A Choice Fulfilled

The Business of High Technology

by

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Preface

My one time colleague in British industry, turned academic professor, and now rector of a famous university coaxed me at all his lectures on highly technical topics, to believe every word that he uttered. Yet every time I tried to convince my audiences that technology had changed our business world, specifically high tech business, no one appeared to be convinced.

Several years ago when I was working in Germany, I took a deep breath one day and wrote the gist of my arguments down. I decided that if I expanded the salient points in full, I should be able to demonstrate unequivocally my convictions. During that hot summer, when all the Germans were on vacation, I roughed out my first draft. Since then I have had the chance to reflect on the subject and to add a couple of chapters.

According to me, this manuscript, when edited into a book, should become a best seller! Much facts are given for the reader to reflect upon, some self-evident and some thought-provoking. The return on investment in buying this volume is very high. The book is organized for fast reading for those who would like to just get a feel, but it is really for readers to browse through and then to think about the many points raised on almost every page. This book, though geared for a person with a science or engineering background, has business pointers that would apply to any high tech market.

A look at the titles of the chapters might convince the readers that much of the book is about technology and not too much about business. This is true. However, the first chapter, "Opportunity Unlimited," reveals the exciting vista of the new brave world in which

technology has wreaked havoc and has turned the high tech business world seemingly upside down. Chapter 9 brings us into tantalizingly almost real participation in a conference on "Technology Transfer." Questions might spring to mind which the reader jumps to his feet in frustration to ask and may well find answered on the next pages. The rest of the chapters are individual examples to illustrate the causes and effects of technology on business. The transistor miracle, the computer revolution, the optical magic and the information age are all there. The multiple impacts of technology are highly revealing; a new business world with an over-abundance of opportunities, ready for any choice to be fulfilled, is awaiting.

I wish to acknowledge all those who have crossed my life and from whom I have learned. The words here are but a reflection of my experiences. In particular, I am greatly indebted to Professor and Mrs. John Espy of U.S.A. for editing the text and suggesting the addition of the two chapters, "Technology Transfer" and "The Third World." They are both retired and living in Kansas after spending over twenty years with The Chinese University of Hong Kong. John retired as a professor of international business.

Without my wife's preliminary editing and constant advice for terse and direct writing, and without her cartoon embellishments, this book would not be as appealing and readable. I would also like to acknowledge the great work done by a number of secretaries: Fraulein Blickle who typed the first manuscript from my atrocious handwriting and others who toiled through the many transcriptions.

In a recent visit to a Japanese automobile manufacturing plant, I was most happy to note the similarity of the actual tour that took place to the fictitious scene described in the opening chapter written more than five years ago. During the intervening time, I was able to consolidate my ideas while observing how the business trend moved closer to my market model. I am indebted to my colleagues and friends with whom we had a lot of interaction and from whom I received a lot of encouragement for getting the manuscript readied for publication.

Abbreviations

1-D	one-dimensional
2-D	two-dimensional
3-D	three-dimensional
ABC	American Broadcasting Corporation
AC	alternating current
AI	artificial intelligence
ASIC	Application Specific Integrated Circuit
CAD	computer-aided design
CBS	Columbia Broadcasting Service
CEO	Chief Executive Officer
COBOL	Common Business Oriented Language (a computer language for business applications)
CPU	central processing unit
CRT	cathode ray tube
DDT	dichloro-diphenyl-trichloro-ethane (an insecticide)
FAX	facsimile transmission equipment
FM	frequency modulation
FORTRAN	Formula Translator (a computer language for general and scientific applications)
GaAsP	gallium arsenide phosphide (a compound semi-conductor material)
Gb/s	gigabits/sec (10^9 b/s)
GE	General Electric Company
GHz	giga-Hertz (10^9 Hz)
GNP	Gross National Product
HDTV	high-definition television

