7. VALUE AND MARKET ANALYSIS

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7.1 INTRODUCTION

This chapter focuses on economic value, market analysis and technology assessment. The goal is to provide a foundation for evaluating the worth of a product, technology or business concept based on value analysis. Techniques for obtaining measures of value from survey data are located in other chapters. In this chapter we seek out more direct methods of evaluation.

Total product value is the theoretical maximum user worth for a product. In practice, however, we measure the users' perceived or computed economic values that we assume approximates the total value of the product. The economic value consists of those factors that can be measured directly from the analysis of how the product is used. The perceived value is determined from the reaction of the potential users to the product or its concept. Perceived value measurement is fairly complex and is covered in a separate chapter of these notes.

In addition to the current value one may need to consider "latent" value that may neither be perceived at this point nor can be calculated based on the present applications. This value is latent in that barriers exist to its present realization. However, it still may affect anticipated demand and long term perceived value.

7.1.1 ANALYSIS FRAME

Value requires a "perspective." We need to know for whom is the value being estimated. Value to the user is different from value to the purchaser; which is also different from the seller, which once again is different from the general public. The choice of the perspective of the analysis is referred to as the analysis frame.

7.1.1.1 Perspective

Usually value and benefits are considered from the perspective of the user and are thought of as the driver of decisions. However, there are multiple perspectives that could be considered.

7.1.1.2 Outcomes

How a product is or will be used is fundamental to all value analyses. The concept of the mode of use of products is referred to as outcomes[1]. That is each potential tangible and intangible potential benefit is viewed as outcomes. It is the outcomes that collective determine the value of the product. Two individuals using a product differently and thereby getting different outcomes is really dealing with different products according to this perspective. Outcomes here can be thought of as benefits but takes on pragmatic implications. While benefits are usually viewed exclusively as positive, outcomes may not be. Outcomes are just what the product does for the user. In most cases, there will be a small number of outcomes that are almost universally associated with a product. These are referred to as key outcomes.

7.1.1.2.1 Tangible and Intangible Outcomes

Not all outcomes may be tangible in that they may not all be explicit. Some outcomes are psychological. Such as trust or confidence. These outcomes are similar to those issues discussed as "Inner Mind" brand characteristics. Two pieces of candy may have the same ingredients and for the most part the same taste but depending on the brand name they each may have vastly different intangible (and non-cognitive) outcomes. No one would say that the inner mind brand characteristics of Godiva chocolates are the same as a "Baby Ruth" candy bar. This is in spite of the fact that the ingredients of the two are not much different.

7.1.1.2.2 Tasks

In order to get to an outcome tasks normally have to be performed. These may be activities which the product needs to perform or they may be things done to the product in the process of getting an outcome. The features of the product generally read on these tasks. In particular, these are tangible tasks. Note that several outcomes can come out of the use of a single task. And that the same tasks may be needed for any number of outcomes. Some tasks are so dominant in obtaining outcomes that they can be preferred to as primary or key tasks.

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[1] Procedures to collect and measure effectiveness of products by the potential "outcomes" from there use has been advocated as both measures of product value and a route to innovative product development. See "*Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant*", W. Chan Kim, Renee Mauborgne, Harvard Business School Press (2005) and "*What Customers Want: Using Outcome-Driven Innovation to Create Breakthrough Products and Services*", Anthony Ulwick (2005).

7.1.1.3 Value Propositions

Value propositions are statements or claims describing the benefits derived from a product. They represent the producer's perception of the potential value of the product. For practical purposes, value propositions are the building elements of position statements, product descriptions and "tag lines" used to promote products. Tools to develop and test these statements for advertising purposes are described in the chapter on communications. Here we focus on the values themselves. An end result of this form of marketing research is the assessment of validity of the value concepts that is used to derive value propositions.

7.1.1.4 Inherent versus Perceived Value

Value exists ultimately in the mind of the user. However, it is useful to consider value being a set of inherent properties of products. Inherent value represents the normative value that should be able to be obtained from the product. It is the normative value, in that if we can remove all restrictions, it should be the value obtained by the user.

7.1.1.4.1 Perceived versus Economic Value

At this point, we have to make the distinction between perceived and economic or inherent value. Perceived value is the dollar equivalent value of a product or its benefits. It is in the mind of the users and its measurement involves assessing the reaction of user (respondents) to a series of stimuli. The methods to measure perceived value involve a number of "psychometric" procedures and are discussed in a separate chapter. This chapter focuses on economic value as obtained from analyses of uses of products.

7.1.1.4.2 Normative versus Descriptive Value

Perceived value, by its nature, reflects how customers' value products and is therefore a description of the present mind-set. Inherent value has a broader perspective. Inherent value may reflect how the customer should view the product. From a marketing perceptive the inherent value is the potential to build value in the mind of the customers.

7.1.1.4.3 Potential versus Realized Value

Not all value can be realized. A major goal of value analysis is to identify restrictions that limit the realization of potential value. While some of these restrictions and constraints can be removed (by programs, promotion and, in some cases, invention) there are some that can not. Typically, there is a difference between social value, obtained by the total economy, and that obtained by individuals. This distinction will be discussed later in this chapter however, at this point it is necessary to recognize the difference between the potential value and that which can be realized.

7.1.1.5 Clientship

Value analyses are done for clients and for specific purposes. This forms the orientation of the analysis. Different elements of value may have different levels of importance depending on this orientation.

7.1.1.6 Scope

The process of evaluation can be infinite, if we allow ourselves unlimited scope. In general, the evaluation process is limited to those issues that are deemed significant and of interest. While this may appear to make all value analyses suspect, it is a basic requirement for a cost-effective activity. Typically, we focus only on those factors of specific interest to the client.

