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Who Is Going To Buy The Darn Thing?

Invest MORE IN MARKETING Than In Engineering To Find Out!
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Why do some new products take off, while others don't sell at all? What is the origin of super success or flaming failure? Marketing is a process of ascertaining needs which customers are willing spend money to satisfy, thus guiding engineering to design the right products. How much shall we invest in marketing to enable commercial success, and when?

A new metric has been developed to answer these questions, the Marketing/Engineering Investment Ratio™ (M/E Ratio™). This model separates marketing from the functions of promotion and selling. Formulating a ratio of marketing to engineering installs marketing concurrently with engineering, and sizes the marketing budget with a readily identified number (engineering investment).

The IEEE will hear evidence to confirm the recommendation that technology-based enterprises invest MORE IN MARKETING than in engineering. Super successes are seen in this survey with an average M/E Ratio™ of greater than 1, investing more than one dollar in marketing (exclusive of promoting and selling) for every dollar invested in engineering. Every flaming failure suffers from a M/E Ratio™ of 0.1 or lower.

Examples will be revealed from diverse technologies; software, machine vision, medical, semiconductor equipment, and instrumentation, to deliver practical advice on dealing with the pitfalls of new ventures. The implication for technology-based enterprises is a fundamental shift in management attention and investment commitment toward decisive, up-front marketing.

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1 The evidence is in

Invest more in marketing, exclusive of promoting and selling, than in engineering.

Invest more in up-front marketing, exclusive of promoting and selling, than in engineering! Furthermore, invest heavily in market research, either before the engineering begins, or concurrently with the engineering effort, or both; before the product is ready.

To an engineering audience, to the technologists, that might seem outrageous. This author is often asked, "How can you possibly suggest that we devote our precious capital to marketing, much less more to marketing than in engineering, when we have this heavy-duty technology to develop?"

In fact, the evidence shows that commercially successful technology-based enterprises do just that. ¹ Super successes in this survey have a Marketing/Engineering Investment Ratio™ (M/E Ratio™) greater than 1, investing, on average, about two dollars in marketing for every dollar invested in engineering. They invest up-front, before the product is ready. They maintain a higher investment in marketing even at the extremes of technology where you might expect more investment in engineering.

Every flaming failure suffers from an M/E Ratio™ of 0.1 or lower. The average failure invests only about two cents in upstream marketing for every dollar in engineering.

Figure 1 demonstrates the relationship of the M/E Ratio™ with success. ² The vertical scale is the log of the Marketing/Engineering Investment Ratio™. A ratio above 1 indicates more investment in upstream marketing than in engineering. Data points are in three columns: clear "Failure" on the left, "Success" on the right, and "Neither" in the middle. Multiple bullets (●●●●) mean that number of data points at one M/E Ratio™.

2 Who needs marketing?

The product's not ready yet.

"Sinking Machines ... Lack of Market Vision Blamed in Fall," blared the 1994 Boston Globe ³ headline announcing the Chapter 11 bankruptcy of Thinking Machines as they blew through \$120 million in capital and began laying off 200.

GCA of Andover, MA shut their doors in 1993 after peaking at 3,000 employees and over \$400 million in annual revenue. ⁴

Becton Dickinson Medical Systems put \$300K into engineering in the 1970s, receiving five US Patents, before discovering they had developed a technology for which there was no need. ⁵ Nobody would buy the darn thing! ⁶

On the success side, Stanley Lapidus raised \$43.6 million to launch his new venture, Cytyc; becoming one of the largest VC financed startups of that period. ⁷ Cytyc's Wall Street Journal tombstone proudly broadcasted news of \$8 million raised in their second round alone. ⁸ These highly visible successes and failures are all around us. Why? What is the process that leads to successful new products and enterprises, and what process leads to failure?

In his IEEE WESCON paper, Albert Ehrenfried discusses new product development process;

"Within technical industry, few matters receive as intensive effort as the continual improvement of existing products and the development of new products. Many managers of technical firms are serious engineers, and one of the most absorbing and challenging parts of their job is to conceive and guide the engineering of new and improved products for the future.

"But, despite the dollar expenditure and engineering skill that goes into the development of new products, the incidence of their failure is shockingly high.

"Too many products are developed to satisfy the desires, urges, and hunches of people within the company, rather than to meet the specific needs of the market external to the company. Products grow out of the desire to tinker, or because an engineer sees a purely technical challenge.

"Recently, studies have been made to determine the fate of products that have been brought lovingly into existence, fully developed, mass-produced, and finally presented to the unsuspecting customer. By actual count [quoting a study by the New England Council of Boston], new products put on the market by 200 leading companies showed a tremendously high 80% rate of failure.

"Putting new products on the market has thus become one of the biggest gambles in the business world ... This is a day of tight competition, growing markets, and the need to shift from government research to commercial products.

"The excessively high rate of failure of new products is not due principally to lack of good engineering, insufficient investment capital, or lack of sales promotion. Products usually fail because there is insufficient demand for them."⁹

Mr. Ehrenfried is pointing to the question: "Who is going to buy the darn thing?"

Albert Ehrenfried wrote his IEEE WESCON paper in 1955, more than fifty years ago. It could have been written today, especially with current military downsizing. The New England Council's failure rate study, which he quoted, was published in 1953, over a half a century ago.¹⁰ It could have been a current survey.

There is a recurrent theme across the decades; the theme of the relationship between marketing and successful new product development process. In the 1950s Albert Ehrenfried wrote of the "challenge ... to guide the engineering of new products." Observing the 1970s and 1980s, Pierre Lamond, a veteran of National Semiconductor, proclaimed in 1986, "In the 1970s, it was technological innovation. Now it's marketing. What's important is which features you choose to put in your chips, not which ones you're capable of putting there."¹¹

This author believes that technology alone never worked as a strategy for sustainable commercial success. Figure 1 contains consistent data from seven different decades; from the 1940s, the 1950s, the 1960s, the 1970s, the 1980s, the 1990s, and from the 2000s.

It is possible that the importance of marketing may have masked in the 1940s and 1950s by the limitations of the day, such as vacuum tubes; engineers had difficulty making much of anything work. Lack of marketing may have been camouflaged through the 1960s by the needs of the military and the space program. In isolated cases in the 1970s, technology alone may have been sufficient (barely) for a temporary (not sustainable) advantage.

In the 1990s, as it always was, marketing is paramount. MacRae Ross writes in his 1991 paper, *Seventeen Deadly Marketing Mistakes*,¹²

- "Deadly Marketing Mistake Number 1, Thinking that technology sells itself.
- "Deadly Marketing Mistake Number 9, Not being a marketing driven business from the top down."

Michael Nevins frames the management challenge in his 1984 article, *Marketing Excellence Takes a Total Commitment*. "In electronics, as in other industries, it has become increasingly difficult to succeed with a strategy based on technological leadership ... marketing becomes all important. Electronic companies' managing the transition from being technology and engineering-driven to being marketing-focused is the number-one issue in industry today."¹³

If more marketing is so important, how do we make it happen?

Engineers know how to achieve an engineering challenge; sizing the engineering budget and staffing. How do we size and staff the marketing challenge?

Exactly how much is "more" marketing?

3 Exactly how much is "more" marketing?

Marketing is defined as the up-front process that comes before the product is ready. (Promoting and selling come after the product is ready.) "More" marketing is quantified into a recommendation that technology-based enterprises invest more than one dollar in marketing for each dollar invested in engineering. This new metric is a Marketing/Engineering Investment Ratio™ >1.

Nevins identified that investment in marketing and a marketing-focused strategy are hallmarks of successful, high-profit electronics companies. He went on to show that those with "marketing-focused strategies invest 50% more in sales and marketing than those with technology-based strategies, and 70-100% more than those with low-cost strategies." 14

However, his data failed to separate marketing, from promoting and selling. Therefore, his data does not help us to know how to independently budget for marketing. Did more investment in marketing make the difference? Or, did a higher investment in promoting or selling make the difference? Nevins didn't say.

Nevins clearly distinguished among them and emphasized that marketing is the decisive factor, "Successful companies think of marketing as the essence of strategy, rather than as a sales and advertising [promoting] function."

Ehrenfried provided additional clues. First, he described and championed an iterative, concurrent, marketing and engineering process before the product is ready. "Product ideas are considered jointly by product development and market development groups and, ... After a favorable evaluation of market needs, the (proposed) product can be placed into research and development. The related roles of product development and market development [market research] are seldom followed.