IBM	International Business Machines
IC	integrated circuit
InGaAsP	indium gallium arsenide phosphide
INS	Information Network Systems
IRRI	International Rice Research Institute
ISDN	Integrated Services Digital Network
kb/s	kilobits/sec (10^3 b/s)
LAN	Local Area Network
LED	light-emitting diode
LISP	List Processing (a computer language for artificial intelligence applications)
LSI	large-scale integration
Mb/s	megabits/sec (10^6 b/s)
MBA	Master of Business Administration
MBE	Molecular Beam Epitaxy
MHz	mega-Hertz (10^6 Hz)
MIP	million instructions per second
MOCVD	Metallorganic Chemical Vapor Deposition
MOS	metal-oxide-silicon
MRI	Magnetic Resonance Imaging
MSI	medium-scale integration
NBC	National Broadcasting Corporation
NMR	nuclear magnetic resonance
NSF	National Science Foundation
OEM	original equipment market
OM	organization and methods
OPEC	Organization of Petroleum Exporting Countries
PBX	private branch exchange
PC	personal computer
PCM	Pulse Code Modulation
PVC	polyvinyl chloride
R&D	Research and Development
RAM	Random Access Memories
RD&E	Research, Development and Engineering

ROI	Return on Investment
TFPG	total factor productivity growth
TV	television
ULSI	ultra-large-scale integration
VCR	video tape recorder
VLSI	very-large-scale integration
WSI	wafer-scale integration

Contents

Chapter 1

Opportunities Unlimited

Br ..., Br ..., the telephone at the bedside rings. The guest in the plush room of an international business class hotel picks up the phone. He hears the computer voice saying mechanically: "This is your 7 o'clock wake-up call. A very good morning to you. The outside temperature ..." He replaces the phone and switches on his TV and tosses and turns a bit to wake himself. At 7:30 he places a phone call to his secretary to give her several messages which he could not send through the electronic mail system from his portable personal computer. "It is such a nuisance that not all hotels have the electronic mail connections," he says passionately. "Next time don't book me into just any hotel," he adds indignantly.

This scene illustrates clearly several customer needs and market opportunities fulfilled and not fulfilled. It is just a tip of an iceberg representing vast and real, but hazardous, market opportunities reachable through the use of appropriate technology. Hazardous because this customer may not be representative of a large number of

customers with similar needs and yet his demand is influential. Should the hotel invest in an electronic mail system so that it can retain this customer? Was the wake-up call service appreciated? An automatic switch to turn on the TV may be quite adequate. Should video contacts replace the need to travel and, hence, displace the need for business hotels altogether? How should a TV manufacturer customize the sets for hotels and thereby secure that particular market niche? What should computer makers and software writers do to cash in on the wake-up call market or perhaps to ensure that they can gain a foothold in the electronic mail service market?

Our starting point is, therefore, a small but typical case of opportunities brought about by our real needs and our ability to meet them through the use of technology. No wonder decision-making is becoming infinitely complex for all users, service providers and manufacturers alike. How can a new product be envisaged and what does it take to introduce it successfully in the marketplace?

What infrastructure is needed to support this new product and how can the users be encouraged to take full advantage of it? The answers to these questions imply the necessary conditions for successful exploitation of any new business opportunity.

The solutions to these questions are, in general, totally elusive, but for specific cases, they can have unlimited opportunities. This situation transforms the very basis of established business practices and calls for new management techniques in all aspects of operations, engineering, marketing and sales. It is no wonder that success in personal computers and electronic gadgets for offices has been so sporadic and unpredictable. We shall begin by looking at what changes technology has wrought and why we have a confluence of achievements which should encourage the emergence of a whole host of good business opportunities.

Perhaps the most significant factor that technology has brought to us is the means for products to be tailored to meet and satisfy individual needs at affordable prices. This is a bold and sweeping statement which must be carefully explained and substantiated.