7.1.2 TIME FRAME

Time frame consists of both the starting point and the time range of interest. The ability to evaluate value and forecast sales differs depending on the frame. Market analysis mainly focuses on the shorter time frame while technology assessment focuses on long term changes and opportunities. Between these points is an intermediate range with overlapping immediate business interest and product assessment. It must be noted, however, that the needs of these assessments are different. In the short run, analysis focuses on operational issues and the means of accomplishing tasks. Long range assessment focuses on opportunities and threats and is usually a part of the strategic planning process.

7.2 CURRENT VALUE

Both economic and perceived value methods are limited to the current applications of the products. As such, the eventual value of a product may far exceed these measurements. However, in this regard the economic value is more flexible than perceived value methods since it allows for alternative (what if) analyses. Furthermore, perceived value analyses are generally forced to use “linear” trade-off models even if such relationships do not describe the underlying mechanisms. Economic analysis on the other hand focuses on the fundamental sources of value and can include (and usually does) non-linear relationships. It is usually preferred to undertake an economic analysis prior to any perceived value study if feasible.

7.2.1 COMPETITIVE PRACTICE

From a value perspective, the competitive nature of the product is defined by its use compared with current practices. While the same terms are used for strategic competitive analysis, these levels are defined differently in value analysis.

Type of Product	Value Definition	Competitive Definition
In-Kind	Drop in substitute without any modification	Same composition of matter and materials (usually a commodity)
In-Type	Substitute with modest modifications	Differentiated material doing the same thing.
In-Function	Substitute providing the same approach to the problem	An alternative material resulting in the same output.
Different Function	Different solution to the problem often removing the basis	Different solution to the problem.

The value definitions focus on required changes in practice. The greater the change the greater the uncertainty. But with greater change comes a potential for greater ultimate value. Traditionally, most economic evaluations are done with in-kind or in-type substitution where the value can be computed based on the existing practices. However, this often leads to underestimation of value.

7.2.2 VALUE-IN-USE

The term “Value-in-Use” is used in economics to refer to the total value of the product as it is used. That is, Value-In-Use refers to the value of primary outcomes of the products use. This is synonymous with “total value” concept describes above and can include perceived as well as economically accounted for value. However, in value analysis, the term “Value-in-Use” means the price for a product that would make it economically equivalent to the best competitor. It is a computed value based on the economic use model for the application.

7.2.2.1 Economic Value (Value-In-Use)

The "value-in-use price" is the price of a product that would make the economic value of its use equivalent to the best alternative. It represents capturing the total additional benefits and costs for the application of the product to its price. This is theoretical limit to price since it allows for no additional value to drive the conversion. Generally, this computation is done based on "current" or retrofitted value. This computed economic value is usually an understatement of the total eventual value of the use of a preferred product. As such, there is often additional value "on the table" for the user. Rarely, however, can the value-in-use price be obtained in a competitive market. In general, it is an input into the pricing policy formulation process.

7.2.2.2 Distributed Values

It is important to understand that values will be different among customers. These differences come from variation in size, in practice, and in their economic environments. The purpose of economic modeling is to collect the basic information for understanding these differences and forecasting their impact on business actions.

7.2.3 CURRENT VALUE AND COST

"Current" value refers to the value obtained by converting to a new product based on current practices and economic structure. This represents a retro-fit of product into the existing process or economic structure. Furthermore, Current Value and Costing focus on economic evaluation rather than perceived value. As such, economic analysis is done of the current operations and practices. Only when economic data is unavailable or unobtainable is perceived value estimates substituted for economic measures.

Economic current value analysis is mainly used for business-to-business application rather than end-user value. This allows us to simply compute economic value based on customer process data. However, the principles can be applied to end-user value, particularly when applied to public policy evaluations.

We start the economic evaluation process with a "proforma" concept that accounts inputs into the process. Current value analysis depends on the nature of the customers' business. Manufacturing operations tend to focus on material use and physical capital investment while distribution businesses tend to be dominated by product turn-over and working capital. No economic analysis is ever totally complete. For an efficient analysis it is critical to focus on the issues of greatest importance.

7.2.3.1 Evaluation Process

The process of developing an economic model is usually a combination of personal in-depth user interviews, telephone user interviews, consultant discussion, and published information. Often a detail user economic model is developed by a firm or consulting company for the industry. If such an initial economic model is available, it is used as a starting point for analysis. Otherwise, in-depth interviews with selected cooperative users are used as the basis for building the industry-wide economic model.

7.2.3.2 Direct Costs

The proforma model usually starts by compiling the relevant sources of costs.

7.2.3.2.1 Material Balance

Businesses usually use inputs to make other things or provide services. Physical materials enter the process and result in the final products. Accounting for these material inputs and outputs is referred to as a material balance. It is critical in these balances to account for the quantities of materials used per unit of output.

7.2.3.2.1.1 Major Material Inputs

With most manufacturing operations, basic materials are converted to finished products. As such, there are usually "major" material inputs which correspond to the majority of the physical material used. It should be noted, however, that they may not correspond to the majority of the "value."

7.2.3.2.1.2 Sub-components

In many cases, sub-components are assembled by the manufacturers to produce the final products. These sub-components are purchased from suppliers and enter directly into the manufacturing process. With integrated manufacturing and some supplier relationships the transition between suppliers and the manufacturer can be unclear. However, additional value is included in the sub-components and if they impact the use of the new product that additional value must be included in the analysis. This is particularly important when yield is affected by new products that act to reduce the loss of sub-components.

7.2.3.2.1.3 Specialties and "Pixie" Magic Dust"

Many products involve small quantities that do critical functions. These may be either materials such as additives, catalysts, lubricates, release agents, etc. or sub-components. They are often critical for the process to be effective and can be a substantial cost in aggregate.