"Most technical firms sadly neglect the entire market development phase of new product planning. Ideas go directly from a technical evaluation into research and development, and then immediately into sales."

Second, Mr. Ehrenfried attempted to quantify fitting investment in marketing and to use some data, "But how much is spent by industrial firms to verify and guide industrial research programs? The shocking fact is that 7% of sales volume devoted to product development is supported by only 0.09% of sales volume for market development." 15

Unfortunately, he uses data expressed as a percentage of sales, but startups have no sales.

"With almost 100 times as much spent for product development as for market development, it is apparent that balanced and cooperative planning [iterative, concurrent marketing and engineering before the product is ready] cannot be, and is not, being used by American industry. Market development is truly the neglected companion of product development and the high rate of failure of new products is felt to be a direct result." 16

He then went on to recommend a marketing budget that is calculated from the engineering budget. "An engineering firm, intent upon a strong and growing commercial sales future, can justify spending one-tenth of its research and development allocation on market development [marketing, exclusive of promoting and selling]." 17

Yet, no proof was presented for the recommended marketing investment level, only data that the then-current broad industrial average was inadequate. Presumably, Mr. Ehrenfried's recommendation was based on "more is better," rather than direct knowledge of an adequate marketing investment.

The problem is that his recommended increase in marketing investment may have been not bold enough. As the new evidence in the following survey shows, his advice, while bold for its day, has never been bold enough for success.

AEA operating ratios

Let us look to the American Electronics Association for guidance. AEA annual operating ratio surveys express the sum of marketing, promoting, and selling as a percentage of sales for established companies by industry segment. The AEA conducts an annual survey of operating companies in electronics, software & information technology to "enable you to compare your company's operations to companies with comparable sales volume and product lines." ¹⁸

Classical guidelines, as derived from American Electronics Association data, define and size the "marketing and sales" budget, for instance, at 25-30% of sales for a system or instrument company. See Figure 2, AEA operating ratios.

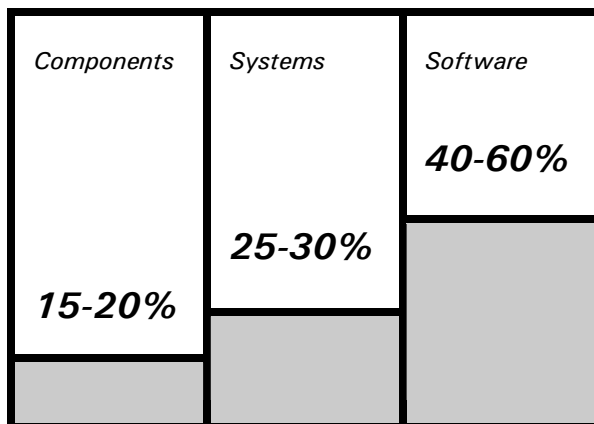


Figure 2, AEA operating ratios
Marketing + Promoting + Selling as a percentage of sales for established companies, by segment

The author finds four problems:

1) Guidelines expressed as a percentage of sales are of no use whatsoever for startups, since startups have no sales! Startups have no operations. While the AEA does survey "developmental stage companies," these are operating companies with significant sales, not startups, and AEA ratios are expressed as a percentage of sales.

For the established company; new products, new markets, and new fields also have the flavor of startups; no sales.

2) Lumping the functions together diverts management attention and investment commitment away from the marketing portion. Since promoting and selling budgets are normally larger, marketing can disappear from view.

3) Time is not in the guideline. When should we invest in marketing? A simple sum does not reveal the time-shape of investment, to correspond to the product development process and to the product life cycle.

4) The AEA data is, by definition, mediocrity: averaging the winners, losers, and the middle performers into a flawed guide. What do the winners do? The AEA does publish data for the top quartile, the 25% fastest growing companies. Recently, they also collect data for the most profitable 25% of the operating companies. However, there is no way of knowing which in the AEA survey are the super successes, which the failures, and which are the "living dead." For example, the top 25% in one segment could all be mediocre. Likewise, the worst 25% in another segment are not necessarily all failures.

A new metric and a recommendation: the Marketing/Engineering Investment Ratio™, a minimum of 1

This author developed a new metric ¹⁹ to solve these issues, the Marketing/Engineering Investment Ratio™ (M/E Ratio™), for the 1992 MIT Enterprise Forum Spring Workshop, *How To Create a Successful New Business*. ²⁰ This new model separates marketing from the functions of promotion and selling. Formulating a ratio of marketing to engineering installs marketing concurrently with engineering, and sizes the marketing budget with a readily identified number (engineering investment). ²¹

See Figure 3 for the Marketing/Engineering Investment Ratio™; a minimum of 1, and concurrent with engineering investment.

With this new metric, the Marketing/Engineering Investment Ratio™, comes a recommendation that technology-based startups, and new businesses inside established companies:

- Apportion the marketing investment relative to the engineering investment.

Marketing is an investment, just as engineering is an investment. Startups and new businesses do not have a sales stream to divide for an estimate of marketing, but they normally have a well-estimated engineering investment.

You can allocate the promoting and selling investment relative to the engineering investment as well. Combined, promoting and selling can be triple the engineering budget. However, this study will focus only on the Marketing portion in order to direct management attention and investment commitment to the upstream marketing process.

- The Marketing/Engineering Investment Ratio™ should be a minimum of 1.

Invest at least one dollar in marketing for each dollar invested in engineering. The magnitude of the challenge simply requires it. Invest more in marketing than in engineering to find out who is going to buy the darn thing!

- Invest those marketing dollars either before, or simultaneously with the engineering dollars.

This becomes one definition of marketing, and a means to distinguish marketing from promoting and selling. Marketing occurs at a special time during product development. Marketing is the process that comes before the product is ready.

This paper, one of four related talks, is intended to convey the fundamental import of marketing with evidence that successful technology-based enterprises invest more in marketing than in engineering.

