Building a breakthrough business concept

Abstract: *The development of a customer-driven organization within the Calculator Business provides some models that may be useful in other situations. The approach relies on a market segmentation that presents an opportunity for competitive advantage. The calculator example does not rely on a technology-driven approach, but emphasizes an intensive effort to build a relationship with influential people in the selected market segment. Technology is crucial but it is mostly software, not hardware technology and the product development that is driven by customer needs. A key factor in the success is an "ego-less" method to develop future product needs by working closely with influential customers.*

The Calculator Business has become known throughout Texas Instruments in recent years for achieving success through customer focus in business, products and marketing programs. Many people have asked us how we have made that work and what lessons we have learned that can be applied to other businesses. As can be expected from such one-sentence summaries, the simple idea of "customer focus" misses much of the Calculator Business transformation that could be useful in other situations.

The Calculator Business has three major product areas: 1) Simple Handheld and Printing Calculators, 2) Pocket Solutions, and 3) Learning Tools. TI has two full-line competitors worldwide, Casio and Sharp. Other competitors such as Canon, Royal and Hewlett-Packard compete against part of the TI product line.

The Handheld and Printing Calculator Business is a typical retail consumer electronics business that has been relatively stable for many years. The usual competitive factors for success in retail distribution apply to this part of the business. A primary factor for success is getting placement in the stores. The addition of one item to the TI assortment carried at a major retailer can mean tens or hundreds of thousands of additional units sold. That can be doubly rewarding if the TI addition causes a competitive unit to be "knocked out." Of course, there is less enthusiasm when one of our products gets knocked out by a competitor.

In this environment, price is important but that is only one factor in the profitability equation of the retailer. Brand-name products often can compete successfully, even against low-cost, non-branded products. Among the major brand names, products are often compared on a limited number of features such as size of display, number of digits, number of colors of print, etc. A retailer will often choose the lowest cost product at a feature point to the exclusion of the other brands.

Our Pocket Solutions Business has been relatively small for several years with products such as databanks that hold addresses and phone numbers and organizers that can, in addition, also hold schedule information. This business has been operated as a traditional retail consumer electronics business but some of the principles in this article are now being applied to improve our competitive differentiation.

The Learning Tools Business evolved out of our business in scientific and financial calculators that prior to 1987 was called Professional Calculators. The old title for the business tells a lot about our mental image of the business. The original business model for the calculator business was engineers designing calculators for other engineers to use. The summary of our business history from that point forward is a need to change confronting resistance to change.

In the early days, TI developed and produced leading-edge semiconductor and display technology and assembled the products in TI factories. TI's initial market position was as the quick follower to Hewlett-Packard, making reasonably competitive products at much lower prices. The Calculator

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Table I. Last 10 years in the calculator business.

	Initial	Now
Mission	Manufacture calculators	Design useful products
Value added	Semiconductors	Software
Key product attribute	Price	Ease of use
Primary market	Engineers	Pre-college students
Distribution	Retailers	Retailers and School Dealers
Sales Driver	Advertising	Teacher recommendation
Business ecosystem	TI does "soup to nuts"	Many partners
Product development approach	"I designed this product for you"	"You designed this product"

Business developed fundamental business values in those days that made it difficult to change and adapt as the market matured. The history of the last ten years is about a basic turnaround in those business values.

A market matures

The market evolution in the 1970s and early '80s posed many challenges for Professional Calculators. The business faced rapidly falling prices and tough competitors. The market grew rapidly in units but not in dollars. Where semiconductor content once dominated the product cost, the cost of labor and mechanical piece parts became the difference between making and losing money. Displays changed from light emitting diodes (LEDs) to liquid crystal displays (LCDs), which eliminated a TI-produced component. That display change also led to CMOS semiconductor technology, which reduced battery drain and significantly extended battery life. The TI Semiconductor Business did not choose calculator chips as an investment direction while several Japanese companies developed calculator-class chips for all calculator companies, gaining economies of scale on their design investment.

By 1985 the Calculator Business was still building calculators and designing calculator chips, but both were done primarily based on business principles of "what we do" rather than investment return. On one hand, there was a strong argument that vertical business integration using TI chip design, TI semiconductor manufacturing and TI assembly lines was our core business value. On the other hand, cost pressure had already forced much production to Far East assemblers. A new family of CMOS calculator chips had recently become available from a Japanese supplier with a broader set of capabilities than the few chips we had designed ourselves. Dollar sales of calculators were falling annually due to price drops and profits were negligible. Product life cycles were short, 1-2 years, which is typical of retail-driven consumer electronics. The computational functionality was becoming a commodity and product styling variations were being used to provide some differentiation.