7.2.3.2.1.4 Yield

Yield is the relationship between the input materials and the output products. Rarely do plants operate at 100% yield and in some cases such as start-up of microelectronics, yield may be less than 1%. A major source of value is in the increase in yield and the corresponding reduction in waste. Improved quality and reliability often provide improved yield.

7.2.3.2.2 Energy Balance

Energy can be a major cost in manufacture. Particularly for fundamental manufacture such as chemical and material processing it is often the most expensive factor. It should be noted, however, when energy is a critical input, it is usually carefully handled and where feasible recycled. It is critical to collect overall energy expenditure and sources of process energy losses rather than consumption by individual parts of the process.

7.2.3.2.3 Utility Fees

Other inputs into the process usually include those requiring utilities. These include water, other energy sources, telecommunications, waste disposal and environmental requirements. Some of the requirements involve capital investments such as with pollution abatement, in many cases these specific charges and fees associated with the use of a new product.

7.2.3.2.3.1 Water and Usage Fees

Costs associated with providing water, both for process and cooling, may be related to the products being introduced. Usually this is associated with a change in process, however, or a marked change in yield.

7.2.3.2.3.2 Waste Disposal

Waste disposal has become an increasingly expensive cost component. This is particularly the case when products or other inputs are considered hazardous. Reducing the hazard of input can have a major impact on disposal costs.

7.2.3.2.3.3 Other Energy Requirements

Even if process energy is internally produced, there is general a need for external power, usually electricity and backup resources for the plant. Once again, changes in the process may effect these requirements.

7.2.3.2.3.4 Pollution Abatement

As previously noted, pollution abatement is usually captured as permanent investment. However, in many cases, this is being outsourced and enters into the total costs as charges to the process.

7.2.3.2.3.5 Telecommunications

Telecommunications is becoming an increasing important factor into process economics. Many of the new products are targeted for telecommunications applications and have "hidden" costs.

7.2.3.2.4 Labor Requirements

Historically, the value of many products shows up in reducing labor costs. Reducing front end labor time often result in increased labor charge rates resulting in a net increase.

7.2.3.2.4.1 Production Manpower Time

Traditionally the key measure of labor savings is the reduction of manufacturing manpower time.[2] Much of the transition from metal to plastics in automobile production was based on these savings. However, care has to be taken in identifying the source of the time savings and whether it will be realized.

7.2.3.2.4.2 Turn-around Time

Not only must the labor associated with production be considered but also the time required between runs. In many cases, turn-around can be more expensive than the actual process time. Reducing the turn-around time between setups can substantially reduce the cost of printing, for example.

7.2.3.2.4.3 Manpower Charge Rate (Skill)

Changes in technology often require increased skills of the labor force with associated increased charge rates and risks. A highly specialized skill workforce is hard to replace and increases the vulnerability of the business.

7.2.3.2.4.4 Union/Government Requirements

If labor reduction can not be realized, it is of no value. Union contracts and government regulations may restrict the reduction in labor with new technology. This has been the case with the American railroad industry and threatened to destroy the American newspaper industry during the 1960's -1980’s. Government regulations are particularly troublesome in Europe where labor force reduction is restricted. It should be noted that restriction can be on the type of labor and sources as well as the extent required.

7.2.3.2.4.5 Supervision

Both reduction and increase in supervision may be required with new technology and products. These changes may be significant enough to include in the total costs and benefits.

7.2.3.2.4.6 Quality Control

[2] This measure dates back to Taylor and Gilberth’s time motion studies.

Quality control can be a major labor cost factor. Reducing or increasing the routine requirement for testing can greatly effect the total labor requirement. This may be overlooked unless it is a central part of the value proposition.

7.2.3.2.4.7 Safety Practices

Safety requirements can be handled under a number of categories. However, it is useful to consider it under labor costs since it usually impacts these costs directly. Safety costs involve equipment, training and practices, which impact total labor costs.

7.2.3.2.5 Maintenance

Maintenance may be a critical cost factor for the use of new technology. In some cases, it is a driving force if maintenance is critical both as a cost issue and as it effects final product quality.

7.2.3.2.5.1 Routine (Wear)

All processes produce wear on equipment. Routine maintenance includes the replacement of equipment such as light bulbs and lubricants but also include realignments and major parts replacement. New technology can change the nature and frequency of required replacement and alignment.

7.2.3.2.5.2 Replacement

Particular attention may need to be put at the replacement issue. Cost not only includes the parts but labor and down-time. Some products such as high performance materials are aimed at reducing the replacement schedule. This can result in values thousands of times the cost of the original part.

7.2.3.2.5.3 The Value of Time

Time is money! As such, the time and the nature of the time required for maintenance has to be considered. This is particularly important with non-routine maintenance. The likelihood of down-time and its effect on product turn-around need to be considered.

7.2.3.2.6 Space Requirements

Space requirements can be tricky particularly if the new product has special conditions. Refrigeration or other environmental requirements increases the expense for space. If space is rented, increasing requirements directly affects unit costs. On the other hand, if space is handled as an investment, it will effect depreciation.

7.2.3.2.7 External Fees

Additional external fees may exist regarding patents, use fees, and licenses as well as additional required services. While these usually do not have a critical effect, in some cases they limit the use of a new technology.

7.2.3.3 Investment

In some cases, product changes affect depreciation charge for new investment or a change in the condition of existing investments. These need to be considered when appropriate. Investments are divided into two categories: permanent investment that includes equipment and space and working capital that pays for inventories and operations. These are separated due to how they are charged to operations.