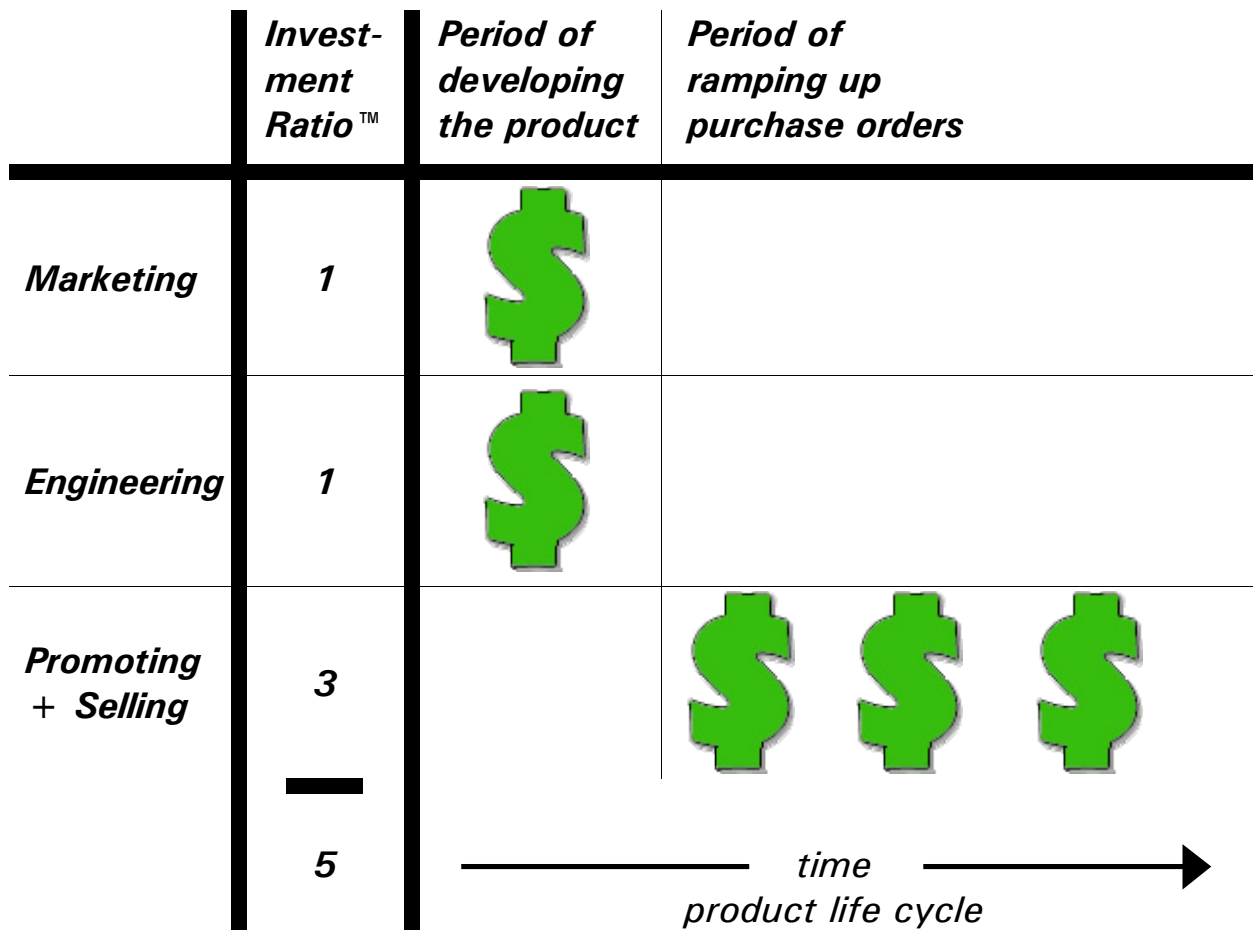


Figure 3, the Marketing/Engineering Investment Ratio™ (M/E Ratio™)

Now that we have a metric to budget for marketing, and have evidence that the marketing budget is serious and should exceed the engineering investment, we might ask, "What are the functions and methods of marketing?" The three companion papers in this Electro/95 sequence are designed to teach three specific tools: market segmentation, understanding customer needs, and primary market research to guide engineering.²²

For additional information, detailed checklists of marketing tasks are available from the National Science Foundation's SBIR Conference.²³ The IEEE Electro/88 Conference brought another outline of marketing,²⁴ and a series of Tutorials and Sessions imparting marketing methods, functionality, and tools.²⁵ The IEEE Entrepreneurs' Network, Boston Chapter, teaches marketing as part of their yearlong entrepreneurial sequence. The reader is also encouraged to take advantage of the marketing segment²⁶ of MIT's annual entrepreneurship course, sponsored by the MIT Enterprise Forum.²⁷

4 Avoid the pitfalls of the flaming failures.

All the failures in this survey suffer from a Marketing/Engineering Investment Ratio™ of 0.1 or lower. The average failure invests only two cents in marketing for every dollar in engineering.

Although Hampshire Instruments consumed \$75 million in capital, only one customer put down a tentative deposit on one of their X-ray steppers. Nobody would buy the darn thing.

Robert Kern, their former CFO, accounts: "Hampshire's M/E Ratio™ was 0.05 from 1984 to 1990. In 1991 and 1992, Moshe tried desperately to find out what customers really wanted, doubling their Marketing/Engineering Ratio™ to 0.1, for a cumulative ratio of 0.07; it wasn't enough. They closed the doors in 1993."²⁸ This resulted not only in a business tragedy, but also in a personal tragedy for the founder, Dr. Moshe Lubin.

Another such personal tragedy occurred for Frank Sterner shortly after Varian Associates abandoned his technology and shut down his group in 1969. Tom Leonard of their marketing team remembers, "The M/E Ratio™ was, at best, 0.05. I would be surprised if we spent as much as one dollar in marketing for twenty in engineering."²⁹

Frank directed the IMPATT Oscillator section at Varian Associates in Beverly, MA. Their technology was the solid state replacement for the microwave klystron tube; probably as significant a development for the radar and telecommunication fields as the transistor was for general electronics. In spite of the advanced technology, they could manufacture hundreds of units a day for a cost of \$8. With the know-how and designs to produce microwave sources from the milliwatt level to the one-Watt level, Varian enjoyed a four-year technological lead on the competition, GUNN diode oscillators.

It was a marketing failure. It was not a failure of good engineering, insufficient investment capital, or lack of sales promotion. Varian's sales staff sold (limited) quantities into the few market segments that their marketing identified. However, there were not enough market segments identified, at not enough volume, to keep the business going. They could not find enough customers to buy the darn things.

This author was a solid-state microwave circuit designer in Frank's group. In frustration, without marketing training and on his own, the writer performed market research identifying five new market segments and obtaining signed letters from customers saying that they would spend \$1,500 for that IMPATT oscillator, which Varian was manufacturing for \$8. Four of those five market segments became multi-million dollar businesses for others over the next ten years. Varian still abandoned the technology and laid everyone off. The author entered Marketing.

This paper is dedicated to the memory of Frank Sterner. The author is gathering data from these personal, professional, and financial tragedies and successes so that we might learn.

GCA created the step-and-repeat system of optical lithography, christened "steppers," for semiconductor manufacturing in the 1970s.

If there is an example of how technology alone might be sufficient for a temporary advantage, not sustainable, it could be GCA. They had no viable competition as late as 1982, enjoying over 95% market share in Japan and 100% everywhere else. Even at the end, it was widely agreed that GCA had good technology.

GCA grew to more than \$400 million in sales in 1984 with over 3,000 employees, becoming #1 in the world in semiconductor fab equipment. GCA was not a failure from a lack of good engineering or sufficient finances. Moreover, GCA could sell; for example, closing \$10 million on a single purchase order after successfully tracking it through thirteen approval levels.³⁰

GCA's M/E Ratio™ was 0.07 in 1981.³¹ As a consequence, they had neither enough marketing horsepower to understand the customer dynamics or the competitive situation, nor the marketing strength to guide the corporation. GCA lost \$145 million in 1985,³² going \$110 million in debt in 1986.^{33 34}

Just before closing their doors, GCA's 1992 Marketing/Engineering Investment Ratio™ was 0.06. Bill Tobey, a former GCA executive, observed, "Absolute arrogance on the part of our technical people, especially engineering. They thought that no one could possibly equal their engineering feats. We just blew it!"³⁵

Thinking Machines declared Chapter 11 in 1994. After blowing through \$120 million of capital, and peaking at \$92 million in sales, they then began laying off 200. "They had excellent technology, but they did not have vision from a market stand-point," said Howard Richmond, an industry analyst with the Gartner Group.³⁶ Clearly, Thinking Machines did not lack from technology, access to capital, or sales.

From their startup in 1983, through 1989, Thinking Machines invested nothing in marketing.³⁷ From 1990 through 1994, they began investing in marketing, raising their Marketing/Engineering Ratio™ to 0.008.³⁸ On a positive note, read of their new President's commitment to significantly increased investment in marketing at section 6, "Go for it!"

Kendall Square Research (KSR), another super-computer startup, also went bankrupt in 1994

after consuming \$170 million in capital. KSR's M/E Ratio™ was 0.03 or lower, from 1986-1995.³⁹

Dr. Linda Garverick's startup consumed \$300K of her own money while selling no product. After receiving a Ph.D. in Physics from MIT, she developed an AutoCAD add-on package, CreaTorr, for vacuum system design. Essential Research software would 'snap' vacuum flanges together while its mathematical technology would calculate pumpdown curves.

CreaTorr impressed everybody who saw it. Nevertheless, Dr. Garverick could not find anybody to buy the darn thing. "The M/E Ratio™ at Essential Research was 0.1. I would bet that we did not invest a dime in marketing for each dollar that we invested in engineering."⁴⁰

Established enterprises, too

Becton Dickinson Medical Systems invested \$300K in engineering over five years, developing new patient location technology for the Coronary Care Unit. By 1978, BD had received five US Patents, with fifteen more pending.

While marketing could have been performed before this project was started, BD initiated primary market research only after engineering was complete. That \$3K (internal labor plus external fee) market survey to understand customer needs established that BD had developed a technology for which there was no need! BD abandoned their \$300K investment.⁴¹

BD's Marketing/Engineering Investment Ratio™ was 0.01 in the 1970s. After pioneering their field in the 1950s, they found themselves with no growth, with losses, and reduced to seventh out of ten in the market, with a declining share.