"Excellent choice," said the car salesman. "We'll have your car in metallic blue color, with factory-fitted stereo radio/cassette, an extra headrest, light alloy wheels and a 1.8 liter engine with turbo-charger readied very quickly. The turn-around time from our fully automated production lines is really good. Sorry that none of the cars here in stock meets your needs, but you'll only need to wait for two weeks. You may like to use our demonstration car in the meantime." The sale was amicably concluded. The customer turned to the salesman as they approached the door. "That is good, in two weeks I can have the car of my choice. Please tell me, how is the car factory organized to meet individual demands like mine when mass-production is needed to minimize cost?" "Well, sir, it baffles me, too. However, I could arrange for you to tour the factory. I went there once and was fascinated by the whole process of flexible mass-production."

"Ladies and gentlemen, a big welcome to our company. In the next hour you'll be conducted around this fully automated factory which produces a single basic car model with customized specifications." The tour guide of this car factory proudly welcomes his daily visitors. It is a routine job for him, but each time he faces a new crowd, anxious to hear about and see the mystery of car making, he anticipates a variety of expected and, yes, unexpected questions. He finds this a challenge. Besides, he knows that the tour is an important marketing action and the company's success is influenced by it. He is well satisfied with his job and warms up to the occasion.

"We will walk alongside the entire production line on a path-way which is routinely used for visitors but is also used as an inspection route. Every day a robot inspector makes periodic inspection tours. We aim for zero defects in our quality control and the robot inspector is a part of this process. At each major stage of production, I'll give some explanations and answer any questions you may have. Please follow me.

"We start our tour in this central control room. Here we have a visual display of the production status of our assembly lines. Here we load our production plan for the day, which specifies exactly the

number of cars to be produced and the parts to be used for each. It is the brain of our factory and it initiates all actions." "A question, please," says one customer, "Who prepares the production plan and how can errors be detected or corrected?" "Well, sir, this is a very good question. Our production plan is not entirely error-proof. What we do is to make sure that machine errors are reduced to a very low limit. We aim at one in a trillion which is readily achievable in our electronic data processing equipment. We then reduce our human errors to a minimum by using the direct input from the dealer who prepared this data together with the customer. Perhaps you'll recall, if you have already ordered a car from us, that the dealer read back to you your requirements after he prepared your order. In this process he actually prepared your requirements on a computer input card and then obtained a printout of this which he checked with you. This way, there is no accumulation of human errors.

"Each day, the production plan is a string of car orders which specify with which parts and finishes each car is to be fitted. The input data is distributed electronically to the areas where the appropriate parts are loaded onto the conveyor belts. Then the belts are programmed to deliver the right parts to the right car at the right time. Human labor is involved only in the stocking of parts and in the assembly in this nearby assembly line. Even in the assembly area robots are used to relieve the monotonous assembly tasks. In fact, most human efforts are devoted to trouble shooting."

"What happens if a failure occurs at one section of the assembly line? Does it mean that the whole line has to stop? I would guess that the cost of idling time must be prohibitive," says a knowledgeable customer who is familiar with the process of manufacturing.

"Of course you are right; we cannot afford to have one or even several local problems along the assembly line that would shut down the entire factory. Generally speaking, we can accumulate sub-assemblies, so that the problems can be corrected while sub-assemblies continue to be produced. There is a trade-off between space requirements, capital investment and particularly the means

to accelerate any process which has been out of action for a while. The solution is complex. In fact, it is the area where the production-control boys are working hardest. They try to minimize downtime of the equipment by preventive maintenance and to optimize the production-line rate applicable to different circumstances after a failure. I just heard that they have tried a new linear programming method which is supposed to be more efficient than the simplex method. If this is successful, I predict that we can reduce the car price by at least 10%. That will give our competitors something to think about.

"As we go through this door, we'll be at the start of the assembly line. Please follow me. The first impression you'll have is the spaciousness of the line with hardly any people in it. Many lines of activities are simultaneously started here at the beginning. On the right are the chassis and rear wheel assembly. On the left is the engine with front wheel and transmission attachments. The people you see here are mainly inspectors. The parts assembly operations here are all automated.