In 1986, Casio, Sharp and Hewlett-Packard all introduced graphing calculators that had large (for a calculator) dot-matrix liquid crystal displays. Hewlett-Packard marketed their HP-28 to engineers and engineering students. The Casio and Sharp products did not have focused marketing. We did not own any of the key technologies to produce a competitive graphing calculator.

An opportunity emerges

In 1986, several college educators contacted us wanting to talk about calculator use in education. They asked for funding from TI to develop calculator-active test questions that could be used in standardized tests. That same year, we received a request for quotation from the state of Connecticut for 10,000 simple "four-function" calculators. These activities alerted us that something might be happening in the education community that would be important to us. Two people volunteered to look into it and uncovered some interesting facts.

The National Council of Teachers of Mathematics (NCTM) is an association of mathematics teachers in the United States and Canada. The leaders of this group had been concerned for some time that mathematics teachers needed "a coherent vision of what it means to be mathematically literate both in a world that relies on calculators and computers to carry out mathematical procedures and in a world where

mathematics is rapidly growing and is extensively being applied in diverse fields."[1] The NCTM had set up working groups to propose mathematics teaching reforms.

Teachers of mathematics felt pressure to add additional concepts to the math curriculum. This was well justified to prepare students to participate in a modern world:

- where statistics are routinely presented in advertising and on the front pages of newspapers
- where computer literacy is a requirement for many jobs
- where factory floor workers are expected to solve problems together
- where manufacturing workers are expected to collect and analyze data.

John Paulos' book, *Innumeracy*[2], cites example after example of the ways people are confused about large numbers, estimation and chance. He makes an excellent case for action to add some important concepts to our mathematics curriculum.

If the desire were to provide this education to a portion of the population, the high math achievers, it could be done through added courses at the high school or college level. The need is most important precisely among those students who are generally poor achievers in mathematics, the ones who often end their math education with their first algebra class in high school or never get that far.

The schools are under a lot of pressure to move students along. This has the unfortunate effect of teaching the lower achievers the same topics repeatedly for several years. In the late 1980s many high school students across the country were still being taught fifth and sixth grade manual computation skills because they had not learned them well enough to achieve satisfactory test scores. As a result, these students were denied access to the higher-order, problem-solving skills of high school mathematics and an understanding of probability and statistics that are important in a modern world.

Teachers were often seeing little correlation between the application of manual computation methods, the ability to add, subtract, multiply and divide using pencil and paper and the ability to apply mathematics effectively (*Figure 1*). Some teachers experimented with the (then) radical of idea of letting high school students who could not calculate well with pencil and paper use electronic calculators in class. Those teaching often found that they could

Figure 1. Students working in a group with their teacher to solve a problem.

move on to teacher problem-solving skills that would make the students more effective money managers and employees. As word of these successes spread, many teachers started to question the importance of requiring competence in manual computation for all students when $5 calculators could do the job. Change couldn't go far because teachers have historically been measured by how well their students do on standardized tests and those tests often concentrate on manual computational skills.

Leading educators in the reform movement summarized the situation by saying "the math being taught today is the math of 100 years ago." The content of the courses and the way students were evaluated needed to be changed to reflect the realities of a technological world.

We see an opportunity

Following the Connecticut purchase we started to meet with educators to understand the dynamics of the education market and whether that presented an opportunity for TI. In hindsight, it all seems obvious but it was not clear at the time. We became convinced that math education was changing, the question was what it meant for TI.

We made real progress when a team of us attended a workshop at TI entitled *Strategic Synthesis* given by Doug Ziemer. The workshop put the team through a series of exercises to determine opportunities for competitive differentiation and got us very excited about the opportunity.

We went into that workshop with the dismal view that we weren't technology leaders, weren't manufacturing cost leaders and that our products were mainly undifferentiated and sold on lowest price. The *Strategic Synthesis* course forced us to focus on a specific segment of customers and we chose the school teachers, deciding what calculator they might want to use for teaching. That was considerably different from a retail-driven, market-to-everyone approach and uncovered some interesting opportunities.

The first step was to discuss the "care-abouts" of this market segment: what are their values and what factors influence them to choose a particular product or favor a particular supplier? After considerable discussion, we decided that the changes in education provided more than an opportunity to sell products in our product line, but an opportunity to design unique products that would work better for teachers in the classroom.

The next step was to evaluate ourselves and our competitors against these customer values. Our U.S.-based marketing and product development capability immediately stood out as an opportunity we could leverage. We visualized an organization that would be very outward focused, where product development teams could meet with influential educators to design better products. Important side effects would be that these educators, if they felt fully involved in the product development process, would feel deep ownership of the resulting products and also feel great about TI. We didn't realize then how far this approach would take us.