"After 40 years in the business, and 13% per year growth rate in the mid-1980s,"⁴² Keithley Instruments identified themselves as a failure! Joe Keithley, Chairman of the Board, laments in his 1992 Annual Report, "Our introduction of new products ... has not produced growth ... Fiscal 1992 was the first time in forty years that Keithley Instruments posted a loss of any kind, and we are not pleased."⁴³

Other Keithley Instruments executives echo the failure, "Our marketing execution is an abysmal failure. We are struggling with our marketing strategy. We don't know what we want to be. We are struggling to develop a new product definition process that can achieve success." 44

Keithley Instruments used to be a \$100 million per year company. By 1995, they had become about a \$90 million company, having been flat to down for the prior four years. Keithley had a Marketing/Engineering Investment Ratio™ of 0.07 – 0.1. They are re-organizing, trying to return to a pattern of growth, with new business development teams, which are conducting simultaneous marketing and engineering. Keithley's pilot groups have a higher M/E Ratio™, in the 0.5 - 1 range. 45

SBIR companies

Physical Sciences, Inc. (PSI) of Andover, MA, has been awarded over 200 SBIR grants since 1984, totaling more than \$40 million.

They have received, have pending, or have disclosures on more than 40 US Patents. PSI has only one commercial product, in a small spinout (see "SBIR companies" in the success stories of section 5, below). With all that technology, and all that funding, the balance of PSI has an M/E Ratio™ of 0.01 and no commercial products. 46 47

From 1984 to 1995, Optra of Topsfield, MA received 88 SBIR grants totaling more than \$14 million, resulting in over 20 Patents granted or pending. They have no commercial products (as of 1995), although they have tried. Optra's Marketing/Engineering Ratio™ is 0.1 where they consider themselves a commercial failure, and 0.4 - 0.7 where they had limited commercial success for a time. Clearly, Optra is not lacking for technology, for funding, or desire to commercialize.

Jim Engel, their President, explains, "We have achieved only limited commercial success; with our laser extensometer. Overall, Optra is a failure. We should have spent more money on marketing! We got what we deserved. We might have achieved more success if we had spent more money on marketing.

"I wish we would have followed your advice a long time ago and invested more in marketing. I wish we'd been more receptive to your input, Ralph. I believe in the Marketing/Engineering Ratio™, investing at least \$1 in marketing for every \$1 in engineering. I believe that even more than \$1 in marketing is required for success!" 48

5 Do what the super successes do.

Super successes invest more in marketing than in engineering. They invest, on average, two dollars in marketing (exclusive of promoting and selling) for every dollar invested in engineering. They invest up-front, before the product is ready.

Stan Lapidus started Cytec to pioneer a new field, PAP smear automation. Cytec represents a high business risk; combining a new field, new market, new company, and new product. They typify the extremes of technology with a fusion of biotechnology, machine vision, medical image processing algorithms, and robotics. With all that risk, Cytec raised \$43.6 million in venture capital financing, 49 went public, and achieved a \$3.65 Billion market capitalization! See Figure 4, Cytec financing. Why?

(2007 update: Cytec was acquired for \$6.2 Billion.)

Cytec financing

\$ 3,600,000	<i>first round VC startup</i>
\$ 40,000,000	<i>other VC rounds</i>
\$ 48,000,000	<i>IPO</i>
\$ 85,800,000	<i>secondary public offering</i>
<hr/>	
\$ 177,400,000	<i>financing</i>

Figure 4, Cytec financing

With the entrepreneur still in his basement, Cytyc invested 1.5 times as much in marketing as they did in engineering. Cytyc invested \$120K in marketing versus \$80K in engineering in their first twelve months. See Figure 5.

Fundamental to Cytyc's business case was the primary market research that compelled investment. Cytyc accomplished market research before much of their engineering, performing marketing when the market did not yet exist.⁵¹

In MIT's entrepreneurship course, Stan Lapidus taught, "We didn't plan it that way. We just did what we had to do. In retrospect, it would have been helpful to have such a planning tool. We didn't think in those terms [of the M/E Ratio™] at the time. We just did what was necessary to launch Cytyc successfully. Now, we have a budgeting tool in the Marketing/Engineering Investment Ratio™."⁵⁰

This author is often asked, "How can we do marketing, when the market doesn't exist?" Since high tech entrepreneurs create new markets, the implication of the question is that marketing cannot be done, and especially not in technology-based markets. In fact, the evidence shows that successful technology-based enterprises, such as Cytyc, do just that. They invest in significant up-front marketing.⁵²

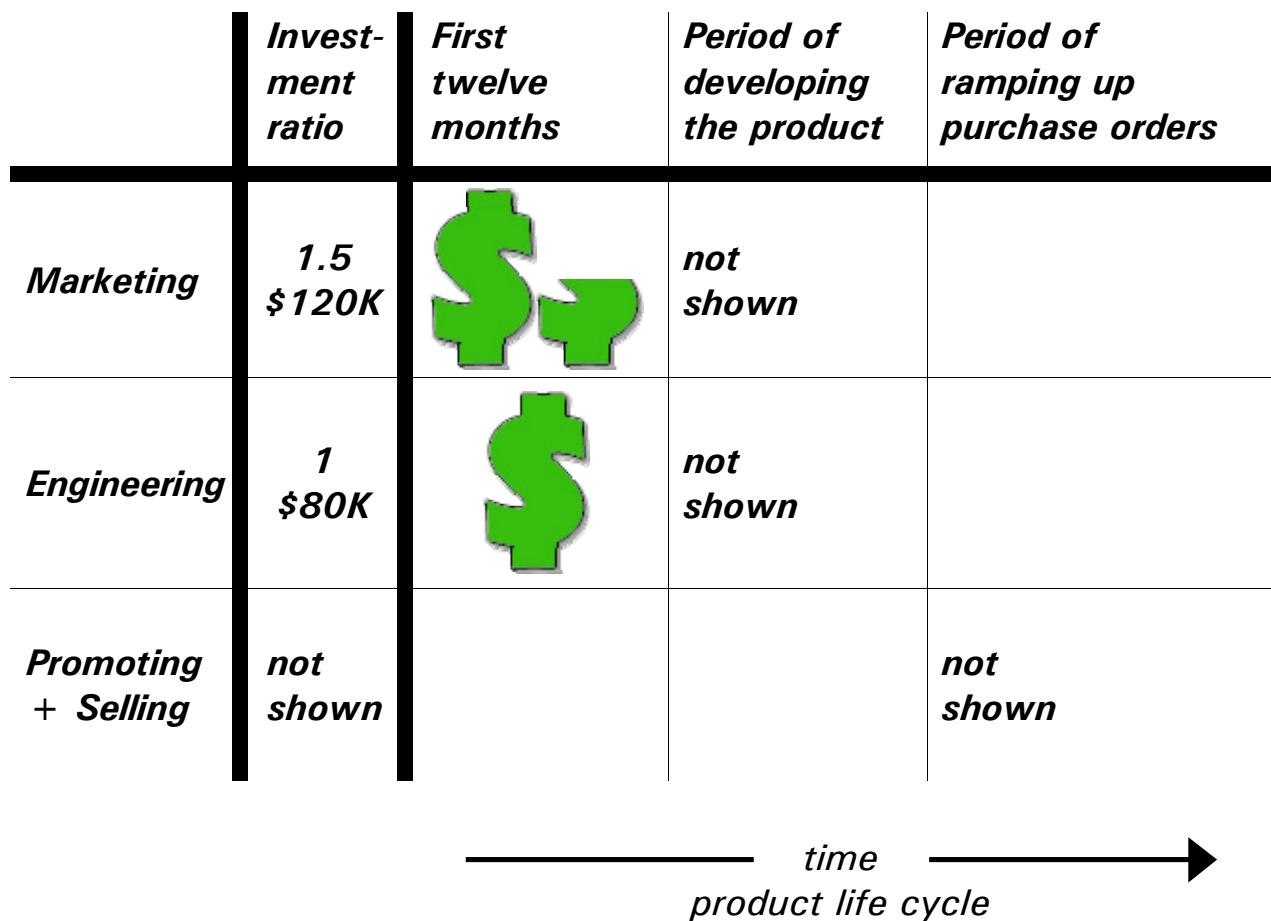


Figure 5, Cytyc's Marketing/Engineering Investment Ratio™

Cytec began their investment with a market segmentation⁵³ to identify the portion to serve, and the access point.⁵⁴ They worked to understand their customers' demographics, market trends,⁵⁵ and the industry drivers, which precipitated an expose of "PAP mills."^{56 57} The outcries lead to Congressional Hearings.^{58 59} By that time, Cytec's market research was available to be used in testimony before Congress, helping to result in new legislation that will speed market demand for their products.⁶⁰

Technology-based startups present two types of technical risk. First, there is the risk that the startup cannot make the technology work. The second risk, as happened at Cytec, is that the startup does make the technology work, but that they are developing the wrong technology. Up-front marketing can guide engineering to the right technology.