7.2.3.3.1 *Permanent Investment*

Permanent investment is typically handled in terms of the depreciation charge. It is affected by new equipment and changes in the expected life of existing facilities.

7.2.3.3.1.1 New Equipment

All new equipment associated with using the new product needs to be included. In some cases, the scrap or resell value of the retired equipment caused by the new product can be credited.

7.2.3.3.1.2 Equipment Life

The process equipment life can be altered by new products and technologies employed. Wear reduces life span or its reduction may increase it. Obsolescence is a more difficult factor to consider. The introduction of new technology can speed up or postpone the obsolescence of a process.

7.2.3.3.1.3 Space

Unless a major new space requirement is needed to accommodate the new products and technology, it is usually not necessary to consider it. However, in some cases, it can be a major expense.

7.2.3.3.1.4 Interest Rates, "Cost of Capital," and Payback

Depreciation rates are set for tax purposes by Government regulations. However, firms may also use separate rules for internal earnings computation. Typically, either the tax basis or the internal rate is used to compute depreciation charges for economic analysis. The only exception is with new special equipment where rapid depreciation may be needed. In some cases, such as computers, payback periods as short as 18 months are considered typical.

7.2.3.3.2 *Working Capital*

Working capital consists of the case outlay that is needed to run the operations. Typically, this takes the form of funds needed to support inventories, feed stocks, and to pay bills prior to collecting receivables. Working capital can be included as a finance charge for the use of these funds. However, this is normally not considered part of the standard cost model but may be necessary if the new products greatly affect inventories.

7.2.4 INCREASED END-USER VALUE

So far we have considered only those factors effecting costs of production not changes in the users' product and services. Value can be gained or potentially lost by changes in the product, its quality, and its price.

7.2.4.1 Market Potential

These changes result from changes in the end-user value of the final product. Even if the benefits are only of reduced costs, if these are transferred to the end-user, it should increase the market size or at least share. If in addition, the changes result in improved products, at a constant price, share should increase with appropriate marketing. The trick is to determine the impact of these factors on the customers' business and if these advantages will be realized. In many cases, though the potential is there, the customer is poorly positioned to exploit it.

In some cases, the customer needs to maintain a market or at least reduce its shrinkage. This is a more difficult problem is estimating value since it requires estimate the effect of not introducing the changes. In many cases, the direct customer is unwilling to accept the reality of a shrinking market.

7.2.4.2 Raising or Maintaining Price

Increased quality and performance may allow increased customer prices or at least maintaining prices in a pressured market. Once again, the issue may be the willingness of the customer to take the appropriate action.

7.2.4.3 End-User Market Research

If the end-user value is critical to the direct customer value, it may be necessary to undertake an end-user market research study. The objective of the study should be on the attribute value and end-user pricing for the direct customer. The techniques for these evaluations are covered in other chapters.

7.2.5 RISK CONTAINMENT AND ASSUMPTION

Risk containment is among the greatest "intangible" benefits for new products. Often the suppliers will provide a number of guarantees which can reduce both real and perceived customer risks. Because we are dealing with intangibles these values are often based on perceived values. However, in some cases actual data exists on events that can allow a quantitative estimate of "worth."

7.2.5.1 Uncertain Events

The key issue is the identification of specific uncertain events that the customer or the supplier assumes and estimating their impact and likelihood. Often this involves covering lost production or joining in covering potential liabilities.

7.2.5.2 Warranties and Guarantees

The nature of the warranties and guarantees depend on: (1) whether they extend beyond the customer to his customer and the end-users, (2) whether the product is identifiable in the final customers' product, and (3) the extent of the coverage. For most industrial products, the warranties cover direct business losses due to unforeseen consequences of using the product. However, they may be additional implied guarantees that are associated with the character of the supplier. Major suppliers are believed to stand by their products and therefore, command a premium.

7.2.6 ORGANIZATIONAL COSTS AND BENEFITS

There are a number of potential organizational costs associated with using a new product. However, there are also a number of benefits provided by a quality supplier that can more than offset those costs.

7.2.6.1 Training and Staffing

New technology often requires the maintenance of a higher level of skills. This leads to increased expenses in training and staffing. If the new technologies introduced by the new products require changes in practice as well as in the required skills to implement, then retraining expenses may be very high. Furthermore, if the technology requires experience workers with unique skills it may be both difficult to find and very expensive to hire. For example, converting to the SAP Enterprise Software System requires access to programmers trained in SAP. Their availability has been a major difficulty in SAP implementation and has had dire consequences.

7.2.6.2 Support

On the benefit side, many suppliers provide services to their customers. These services often extend beyond the support of the product and focus on a “partnership” or “strategic alliance” that provides a range of additional support. These services are often given free to the preferred customers. Recently, there have been efforts to provide the services for fees. However, there is reluctance to do so.

The key problem is to evaluate the value of these services. Typically alternative outside costs for these services are used. For unique services, perceived value measurement may be the only available tool. It must be noted that perceived value measurement of these incorporated services tend to underestimate their “true” value.

7.2.6.2.1 Marketing Support

Suppliers can provide assistance in the marketing to the customers’ customer. This is particularly important when the identity of the input product is maintained into the final customer product. For example, the “Intel Inside” program extends the awareness of the Intel processor to the personal computer. In these cases, it is customary that the supplier assists in the marketing program by contributing to “cooperative advertising.” These programs involve shared advertising expenses as well as specific push through programs as tagging and end-user advertising. In some cases, “cooperative advertising” has become a form of discount to preferred customers.

7.2.6.2.2 Testing Services

Testing often requires specialized equipment unavailable to small and medium size firms. Large suppliers often are able to provide these testing services gratis to their preferred customers. Often these testing services are in connection with the products being used.

However, in some cases, it extends beyond the products to include end-use product and environmental measurements.