The paranoid survive and prosper

The early days of the school efforts were spiced with a sense of doom. We worried that our competitors would observe us, see the success we were having and duplicate it with their greater resources. We adopted the spirit of the book *Marketing Warfare*[3] by Ries and Trout, which interpreted business competition in terms of strategy in war. With these principles we interpreted the education market as an unoccupied flank of our competitors, one that we might be able to occupy silently because our competitors were focused elsewhere. That book is an easy read but provides lots of sound advice for defining strategies in terms of competitors and competitive advantage.

In the late 1980s, we cobbled together a line of calculators for schools by making minor modifications to existing models and developing one product from scratch, the Math Explorer. The development and introduction of that product taught us some important lessons about the school market. The Math Explorer was a big hit among leading teachers when it was introduced in the spring of 1989, but sales were slow and inventories were growing in late 1989. The enthusiasm was not translating into sales.

One customer for the Math Explorer, a textbook publisher, wanted to return excess inventory. Detractors inside TI, people who were not hearing from teachers how exciting the product was, were talking of closing out the product and cutting our losses. We held on for another few months. In February 1990,we received an urgent call from the publisher. The inventory of Math Explorers had all been sold and they needed more immediately. We spent the next two years struggling to work down a seemingly constant backlog of orders.

The slow start of the Math Explorer sales taught us that the funding cycle of schools requires a year or more to adopt new products. This is exacerbated with calculators because often it is not clear which budget line they fall in. A positive aspect of the lengthy adoption process is that once schools decide to purchase a calculator, they don't want it to change with the next retail season. Particularly when calculator exercises are featured in textbooks, as many now are and textbooks have a life in the classroom of five to ten years, it is an unwise calculator purveyor that would change the color or placement of keys every year or two. The Math Explorer is only now, almost eight years after its introduction, being restyled slightly. Other products in the Learning Tools line have similarly long life cycles, although the more advanced products, where the technology and product features are evolving more rapidly, come and go more quickly.

The first big investment

Professors Frank Demana and Bert Waits of The Ohio State University first contacted us in 1987. They were contacting the calculator companies to describe their work experimenting with Casio graphing calculators in pre-calculus classes. Their National Science Foundation projects started with computer software for visualizing mathematical functions. The unavailability of computers for daily use by students in most schools frustrated them and they saw the introduction of Casio's graphing calculator as an ideal solution. They saw that the Casio machine could be improved for teaching mathematics. In particular,

Demana, Waits and the teachers they were working with, felt that the product could be made much easier to use.

They were impressed when TI, the only company without a graphing calculator, was the one most eager to talk to them about their product ideas. At that time we had none of the technologies to develop the product they wanted and we were quite honest with them about that. Waits told us it would be very simple, "just cut the liquid crystal display off of your simple TI-30 Stat calculator and put a big display on." Nothing to it and it shouldn't cost much either! Actually, we did have access to the technology, just not at a cost that seemed reasonable or competitive. Our work with Waits, Demana and others made us believe that we had to get the product to market for around $50 to have a real hit. Our own internal estimates of cost drove almost double that price and well above the prices of products from our competitors, not a formula that looked encouraging to us. We put a team of people together to see if we could get the cost down and worked closely with one of our assembly suppliers and a Japanese semiconductor company.

While the team was looking at hardware designs to get the cost down, we developed a simulation of the user interface for this proposed new product. We worked with Demana, Waits and scores of teachers to design the calculator to have the right features to be easy to use. We were especially open to copying the best features of a software program by Demana and Waits called *MasterGrapher*. We started showing this simulation to teachers using computers and the Casio graphing calculators in the classroom. The enthusiastic reception for the features of the proposed product and the way the features worked together convinced us that we had a winner if we could design the hardware.

The semiconductor company we worked with developed a new ASIC that could be built around a Z-80 processor core. With that ASIC and a lot of hard work with our manufacturer on the rest of the product, we were able to get the street price down to about $80. That didn't meet our cost goals but the enthusiasm by potential users for the product concept convinced us that the product might have enough value to support the higher price.

Our work with the simulation taught us that the education market responds very well to suppliers that care and listen. We continued showing it to teachers under non-disclosure agreements long after the point where changes could be made in the product. This was our first experience doing pre-launch activities with a large number of "market influencers."

The TI-81 was a big hit when it was introduced in 1990 (*Figure 2*). Our work with educators prior to the introduction resulted in a large group of leading educators who already knew about the product and were ready to adopt it. Because of their interest in changing math education, they quickly worked to spread the word about the benefits of the TI-81. This was better advertising than anything that we could have done ourselves. Many of the educators were proud of the contributions they made to the product and started spreading the word that TI listened to them when they developed the TI-81.