"Here we see a critical stage where the engine is mounted on the chassis. Failure at this point will cause a considerable pile-up of engine assemblies and chassis assemblies. Therefore, several lines are in parallel here. Look to your left; you'll see the body-conveyor line. The finished bodies have gone through rust proofing, painting and baking before they reach the next assembly point where they will be mated to the engine/chassis assembly. The number of parallel lines is decreasing. Please note the different velocities of the various conveyor lines.

"All this time, the instructions of your specific order are being obeyed. This green car has a sunroof and an air-conditioner. It has a 5-speed manual shift, etc. Note that the process is really simple when everything is modularized. Well, it is simple after a hell-of-a-lot of work has gone into making the optional parts interchangeable. We have come a long way to make customer-specific cars. Without the computer we could never achieve this. Just look at all those localized

computers in the robots, the big computers doing the control and programming of the parts and the other computers used by the designers to make parts compatible and interchangeable. We are really very lucky to be able to satisfy our customers' individual needs in a car so admirably."

"Hold on. I object to that," a somewhat irritated would-be customer retorts. "I wanted a two-tone body and you discontinued it last year. What about the anti-skid brake option; why can't you make that cheaper so that I can afford it? Why on earth do you not spend money on making this great safety feature affordable instead of spending money on research to provide drivers with automatic location indicators and street-map facilities when most of us know exactly where we are going most of the time?"

This story about cars contains many salient points. It illustrates the interrelationship between the customers' requirements which are part generic and part specific; the manufacturer's constraints on cost and product options; the salesman's position on selling and education as the linkage between customer and manufacturer; and technology's role in enabling the whole process of supply and demand to be met. It also indicates strongly that even with a well-established product, namely a car, the needs of the customer far exceed the basic function of the car. Technology enables the cost of production to be lowered while options increase. The car market becomes a mass market with built-in individualism. It is a mass-customed market. Opportunities for innovation are substantial. However, the cost reduction or increase with less or more features really makes marketing more complex and customer targeting more speculative. An increase in choice is always accompanied by more difficulties in decision-making, both for the manufacturer as well as the customer; this increases the importance of marketing.

Another example from the pharmaceutical industry illustrates further the consequences of technology-induced product proliferation.

In a board meeting at a leading pharmaceutical company the newly appointed chairman and CEO made his first recommendation.

"Gentlemen and ladies of the Board, I have carefully studied our research capabilities and assessed the complex new drug market. I have come to the conclusion that the cost of marketing a new drug is too large. We must take a longer-term view. I recommend to the Board that we channel our research resources towards the causes of disease instead of our current efforts of studying the effect of variants of drugs on a disease based on our current understanding. This is a highly innovative recommendation and is not made lightly."

The boardroom buzzed with excitement and some air of disbelief. The wily new CEO continued:

"When 300 or more types of Cortisone drugs are available for minor skin ailments, what can make a real impact in the marketplace? Doctors are flooded with advance notices of these brand-name products. They really cannot be bothered with another new addition, even if it has been shown to have several percent higher effectiveness. Patients are at an even greater loss since every advertisement extols the superior virtues of a product. If our research staff start by uncovering the basic causes of diseases and then explaining the nature of treatment, they are not only contributing greatly to knowledge but also are laying down very significant marketing strategies and directions. Naturally, we will be first to announce the new drugs, and our voice will be heard as the voice of authority instead of as an also-ran or, worse, as an outsider. I submit that there is no more sensible plan than this one. Besides, the research into the causes of diseases does not have to result in breakthroughs. A better and more logical presentation of the interpretation of our current understanding could enhance and guide our marketing efforts and increase the success of our research and development efforts on the more conventional drugs already under investigation. Furthermore, the research cost can in fact be recovered by lowering our wasteful marketing efforts in low-margin, crowded markets."

A respectful hush ensued. "I'd like to see a return-on-investment analysis done on this," said one Board member steeped in traditional thinking. "I do have an analysis ready for presentation here. However,