7.2.6.2.3 Safety and Environmental Consulting

It is often in the interest of suppliers to reduce the safety risks associated with their products as well as reducing the overall safety concerns. Suppliers develop safety and environmental protocols as a part of the regulatory and risk reduction activities of product development. As such, they are often in a preferred position to consult in these issues. Some firms, such as Dupont, have developed an independent business in safety consulting which is extended gratis to their preferred customers.

7.2.6.2.4 Technical and Operations Support

Most large technical product suppliers provide some level of technical support for the use of their products in the customers' processes and products. These services have been extended to provide a broad-based operations and business support. In some cases, operations support may extend to strategic planning. It is not uncommon for preferred suppliers to control inventory, placement, and reordering of whole product categories in the resellers and retail markets. This provides services to both the supplier and the customer.

7.2.6.2.5 Total Quality Management

Total Quality Management has become synonymous with supply chain management. It has become increasingly important to manage the process and the consistency of the supply chain. As such, firms both as suppliers and buyers have insisted on the existence of a well structured and often certified Total Quality procedure. Depending on the size and industrial position of the suppliers or buyers, services are often made available to implement these programs.

7.2.6.2.6 Industry and Business Information

Suppliers often provide customers with marketing, business and industrial information regarding the customers' business. In many cases, these are the major independent data sources for the customers' business plans.

7.2.6.2.7 Financial Leverage

Having major well-respected suppliers helps establish the financial reliability of the customer. These suppliers often provide first line operational credit. In some cases, such as General Electric, the supplier may provide a full range of financial services.

7.2.7 TRANSITION COSTS AND BENEFITS

The previous discussion focused on on-going costs and benefits. In addition, there are single occurring costs and benefits associated with the transition between existing and new input products and technologies. We do not include here new investments since those are amortized over the life of the equipment and are therefore associated with on-going expenses. However, those costs psychologically may need to be included in this category also.

7.2.7.1 Process Qualification

Most new industrial products must be used within an existing process. In order to be acceptable, the product must be proven-out in that process. This can be an extremely expensive prospect or fairly inexpensive depending on the nature of the process and the availability of “semi-works” facilities designed for process development. If only a full-scale manufacturing test will be acceptable, significant risk will be incurred. Costs for process testing may be underwritten by suppliers. But, in most cases, suppliers only provide sample products.

7.2.7.2 End-User Qualification

If the new technology or product affects the customers' product materially then it is often necessary to test the modified products with customers. This can also be a very expensive proposition with significant risk. The risk exists both in regards to success as well as failure. Presenting a new modified product that the customer may not intend to produce, can generate end-user expectations that may not be met.

7.2.7.3 Training and Staffing

All things new require training and education in some form. Transitions produce a great need for immediate skills and knowledge. Often this is supported by the technology suppliers during the transition phase. However, costs for that training and the debugging process that comes along with learning new skills is usually covered by the customer.

7.2.7.4 Inventory

New products mean new inventory. Often this also requires different conditions as well as holding multiple sources of materials. This is a net increase in the value of inventory that must be rapidly accommodated. In many cases, suppliers help “fill the pipeline” at its expense and provide on-site supplies.

7.2.7.5 Liability and Risks

There may be implicit and explicit liabilities with new technology and the use of new products. Process parameters may be pressed to new limits that contain additional risks.

7.3 LATENT VALUE

To this point, we have dealt with values derived from using a product or service for existing or current applications. The basis for evaluating value is captured by understanding how things are presently being done. This limits applications to those where needs and business practices are well established and where barriers against use are weak. However, with new capabilities come new opportunities. Changes in business practices and reduce existing high barriers and new opportunities appear which may far out-weigh existing applications. Many of the traditionally "poor forecasts" are set by limiting value to current applications. Watson was correct that the current needs for computers in 1945 were only a few isolated machines. Practice, capabilities, infrastructure and most of all costs are needed to change in order to expand the opportunities.

7.3.1 LATENT NEEDS

The underlying principle for identify latent value is the existence of "latent needs." These are opportunities that would be apparent if presented in a feasible manner to potential users. The trick is to identify them. This is a "creative process" in that we wish to explore possibilities from which core needs and desires can be identified. The problem is that we need to push "reality" and in some cases ignore conventional wisdom (what is sometime called "the fundamentals") in order to reveal these opportunities.

7.3.2 BARRIERS

Barriers represent those forces that limit the penetration of a new product or technology beyond inherent value and price. Those firms interested in expanding the use of technology may act to reduce or eliminate these barriers.

7.3.2.1 Change in Practice

Changes in the way "things are done" are the major source of latent value. The discovery of inexpensive overhead transparencies using Xerox technology changed communications in business. The very practice of reporting to management changed and with it the value of plain paper copiers. It is this type of change in practice that is at the heart of the concept of diffusion of technology. As technology is made available, new applications are found which changes the way business is done, which in turn creates further opportunities.

From an evaluation standpoint the problem is to identify potential new practices and the impact if the "promise" of technology is real. In general, the market is reluctant to adopt technology where the practice must be changed. Early assessments of herbicide resistant genetically altered seeds (Round-up Ready Soybeans) were viewed as of only limited penetration approximately 10%. However, when the promise was found to be true and justified the major change in agricultural practices, the estimated penetration in US reached 75%. It is still too early to know if that will happen, given other forms of resistance.

7.3.2.2 Infrastructure

Lack of infrastructure is a standard problem limiting new technologies. The failure of early very large aircraft (1948) was mainly due to the lack of large runways capable of accommodating them. Eastman Kodak tried to introduce a new 35mm type format camera in the 1950’s that failed mainly because of the unavailability of the film (Bantam). On the other hand, the availability of videotape renting stores generated the required infrastructure to promote home video recorders and players (VHS). Similarly, the lack of programming in high definition television (HDV) is probably the single greatest limitation to the penetration of that technology.