Figure 2. Twenty years of TI calculators leads to the TI-81.

As our customers gave us the market position of listening, we immediately became a focus for their product suggestions. We embraced that by regularly organizing discussion groups with teachers and developing large networks of advisors on new projects. The close market ties led to the evolution of the TI-81 into the TI-82 and TI-83, with additional features the teachers want and can use while keeping the products easy to use and focused on education.

As our products evolved, the math reform movement continued moving ahead. The availability of education-focused calculators inspired many teachers to tackle new math activities and the students responded well. Calculator-active questions moved out of the research arena and onto most of the leading standardized tests. This in turn prompted more teachers who saw the need to prepare their students for the exams to adopt calculators.

A retrospective

There is a saying "if I have to chose between luck and skill, I'll take luck every time." There's a lot to be said for that, but a good combination of luck and skill is probably superior. We had the luck to stumble upon some significant changes in the way math education was being taught in the United States. We were also lucky that it was happening in the U.S. first, where we could be closer to the market. We were smart enough to grab hold of that opportunity and see it as a chance to change the driving forces of sales and competition in the calculator business. We were lucky (in a sense) that our recent history and difficult business situation had made us willing to change our business to meet the market needs rather than simply interpret it in our existing framework.

Because we were adapting to the market, we were fortunate to be able to develop a network of expert users to give us insight. We built a TI team of people who could work well with the wise and influential customers in our market. We didn't try to form an organization inside TI composed of those experts. By keeping most of that expertise outside TI, we found that we can be more open-minded about the different points of view among our customers and can judge them on their own merits. We try to avoid commitment to the views of the market developed in our organization and always test them against the real customers.

On the other hand, we could not simply let our customers tell us what the products should do. We found that users of products usually think in terms of incremental solutions. Our role in product development is to analyze the user suggestions and the market trends to deliver more than the customers asked for and deliver it in ways that exceed their expectations.

A key step was the reengineering of our product development process. That effectively eliminated the Marketing Department and Engineering Department mindset and created multi-disciplinary teams that sit together and work together to make a new product most suitable for the target customers.

The concept of change is an important one that we are becoming more comfortable with. The evolution of the business and our position in the marketplace has forced changes in our business every year. We are now more comfortable talking about the continual changes ahead of us rather than thinking of change as a negative, one-time event.

References

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Tom Ferrio

Tom Ferrio has held numerous position in several TI businesses during his 23-year career. He joined the TI Equipment Group, with a B.S.E.E. from Michigan State University, developing test equipment software for defense systems, semiconductors and manufacturing in the (then) new Calculator Business. In addition to many years with the Calculator Business, Tom also has worked in the Central Research Laboratory and the Corporate Engineering Center. In 1981, Tom was appointed a Senior Member, Technical Staff.

In 1982 Tom received his M.B.A. from Texas Tech University and gradually shifted over to the "dark side" (marketing). His primary interest is the study and application of marketing strategy and positioning for competitive advantage. He also is studying ways that organization design and information technology can make a business more responsive to market needs. Tom is a strong supporter of the Integrated Marketing Management (IMM) courses at TI and wishes that more of our "marketing types" attended them.

Ann Phipps

Ann Phipps is currently managing the Learning Calculator groups strategic relationships with other businesses serving education.

Ann was hired in 1989 by Norman Neureiter to work in TI's Corporate Communications. She moved to the Calculator SBU when she saw a chance to use her mixed educational background (B.S. in mathematics, computer science and English, Vanderbilt University; M.A. in English, University of Texas) in a product group dedicated to serving teachers.

Since joining the group, she has worked in product support, product development, line management and business strategy. She led the development of TI's most popular graphing calculator to date, the TI-82, earning, in the process, two patents and many friends in the nation's math education community.

Richard Schaar

Richard Schaar is senior vice president, Personal Productivity Products Group. He joined TI in 1984.

Richard has held numerous management positions including product marketing manager of the Consumer Products Division and business manager of Calculator Products. Calculators continues to be TI's most visible business to the end user. Richard was named vice president, Consumer Products Group in 1991 and senior vice president, Personal Productivity Products in early 1996.

He previously had held various positions including: vice president, Marketing Car Audio Divison with International Jensen, Inc; president, York Radio and Television Corp; and assistant professor of mathematics at the University of Southern California.

Richard holds a bachelor's degree in science from Purdue University, a doctor of philosophy in applied mathematics from the University of Chicago and a master of business administration from the University of Illinois, Champaign, Illinois. ❑