Cytec's up-front marketing investment identified profound changes from the initial product concept, which used machine vision.⁶¹ An entirely new product idea arose from the primary market research; a patented slide prep system, ThinPrep™, which creates a cell monolayer and simplifies the PAP reading process.⁶²

With marketing guidance, Cytec's engineering developed the right technology.

Phoenix Controls launched a new field in the 1980s, variable air volume (VAV) building controls, with a prototype electronic air control system for chemical fume hoods. They invested in up-front market research, which proposed simple product changes that resulted in decisive market viability and a US Patent for an unfair, defensible position. For example, in their first twelve months they invested \$1.25 in marketing for every \$1 in engineering.

The MIT Enterprise Forum spotlighted Phoenix Controls' successful financing, continuous growth through \$20 million in annual sales, and world domination of their market niche.⁶³ INC Magazine honored Phoenix as one of the "500 fastest growing privately held companies" three years running, in 1991, 1992, and 1993.⁶⁴ Only 10% of the 500 ever appear three times.⁶⁵ Gordon Sharp, the Founder and President, summed up the key to their success, "Market research gave us a handle on where to go."⁶⁶

Some entrepreneurs achieve their financial goals when they sell the company in an acquisition. Microsoft offered \$2 billion to Scott Cook for his twelve-year old software startup in 1995.⁶⁷ Intuit's M/E Ratio™ is about 1.5.⁶⁸ Enjoying sales of \$600 million (fiscal year ending July 31, 1997), Intuit controls approximately 70% of the personal finance software market with a product called Quicken.⁶⁹

Stephen Robbins, as an Intuit engineering manager, recognized that "Intuit is absolutely driven by marketing. It is perceived as a good thing that Intuit is marketing directed. Marketing is viewed as the key to success. Inside the engineering department, for example, engineers have a keen awareness that marketing is quite important to the success of the company."⁷⁰

As another example, DIVA, with software for video editing on the MAC, was launched for \$385K from family and friends. DIVA was sold for \$4.5 Million two and one-half years later in an acquisition by a larger company called AVID. DIVA's Marketing/Engineering Investment Ratio™ was 4. The entrepreneur, Jonathan Harber, invested one year in market research around the globe, and in business planning, before initiating software engineering.⁷¹

Molten Metal Technology (MMT) leapt from a raw startup to a publicly traded company with a \$500 million market capitalization in 4 years.⁷²

Their technology uses a molten metal bath, typically 15 tons of steel at 3,000°F, to dissolve and catalyze hazardous and non-hazardous wastes to their component elements. At that temperature, the efficient liquid reaction consumes wastes at supersonic speeds. Commercial scale tests achieved 99.99999% conversion in a closed loop, sealed system, with heavy metals recovered as slag, gasses as raw materials, and useful metals as alloys.

"I've seen a lot of environmental technologies over the years. But I've never seen anything that's excited me as much as this,"⁷³ said Maurice Strong, Secretary General of the 1992 Earth Summit in Rio de Janeiro. "It can literally revolutionize our ability to deal with toxic wastes,"⁷⁴ Strong said, in an Industry Week article proclaiming MMT's process the "Technology of the Year."

"Here was an invention that could help society and improve the quality of life," ⁷⁵ said John Preston of MIT's Technology Licensing Office, seeing gold. "It is one of the few 13's on my scale of 1 to 10 - maybe the only one." ⁷⁶

John Preston has a unique vantage point to place technology in perspective with marketing. Under John's direction, MIT commercializes [licenses] about 100 technologies every year. "I believe in the Marketing/Engineering Investment Ratio™. Out of 450 patent submissions a year that come through my Office at MIT, I see one outlier a year that does not need as much marketing.

"Molten Metal's technology, for example, satisfies such an obvious societal need that MMT needs less marketing than any of the other [449] technologies. Furthermore, MMT has a huge R&D staff making an enormous investment in the [awesome] technology." ⁷⁷ MMT's R&D investment resulted in more than 200 patents granted, pending, or disclosed. ⁷⁸

Nevertheless, MMT's M/E Ratio™ was 1.25 in one of their early years, 1991, and 0.36 from 1990-1994. Not only was the M/E Ratio™ high, but also the absolute dollar amount was large. MMT invested \$.84 million in marketing in 1991, and a cumulative \$12.2 million in marketing in 1990-1994. ^{79 80 81}

Molten Metal is marketing driven from the top down, with their CEO, Bill Haney, and other (non-marketing) executives estimating that they devote 20% - 70% of their time to marketing. ⁸²

John Preston concluded, "Normally, marketing investment should exceed the R&D investment. Molten Metal has such a radical invention that they are an exception. MMT needs less marketing. All the other technologies need more marketing." ⁸³

"I think the Marketing/Engineering Investment Ratio™ is insightfully correct," ⁸⁴ wrote MMT's VP of Marketing, Dr. Ian Yates.

"We invested in a large amount of market research to identify our entry strategy and to target the right first set of customers. Additionally, marketing provided input for our corporate financial processes." ⁸⁵

MMT illuminates their marketing focus in their 10-K Form, referring to specific marketing methods and listing the results achieved:

- Primary market research and segmentation

"MMT has identified its initial target markets through discussions with potential users that have specific requirements, by analyzing the total US market ... and by determining which ..." [MMT can readily address].

- Targeting entry points

"For the initial commercialization, MMT has identified three markets where it believes MMT offers the greatest immediate value and meets pressing customer needs: ... "

- Strategic alliances

"In each of those markets, MMT has formed relationships with market leaders to deliver initial facilities."

- Engineering guidance

"The Company's commercialization strategy includes identifying industrial market leaders as initial customer prospects and performing technical evaluations on customer waste streams at MMT facilities. Such activities are intended to keep the technical development focused on market opportunities." ⁸⁶

Supported by that marketing guidance, MMT formed strategic alliances with DuPont, Rollins Environmental Services, and L'Air Liquide. ⁸⁷

From marketing direction toward 'the right first set,' "Molten Metal executed agreements with leading customers in each of its target market segments:" ⁸⁸ Martin Marietta, Westinghouse, and Hoechst Celanese. ⁸⁹

With 'marketing input for the financial processes,' MMT raised \$140 million in equity capital. ⁹⁰

Yet, they did not have the courage to maintain their M/E Ratio™, which declined to 0.1 by 1997. MMT declared bankruptcy in December 1997, and is thus also reported as a failure. John Preston was wrong; MMT needed more marketing.

Established enterprises, too

When Varian Associates created the Model 990 Component Leak Detector at their Vacuum Products Division, there were indicators of low market research investment in mature businesses: a one-half century old, \$1 billion, Fortune 500 company; a two-century old technical field, and a fifty year old product category.

At the same time, there were indicators of significant engineering investment: a high tech product selling for more than \$25K, customers who are in highly technical fields, Windows software, an embedded microprocessor, CAD designed N/C machining of exotic metals, gas handling, highly engineered pumps, motors, and valves; and complex safety and operational interlocks.