7.3.2.3 Learnings

Knowing how to use, repair, or work with a new technology can be critical for penetration. If the knowledge is very limited and specialized, it acts as a severe barrier against wide use and penetration. This is been a historical problem in database software packages where special languages need to be mastered in order to use the software effectively. Initiating firms typically find themselves in a dilemma of either giving the knowledge away or selling it. During the initial stages giving it away tends to be preferred. The question then is when can a firm extract value while not limiting the penetration of the technology.

7.3.2.4 Access

If a market does not have access to the technology, it can not penetrate. This appears to be an obvious “truism” but it has strong implications. Geography, language, and proprietary intellectual property can limit access. These can grossly limit the extent of a technology and therefore its penetration. For example, the French developed a national telecommunications system during the 1970’s but due to language and national intent, the system remained in limited application rather than becoming the Internet.

7.3.2.5 Extent

The value of some technologies depends on the extent to which they have been adopted. E-mail for example is vastly more useful when it is ubiquitous. If it is everywhere, its value is enormous. On the other hand, if it is limited it has little value. The value of these technologies appears to be almost quadratic on extent. However, it has to be noted that not all technologies are this sensitive and in some cases exclusivity has competitive advantage.

7.3.2.6 Standards

The lack of standard or competition between proprietary standards can greatly limit the penetration of a technology. The Betamax vs. VHS and the Westinghouse vs. RCA color TV systems are common examples of this problem. Once a standard is established, however, expansion tends to follow quickly.

7.3.3 USABILITY

For a technology to penetrate an adequate number of targeted people must find it usable. For example, the original VHS recorders were very difficult to program and only a small fraction of the population was able to use anything other than the playback mode. Fortunately, for that technology and industry, that was adequate for penetration. In other cases, such as computer dictation, very high level of performance is needed by a fairly large percentage of the targeted population (98% performance/75% population). Other technology was far less critical such as word processing being approximately (15%/75%) and spreadsheets (10%/35%). Both of these latter technologies were easily able to penetrate while computer dictation has a far more difficult route to go.

7.3.4 CAPABILITY

Restrictions on the capability of the technology, limits its penetration. This often considered a time issue rather than a barrier. As long as the capability requirements are within technical feasibility (not breaking any known laws of physics) then the capability should eventually be obtained. The issue is then when. If it is in the far future, it might as well be never. In this regard, we need to differentiate between fundamental limitations and those of practice. Many capability limitations are imposed due to technologies being applied rather than some fundamental limitation.

7.4 PUBLIC VALUE

Public or social value reflects the interests of the general population on the introduction and expansion of the use of specific products and technologies. These values and costs can be contrary or supportive of private value. It is usually accepted that it is a legitimate role of government to act in such a way to promote public value by incentives, programs, regulations, or other forms of legislation. In some areas, such as public defense, education, environmental protection and public health care, the public interest is well accepted.

7.4.1 PUBLIC POLICY GOALS

Private value analysis goals are usually assumed from an economic perspective as based on the maximization of utility or wealth. However, on a public interest basis it is often not that straight forward. The "public good" often depends on who will receive that good and who will pay. The specific nature of the policies sets this balance. It also determines, to some extent what is to be included in the additional values and costs that are to be considered. There are two general principles that help determine public value: (1) Potential Social Value and (2) Pareto Optimal Conditions.

7.4.1.1 Potential Social Value (Social Benefit)

Potential social value is the total worth that could be obtained if monetary exchanges within the population were feasible or allowed irrespective of wealth distribution. All sources of public costs and value are to be considered whether or not they can be paid for. The goal in this analysis is to measure the improved "living standard" or intrinsic wealth of the nation. Because of the focus on general living standards it is referred to as a welfare economic structure. It should be noted, however, the improvements of the wealthy segments are considered as well as those of less fortunate groups.

7.4.1.2 Pareto Optimal Conditions

The Pareto Optimal Condition is that where no individual or group can be made better off without damaging some additional people. A Potential Pareto Optimal Condition is meet when through some reasonable exchange process will lead to the conventional Pareto Optimal Condition. While this is similar to the Potential Social Value (and we often consider it so) it can be very different if no such exchange is feasible. In a democratic process, we often think in terms of the Potential Pareto Optimal Condition being met through market place actions with government incentives.

7.4.2 PUBLIC COSTS

Public costs and values have a stochastic nature to them. We are usually dealing with uncertain events happening to unknown individuals from the population. However, the number of people effected and the likelihood of events usually can be estimated. While most economic factors are common to both public and private values, there are four that are unique to social benefit analysis.

7.4.2.1 Integrated Costs and Benefits

Private costs are focused from a specific perspective, usually the user of the product. Gains to people other than the users of interest, such as their suppliers, their customers and the ultimate users are usually neglected depending on the focus. From a social perspective all "significant" sources of values need to be included in the social analysis. The term "significant" is introduced here to recognize that it usually is not feasible to track all possible impacts. What is significant is often an analyst call.

7.4.2.2 Social Property Costs and Benefits

Some properties are held in common and therefore must be considered public. Some are own by governments and are therefore legally public property. The destructive use of these properties produces a cost to society. However, it is not only one sided. Activities that are considered to be improvements are public benefits.

7.4.2.2.1 Public Properties

Public property such as national forests, reserves, and parts are clearly under the control of the government. However, other properties such as waterways, highways and air rights are also within the government domain. Things that affect them will have costs and benefits. The computation of value often takes on a long-term present value calculation of total commercial worth. However, this may understate the potential value.

