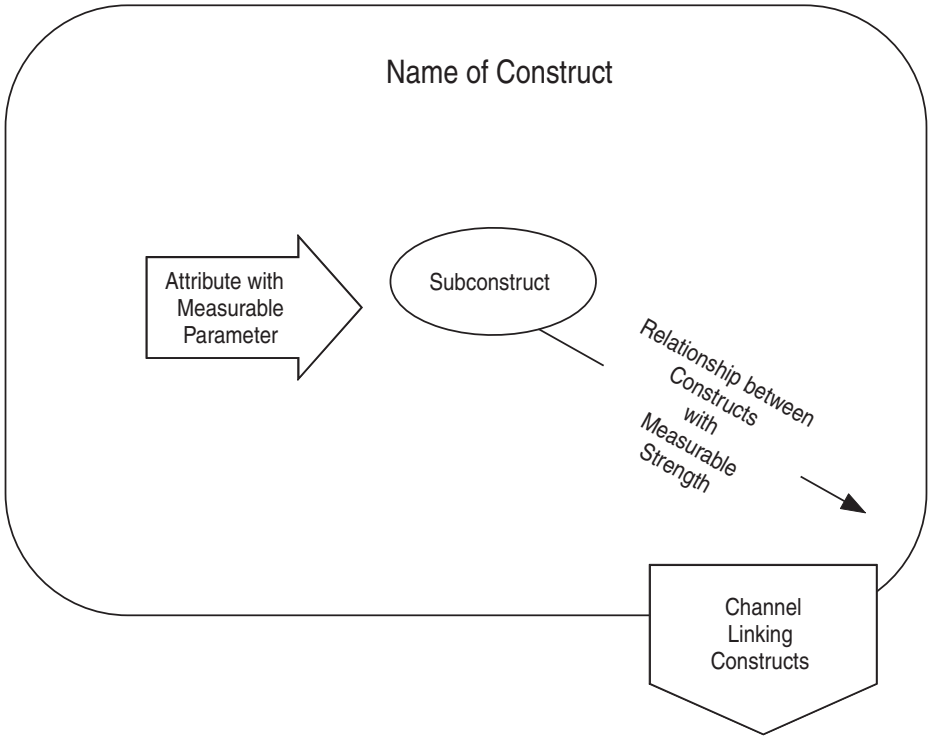

EXHIBIT 1.1 Components of a Construct

that is, ideas that have been reduced to an embodied format (paper, products, etc.) and that can be legally protected (patented, trademarked, copyrighted, covered by trade secret, etc.), so the coercive power of the state can be used to punish any party breaking the deal.

In market transactions, what we are saying is so much of X equals so much of Y. Where two things can be put into this market equation, we say they have equal value.

One way to visualize value is to think of breakfast cereal. How many bowls of cereal would you want to sell your hat? How many bowls to sell your car? How many to sell that great idea you had last night? Technology transfer can be modeled as trading ideas for bowls of cereal. Using money makes the calculation easier but changes nothing in the basics of exchange. Return on investment is like a potlatch. When the deal is signed, it's time to celebrate.

Now, how many bowls of cereal you want for your idea probably depends on all sorts of things. Three factors often involved are: desirability, attachment, and available substitutes. Each of these is a relationship between a player's needs and attributes of a technology.

Desirability measures how well your technology meets a player's criteria