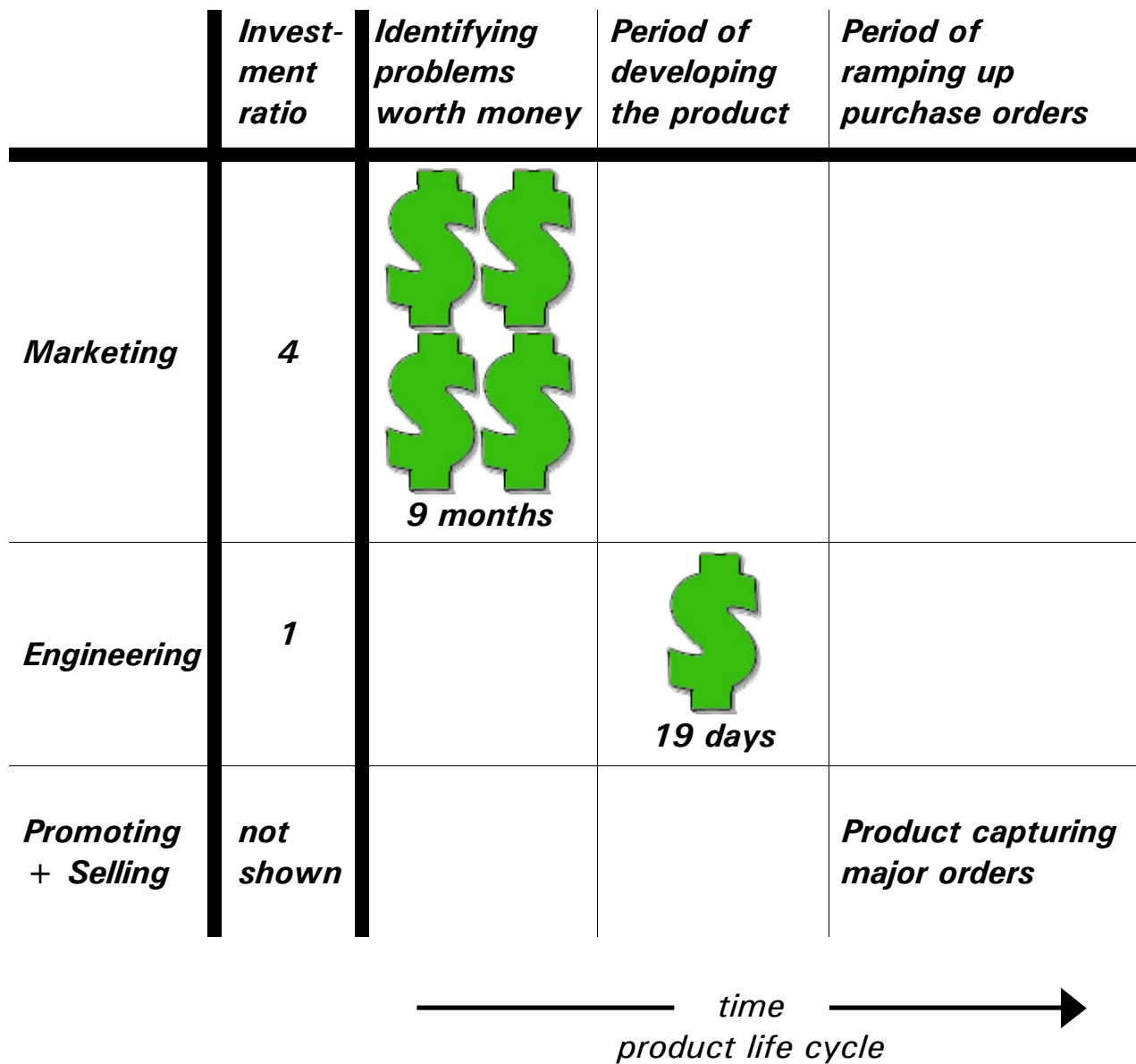


Figure 6, time history of Varian's Marketing/Engineering Investment Ratio™

However, Varian's M/E Ratio™ was 4! They invested in nine months of marketing effort before beginning engineering. Varian's marketing effort surfaced the "voice of the customer" to develop explicit lists of what engineering should design, and of what engineering should not design. Armed with definitive guidance from marketing, engineering designed the product in nineteen days. See Figure 6 for the time history of Varian's M/E Ratio™.

According to their Division Manager, "We are taking major market share away from our competitors, fast. We're seeing volume orders, more than one unit on purchase orders for the first time, ever. We just got a \$250K order. Marketing is very cost effective for us." 91

Becton Dickinson Medical Systems installed a new management team in 1977 who began investing heavily in marketing, raising their M/E Ratio™ to 4. Marketing identified and plainly specified the technology for engineering to focus on for decisive competitive advantage. BD returned to profitability, tripled market share, and rose to #2 against HP as #1 within 24 months! 92

See Figure 7 for BD's global success as a result of increasing the M/E Investment Ratio™ to 4. 93 94

Before 1977, BD had initiated a number of engineering projects for their "gee-whiz" value. Many engineering efforts had been urged by the sales force, which had hoped to exhibit technology that would make customers' jaws drop.

Marketing* /Engineering Investment Ratio™

(*) excludes promoting and selling

increased from 0.01 to 4

	1977	1980
Systems sales	<i>\$ 7 million</i>	<i>\$ 10.5 million</i>
Profit / loss	<i>3% loss</i>	<i>2% profit</i>
Market share	<i>#7 of 10 USA 7% Europe 5% Japan 0.1%</i>	<i>#2 after HP > Tripled to 25-30% Europe x7 to 35% Japan x1000 to 100%</i>
Engineering employment	<i>1</i>	<i>15</i>

Figure 7, BD's global success as a result of increasing the M/E Ratio™ to 4

Becton Dickinson had fallen victim to what the Price Waterhouse entrepreneurial guide lists as *Common Pitfalls to Avoid*:⁹⁵

- Common Pitfall Number 10, Enthrallment with technological wizardry that ignores what customers actually need.
- "Common Pitfall Number 18, Mistaking selling for marketing."

By the time BD's new management team arrived, there were fifteen major projects already going on in engineering. The patient location technology, Telocate, described earlier was one of the fifteen. New BD marketing staff rigorously examined all fifteen against three questions:

1. What benefits does the customer wish to spend money to receive? Quantify them.
2. Considering only those, where might we already have, or develop in engineering; a decisive, defensible competitive advantage?
3. In which market segment(s) can we deliver the most value to the customer?

Armed with customer and market data, in six months, BD marketing abandoned or shelved fourteen out of the fifteen engineering projects as unneeded, ill conceived, or not decisive.

For example, even though BD had been the Coronary Care business for twenty-five years, and in the telemetry unit for twelve, they had become so enthralled with the technology that they overlooked a basic customer need: ten days after a heart attack, the patient who is fitted with a telemetry transmitter and told to walk around is still frightened, and remains in sight of the nurse who has a defibrillator. Therefore, Telocate was a technology for which there was no need.

Surprisingly, the market analysis which nixed Telocate discovered that BD already had a competitive advantage with their existing telemetry system, and did not realize it.⁹⁶ Marketing proceeded to train the sales force to think in terms of customer needs. BD's telemetry sales doubled in six months; a dramatic development for a zero-growth market.

BD marketing then assembled a "task team" led by a marketing person, with two engineers. That nucleus invested the next six months in up-front market planning in the one technology area, out of fifteen, where BD had a defensible competitive advantage and could deliver the most value. They targeted the segment where BD could exploit technology-induced market dynamics to rapidly improve market share.⁹⁷ They segmented the market, analyzed the competition, and specified engineering features that would deliver customer benefits.⁹⁸

The group wrote a detailed business plan that compelled several hundred thousand dollars of BD investment. Engineering resources focused on this one project, Arrhythmia Recall (A/R).

BD's resulting success is displayed in Figure 7. The astute reader will notice that market share tripled, while sales went up 50%; a consequence of deliberate market focus and segmentation.

Incredibly, no A/R units were delivered during this period. BD engineering was addressing a significant technical challenge that simply took time. Even though competitors were delivering (poor quality units designed rapidly), customers recognized that BD's A/R upgrade would better address their needs. They decided (there's that word, decisive) to purchase from BD.

SBIR companies

PSI Environmental is the commercialization spinout of the SBIR company, Physical Sciences, Inc. They have one product, a temperature monitor for coal-fired utility boilers. Their M/E Ratio™ has been 1.5, and is now in the process of being increased significantly beyond 1.5.

In less than two years, they sold more than sixty units at \$25K each, for \$1.5 million. President Dr. Art Boni remarked, "I certainly consider this a resounding commercial success, especially considering that selling to electric utilities must be one of the toughest sells that there is. They have a long, multi-year adoption cycle. So, to sell so many units in our first two years must be considered a success."⁹⁹

6 Go for it!

Invest more in marketing than in engineering.

Go for it! Invest more in marketing than in engineering. Divide the logarithmic scale of the Marketing/Engineering Investment Ratio™ into three zones. Stay in the GO zone, above 1. Avoid the CAUTION and WARNING zones below 1. See Figure 8, for the GO, CAUTION, and WARNING zones of the M/E Investment Ratio™:

- M/E Ratio™ above 1 - GO

In this zone, the strategy is to invest more in marketing than in engineering. Management attention and investment commitment is devoted to decisive, up-front marketing. The evidence is in. Super successes in this survey invest more in marketing than in engineering. They invest up front.

- M/E Ratio™ between 0.1 and 1 – CAUTION

In this zone, the strategy is to invest more in engineering than in market research. Here, marketing is being done, but below threshold. The results tend to be indecisive, neither clear success nor clear failure.