7.4.2.2.2 The Environment

Environmental concerns have been increasing over the past several decades. These cover both local issues of water and air quality and global issues of warming and the extinction of species. Computation of value here is extremely difficult. Typically, this is handled as a distribution of extreme events with finite impact. However, this may be short-sighted in that the effects may be very extreme.

7.4.2.2.3 Intellectual Property

It has been argued that the public has a claim to intellectual property particularly when a patent has been granted. The issue lies in the potential economic gains that the intellectual property will give verse the cost. Much of the argument around public funding of research, particularly at universities, focus on this public value.

7.4.2.2.4 The Economy

The economy as a whole can be viewed as a public property. Based on this argument the whole mechanism of government control and regulation has been established. Products and technologies that greatly influence of the overall economy are, therefore, of public interest. Its value is of course computed as the growth in the economy or the Gross National Product (GNP). This issue is covered in more detail is the subsequent section.

7.4.2.3 The Value of Life

Life is terminal. As such, from an economic perspective you do not save lives but extend them. In this context the value of life is the ability to extent it. For the western legal tradition, the value of a life that was "unlawfully taken" is its earning power of the useful life span. The argument for this is based on the willingness of society to pay for the services of the individual. However, it has also been argued that the typical costs of maintenance of the individual should be deducted. It should be noted based on this type of calculations, that not all individuals have the same value. In particular, individuals from different regions and occupations will have very different values of life. Typically, we use averaged values based on actuarial tables to compute life values.

However, not all deaths are considered equal. There is a personal value common to a culture on the "quality of death." This value can be computed based on the willingness of society to prevent specific forms of death. In the United States, for example, death by some diseases are considered very odious based on the funds dedicated to their reduction of a few deaths per year while death from automobile accidents appear to have lower value.

7.4.2.4 The Value of Time

The value of "non-compensated" time is a sticky problem of social benefit analysis. Compensated time is defined as that time spend in activities for which there is direct compensation. While the value of even this time is difficult to evaluate there is a commonly accepted metric, that being the "charge rate." The problem is that non-compensated time is neither non-productive nor not valued. From an economic perspective, this is time that people have decided to spend in leu of compensation. Remember that this includes chores such as child rearing that is a fundamental of society as well as volunteer work.

There are four approaches to this based on:

7.4.2.4.1 No Value

Non-compensated time is often considered to have no value. This is the simplest approached and is typically used for private value calculations. Unfortunately, it is usually wrong for both private and public value. There is value there, the problem is measurement it.

7.4.2.4.2 Existing Compensation Rate

Using existing compensation rates is an alternate means of measuring the value of time. This is based on the argument that people chose not to work and therefore this time is worth at least the compensation rate. Unfortunately, this leaves open the issue of compulsion not to work verses free choice. Typically, results using this approach are considered over-estimates.

7.4.2.4.3 Equivalent Activities

Equivalent activity is another alternative where the value is set at the costs of having to hire someone to do the same activities. This is very problematic in that many of the activities are not easily assigned to suppliers. However, this is a typical means of estimating the value of time of homemakers.

7.4.2.4.4 Alternative Value

Probably the best method, but most difficult to measure, is based on alternative value. Using data such as bonuses for getting passengers to give up seats on over booked flights can be used to estimate the value of lost time. These estimates are generally based on the "free market" and therefore, reflect the underlying value distribution.

7.4.3 Economic Activity (Macroeconomics)

As previously mentioned increased or decreased general economic activity is of public interest. General public welfare is tied directly to economic activity in terms of jobs and income. Furthermore, government interest requires attention to economic changes has they effect the need for social programs and the tax base. This effect may dominate the public reaction to a business program or proposition.

7.4.3.1 Multiplier Effect

The expansion of business in one area will produce likewise expansion in others that depend on it. In most business focused analyses this effect is ignored. However, for large-scale projects and developments it may need to be considered. The tool of analysis is the "multiplier effect." That is, a factor reflects the local economic impact due to an exogenous (outside) increase in wealth and capital.

The calculation of the multiplier effect is:

Multiplier = (Direct + Indirect + Induced Expenditure)/Direct Expenditure

For military programs, estimates can be as high as three to one have been given. This means for every dollar spent by the government, three dollars of outside economic activity is generated. Tourism has been heavily studied and multipliers calculated, examples of this are shown below[3]:

[3] From: http://mail.admin.gov.gu/commerce/multiplier.htm

Country	Multiplier
Turkey	1.98
United Kingdom	1.73
Irish Republic	1.72
Jamaica	1.27
Egypt	1.23
Dominica	1.20
Cyprus	1.14
Bermuda	1.09
Hong Kong	1.02
Mauritius	0.96
Antigua	0.88
Bahamas	0.79
Fiji	0.72
Cayman Islands	0.65
Iceland	0.64

Notice that some multiplier values are less than one. In these cases, not all of the direct expenditures are returned to the local economy. It should be noted, therefore, that it is critical to determine at what level the multiplier effect is being computed. In general, we consider either a local calculation or on a national basis.

7.4.4 Infrastructure Requirements

Additional public costs may be incurred and benefits gains by private action due to changes in infrastructure. In some cases private funded infrastructure improvements yield public value, however, in most cases changes result in demands on the existing infrastructure and requirements for improvements. It should be noted that computing infrastructure costs and benefits tend to be very imprecise.

7.4.4.1 Direct Requirements

Products and business activities require increased infrastructure. This infrastructure maybe simply increases in roads, highways and telecommunications requirements or more subtle changes in nature of the infrastructure. This is particular noteworthy concerning changes in technology. Larger and more powerful aircraft, for example, required improvements in airports and control systems. Some of these changes are covered by private investment but some are carried across into the public domain. This carries-over can be effect the use of public funds or, establishment of public regulatory action or private action. Some of these changes also provide public benefit particularly through increase capabilities.