- M/E Ratio™ 0.1 or less -WARNING

In this zone, the strategy is to not invest in marketing. Engineering is the priority. Compared with engineering, little, if any, marketing is accomplished. What marketing is done tends to be later, rather than up-front, or is performed after the engineering is complete. All the flaming failures in this study are in this zone.

Be bold. Becton Dickinson raised their M/E Ratio™ by a factor of four hundred in six months! BD more than tripled their market share rapidly, became profitable, and hired more engineers.

Learn from the experience. Jack Derby learned as one of the middle managers during BD's turnaround, "Very avant-garde, wonderful stuff! I remember a very high [4] M/E Ratio™ and the 'task team.' I learned the value of marketing from that success. When I became President of the successor operation, Litton Medical Systems, I raised the Marketing/Engineering Ratio™ even higher, to about 9." 100

Thinking Machines may be learning. They hired a new Chief Executive, Bob Doretti, who asserts that he will be giving management attention and investment commitment to marketing. In a quotation specifically for this research, Bob states, "We intend to significantly increase our investment in marketing. We expect significant growth in our marketing staff. We are trying to turn an engineering oriented company into a business oriented company." 101

Have courage. David Brock describes Keithley's reaction to their failure, "We changed from a product focus to a marketing focus in June of 1993. We changed from a product strategy to a marketing strategy. We are creating a new project process that has a significantly higher M/E Ratio™, an order of magnitude higher, than has been our tradition. This order of magnitude higher M/E Ratio™ may be the way that we need to be across the board."

However, David continued, "I am concerned that we are not going high enough, that we are not investing enough in marketing, even at an M/E Ratio™ of 0.5 - 1. I am also concerned that we have the courage, and management foresight, to maintain even that level of marketing investment without getting the marketing funds diverted into engineering." 102

Don't backslide. Optra's M/E Ratio™ slumped, and their project slid from "almost a success" to "on hold." President Jim Engel traced their semiconductor metrology unit's descent, "Since the end of 1993, we have spent a lot more on engineering, and very little on marketing. As a result, our cumulative M/E Ratio™ slipped from 0.7 to 0.5. It's on hold. It's the living dead!" 103

Marketing* /Engineering Investment Ratio™

() excludes promoting and selling*

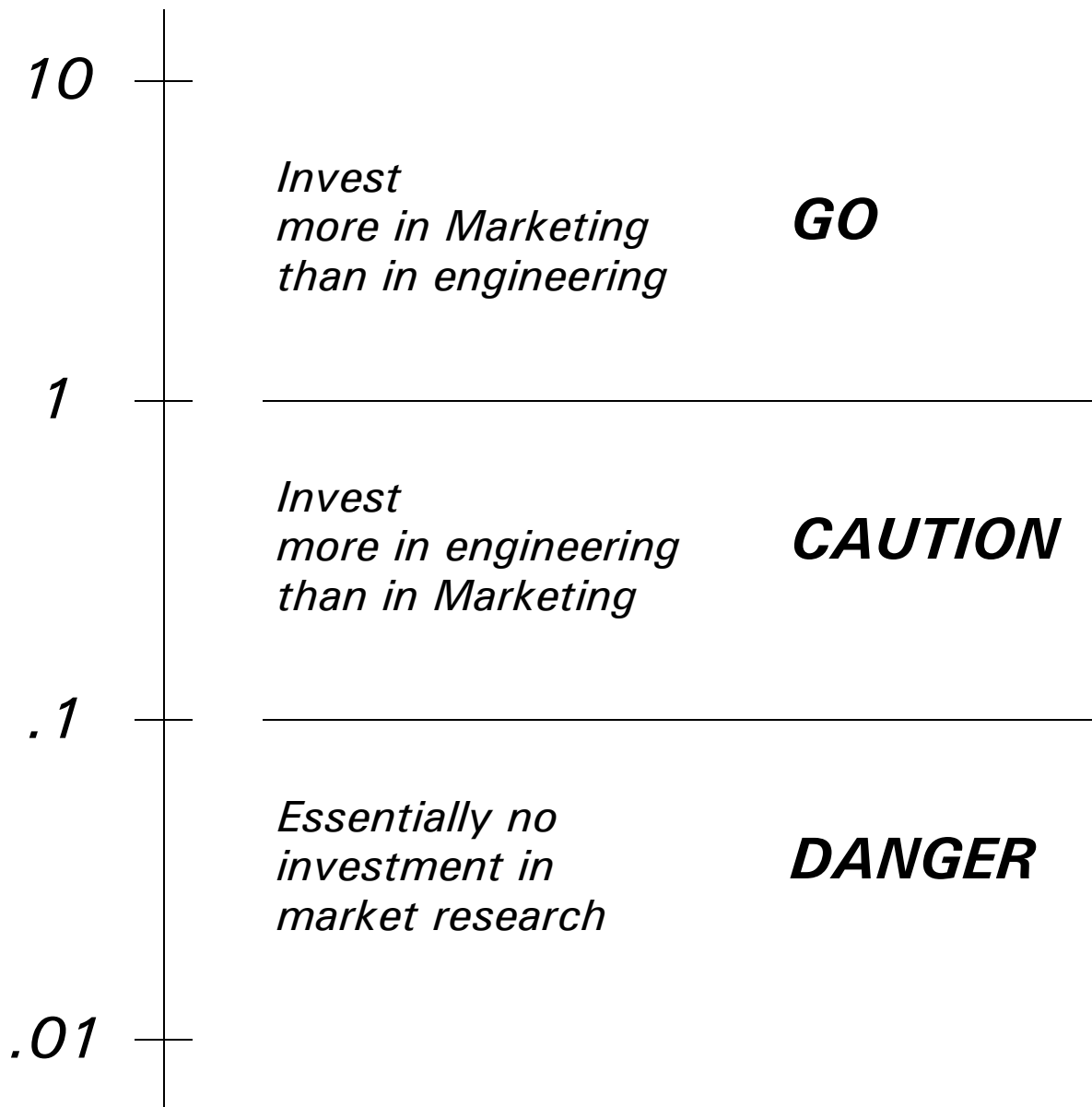


Figure 8, the GO, CAUTION, and DANGER zones of the M/E Investment Ratio™

7 Implications for technology-based enterprises:

Invest more in marketing than in engineering.

The implication of the evidence is a fundamental shift in management attention and investment commitment toward decisive, up-front marketing. Successful technology-based enterprises invest more in marketing than in engineering.

"I think that your conclusions are correct, Ralph. I'm struck by the singular difference, by the gap in the Marketing/Engineering Investment Ratio™ between the failures and successes. The dichotomy falls right out of the data," ¹⁰⁴ concluded Bob Kern of Hampshire Instruments.

for Entrepreneurs

Re-think the early investment priorities. Affect a fundamental shift to a marketing focus, away from a technology focus.

Perform marketing early on, up-front. Assume, for the moment, that the technology will work, and focus on the marketing. The marketing is the big risk. Assume that the technology is not a risk. Having good technology that works is necessary for success. However, having good technology is not sufficient. Every one of the failures in this study had good technology.

For example, Thinking Machines is regarded as having excellent technology. One of Thinking Machines' technologists, Jacek Myczkowski, won three Gordon Bell Prizes for supercomputer achievements. They went bankrupt.

Becton Dickinson's telemetry product was between one and four orders-of-magnitude technically superior, even before Telocate. As one example, their major competitor, HP, had a telemetry transmitter with a range of 100 feet,

while BD's unit had a range of two miles. BD's unit had 100 times more range, or two orders of magnitude superiority. BD's technology languished until they raised their M/E Ratio™ over one, whereupon their telemetry sales took off.

for Engineers

Don't be afraid that investing in marketing means less money for engineering.

Nevins' data [for established companies] shows identical R&D investments in companies with a marketing focus and in those with a technology focus [as a percentage of sales]. He went on to conclude, "R&D differences between [all other] and marketing-focused strategies tend to be relatively small ... illustrating that it is the marketing expense, coupled with ... R&D focused on a few high-value tasks, that support higher margins." ¹⁰⁵

Logically, successful high-growth enterprises tend to hire engineers, and to grow their engineering capability. For example, Becton Dickinson Medical Systems raised their M/E Ratio™ to four, and had to significantly expand their engineering staff to handle the success.

The real anxiety ought to be a fear of layoffs. Before BD raised their M/E Ratio™, between layoffs, and engineers who left in disgust or because there was no money for raises; BDMS was reduced to one degreed engineer. GCA employed 3,000. They are all gone now. Hampshire Instruments had a \$12 million per year engineering budget. Hampshire ran out of money for engineering, or anything else, and shut their doors. KSR had more than 100 people in their technical staff alone. KSR went bankrupt. Thinking Machines laid off 200. Varian Associates laid off their entire IMPATT oscillator group, including this author.

What kind of organization would you like to be part of? The choice is yours.

for Venture Capitalists

Use M/E Ratio™ as a test of whether to invest. If the business plan demonstrates that the cumulative Marketing/Engineering Investment Ratio™ is already more than one, proceed to consider the other issues that you normally would. If the M/E Ratio™ is less than one, then either put money in earmarked for marketing, or introduce the applicants to potential marketing team members, or encourage them to find marketing people themselves.

When you do decide to invest, incorporate the M/E Ratio™ into the terms as a financial covenant. Maintain the M/E Ratio™ above one.

As a CFO who had to raise money from investors, Bob Kern made the connection, "Your findings are right on the mark. Your findings are just very important for investors, and for startups. The investors will control the startups. Those who control the purse strings will make the entrepreneurs jump." 106

Monitor the M/E Ratio™ as a key financial ratio in portfolio companies. If the M/E Ratio™ falls below one, raise the M/E Ratio™ above one.

Use the M/E Ratio™ as a tool to revive the "living dead" companies that are in every venture capitalist's portfolio.

Account for marketing distinctly from promotion and selling.

As one venture capitalist, Gordon Baty of Zero Stage Capital, observed recently, "The Vice President of so-called Marketing at one of my 'living dead' companies thinks that he can 'market' his way out of their problems with just one more slick brochure. [He's thinking about promoting, rather than about upstream marketing.] He needs a lot more than that!" 107

for established enterprises and corporate America

Make a major shift in funding to real marketing.

There is no difference in the data of Figure 1 between startups and established companies. Successful established companies also invest more in marketing than in engineering. For example, Becton Dickinson made a major shift in funding, raising their M/E Ratio™ to four.

Observing failures and successes in established companies, Nevins concludes, "Successful companies think of marketing as the essence of strategy rather than as a sales and advertising function. The shift in spending decisions [toward up-front marketing] and control systems [accounting separately for promoting and selling] is the single most common roadblock to achieving marketing excellence."

Re-structure and re-organize to be marketing directed, from the top down. Change people.

Nevins tells of the structural and personnel challenge, "Perhaps the most difficult task faced by senior managers is creating a management team infused with [upstream] marketing expertise. Most traditional electronics companies' marketing departments lack key [market research] skills such as analyzing customers ... Without personnel or organizational changes, additional 'marketing' dollars often are spent hiring staff who are diverted into sales or sales-support activities. Changing people and organizations is often the only feasible approach." 108

Becton Dickinson brought in a new management team for the Medical Systems Division in 1977. The new Division President had a marketing background. They recruited staff who possessed distinct upstream marketing skills, tools, and experience; and who proceeded to rigorously apply formal market research methods.

Varian Associates changed. The Varian Division Manager who reported an M/E Ratio™ of four on a 1993 project said, "We're not the same company that we were in 1969. We have new management leading us to be marketing directed from the top down." 109

Think in terms of dynamics. Imagine your business as a series of intreprenurial startups. Abandon the operating ratio philosophy.

Time defines marketing, just as much as a functional demarcation does. Marketing and engineering are executed in the period before the product is ready. After the product is ready come promoting, selling, and manufacturing (operations). Review Figure 3, which pictorially places the various functions in time. There is no marketing or engineering, by definition, during manufacturing operations of any one product. The marketing and engineering for that product took place at an earlier time, during the design phase of that product while there were not yet any operations for that product. (Realistically, there is some sustaining engineering and marketing work, but they are small relative to the original efforts.)

In established companies, product generations normally overlap; the engineering and marketing for the next generation occur during the current generation's manufacturing operations. It makes no sense to calculate marketing as a current operating ratio, because marketing (for the next generation product) is not related to operations for the current generation of product. Marketing for the next generation product is related to operations for the next generation product, of which there are now none.

Officers of certain established companies with little or no current marketing have pointed this author to their current operations, suggesting that little or no marketing is necessary.

However, they would not suggest that little or no engineering (for the next generation product) is necessary. Technology-based business people recognize that, with little or no engineering, they would shortly be run over by the competition and by evolving technology. Furthermore, they really did do marketing for the current product. However, that was in the past. They either don't remember it, or didn't separately account for it.

Engineering budgets are scaled to the next generation product, as marketing budgets should be. Together, marketing and engineering form an intreprenurial startup dynamic.

Get visibility. A startup normally has, by definition, only one project. However, established corporations tend to have a number of business lines. Like industry averages, a corporate rollup can mask what's going on. "Often, the issue of better marketing gets buried in a forest of ... data. A useful first step ... involves segmentation of the market." ¹¹⁰ Get visibility by separating divisions, market segments, projects, products, and product lines.

Any established company surely has some pieces that do less well or fail, and some that do better or are super successes. Track the winners and the losers, separately. Do NOT aggregate marketing investment. Do not aggregate engineering investment. Calculate the M/E Ratio™ for each, separately.

for Finance and Accounting

Finance the marketing, not just the engineering. Finance the marketing at the same level, or higher, than the engineering. Finance the marketing early on in the investment cycle. Insist upon (demand) customer and market data from up-front marketing to justify the financing of investments in engineering.

Account separately for each of marketing, promoting, and selling. Include the marketing function done by people without marketing titles, such as company management.

Abandon the present "marketing department" cost structure, which often lumps marketing, promoting, and selling together into one department. Each separate function is valuable. However, you can't tell how much is devoted to each. Selling and promotion are normally large. As a consequence, marketing can lose visibility.

Abandon marketing as a cost center. Consider promoting and selling as a cost center for existing products.

Account for marketing as an investment in new products, just as engineering is considered an investment in new products.

for SBIR - financed firms

SBIR programs do not allow explicit marketing charges, but DO allow "identification of technical specifications." This is still a marketing function. If you wish to be commercially successful, obtain funds for marketing, from this method, or from outside investment.

for the SBIR program

The SBIR Re-authorization Act of 1992 contains a Congressional mandate for demonstration of commercial viability. It has been helpful, but doesn't go far enough. SBIR recipients are encouraged to partner with established firms, who don't necessarily understand marketing. Technical evaluators (with no marketing credentials) evaluate SBIR proposals for both technical and commercial viability. This list is a proposal for changes to the SBIR program:

1. Allow (demand) up-front marketing.
2. Write explicit commercial viability criterion into SBIR proposal requirements.
3. Teach marketing to entrepreneurs.
4. Create separate commercial viability review panels staffed with reviewers who have marketing and business credentials.
5. Fund more research into the relationship between investment in marketing and success, especially among SBIR recipients.

for defense conversion

For defense contractors, to "convert" means to master commercial products. The evidence indicates that, to be successful in commercial products, you must invest more in marketing than in engineering. However, this philosophy is foreign to the culture of defense contractors. Nothing less than a radical re-structuring will work; a cultural upheaval to a marketing focus.

8 Summary

Assume that your technology will work, and ask yourself, "Who is going to buy the darn thing?" Evidence is now available to invest MORE IN MARKETING than in engineering to find out! The implication for technology-based enterprises is a fundamental shift in management attention and investment commitment toward decisive, up-front marketing.

Engineers know how to develop an engineering budget. Simply use the engineering budget to establish the size and timing of the up-front marketing budget.

As the engineering investment proceeds, there are known engineering processes, tools, and methods brought to bear. As the up-front marketing investment proceeds, both entrepreneurs and established companies also use known marketing processes, tools, and methods to achieve success.

Employ the Marketing/Engineering Investment Ratio™ process as a fundamental tool for success.

Author

Ralph Grabowski is an MIT-degreed Electrical Engineer who focuses on the fact-gathering, analytical marketing process to steer technology-based enterprises. He has helped launch new products, new companies, and more than seven new fields that gainfully employ thousands of his fellow engineers; and which have grown to become worth over ten Billion dollars.

Mr. Grabowski practices as a VP of Marketing for startups, as a temporary executive, and as a Marketing Consultant. He writes about marketing, teaches marketing, researches how marketing drives success, and supports the institutions of technology-based business and entrepreneurship.

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