7.4.4.2 Indirect Demand

Indirect demand consists of those requirements by personnel affected by the product or service. Indirect effects are particularly noticeable in terms of the employees of a new facility. These employees demand housing and education for their children. Housing requirements effect the property evaluations and the education requirements influence public school capabilities. What are costs and what are benefits will depend on the frame of the analysis.

7.5 DISTRIBUTIONS OF VALUE

Typically cost models are developed for a "generic" customer and modified to reflect the specific operating conditions of individual situations. To capture the individual variation, there are usually three key issues that need to be address: (1) the practice being used, (2) quality or focus of the business, and (3) size or scale. The first of these is covered by the specific process design. Structural differences, such as between sheet and rotary printing, may be so major that each requires a separate economic model. In many cases, this will be covered by changes in the performance relationships. Similarly the business-focus also affects the costs and benefits and often requires modification in the model. The last issue is size of operations that is a scaling issue.

7.5.1 SCALING

There are two types of scaling issues that arise: (1) variation in production within the firm and (2) variation in the sizes of firms.

7.5.1.1 Variation in Production

The variation in production is important only if it impacts the overall economics and if the use of the product effects volume. In general, these conditions are rarely a key issue. However, when it does usually this scaling effect is captured through the consideration of fix and variable costing. Costs are divided between those associated with the operations itself (fixed costs) from those directly related to the production volume (variable costs). The variable costs are in terms of dollars per unit of production while fixed costs are in total dollars per year. This is a fairly routine accounting analysis that is usually incorporated into standard economic evaluation. In regards to most variations in production, variable and fixed costs can be assumed constant unless there is some extraordinary change in industry structure due to the introduction of a new proprietary technology[4].

7.5.1.2 Variation in Business Size

Market models require estimates across the individual customers. In industrial transactions (business to business) this usually involves firms of widely differing sizes. Under these circumstances many economic factors will vary. For convenience, we group them together in terms of investment and costs.

7.5.1.2.1 Fixed Costs

Concerning variation in operations sizes, fixed costs are not fixed. This is the great effect of economies of scale. Scale allows higher degrees of automation and internal manufacture that are often impractical for smaller niche operations. However, it must be

[4] This is discussed in more detail in the section on Technology Assessment.

noted that there are typically diseconomies of scale. Plants tend to come in fairly uniform sizes with the most efficient being referred to as a “world class facility.” This can be used to scale fixed costs except for depreciation that is tied to the process investment.

7.5.1.2.2 Process Investment Scaling

Process economics is fairly well understood, at least as far as the chemical and material process industries are concerned. Typically plants scale to the “6/10ths Rule.” This simply states that investment costs tend to increase with the 6/10ths power of the volume. In other words, doubling the size of the plant capacity results in approximately a 50% increase in investment.

7.5.1.2.3 Variables Costs

In the long run, variable costs will change with industrial production[5]. However, while variable costs may vary somewhat depending on the size of operation there tend to remain within small range. As such of analysis purposes we usually assume variable costs to be fairly constant within a particular practice.

7.5.1.2.4 Overall Costs

In capital intensive industries we tend to assume that costs variation with size follows the 6/10th rule. While this might appear to be an over simplification it does appear to follow from general material costing behavior.

7.5.2 PERFORMANCE RELATIONSHIPS

Differences in practice produce different economic relationships. Fortunately, in most cases economic analysis is done with groups of firms with common practices and it is unnecessary to analyze the engineering details of their operations. However, in some cases it is necessary to interrelated factors. This is particularly the case where there are trade-offs between operating considerations, materials and labor.

7.5.2.1 Fundamentals vs. Practices

Operational relationships can be derived from fundamentals or from the specific practices. Those developed from the practices are referred to as operational and are usually based on statistical data in specific applications. The problem arises when different practices are being compared. For example, traditionally filtration rates are proportional to the pressure used. By increasing the pressure a smaller piece of equipment can be used. This is true for almost all types of filters except for dynamic cross flow filters where filtration rates go with the square root of pressure. This finding

[5] This is discussed in the section on Technology Assessment

is, therefore, based on experience but is not a "fundamental." There are conditions where using the rule may lead to wrong predictions. It is critical when using these relationships to understand their limitations.

7.5.2.2 Fundamental Relationships

The line between fundamental and operational relationships is often foggy. But generally, fundamental principles (even those based purely on empirical findings) can be considered universal. These include:

- Conservation principles such as material and energy balances and
- Constitutive relationships relating types of phenomena that include physical properties as well as established scaling factors such as Fourier's Laws.

7.5.2.3 Operational Relationships

Operational relationships are either derived from fundamental (first principles) or are obtained from empirical studies. As previously noted that relates output to operational conditions and inputs[6].

7.5.3 DISTRIBUTIONS OF VALUES ELEMENTS

As previously discussed, overall customer value, opportunity, or public value is derived from the combination of a large number of elements. While they are often thought of as single valued opportunities, in general we need to combine a population of varying conditions. This requires understanding how value elements are distributed.

7.5.3.1 Distributed Models

Elements of costs and benefits are rarely single valued. Different customers operate under different conditions producing distributions of these elements. Algebraic cost-benefit models are constructed that allow estimating the total value based on specific estimates of value elements or parameters. These are "value" models. Simulation involves using these models then to estimate the distribution of values.

7.5.3.1.1 Models of Averages

In some cases, we can consider a small number of similar cases, often referred as "segments" and evaluate their value based on averages of the parameters for those segments. The resulting values are presented either as "average" values or more correctly "typical" values. In reality both are likely to be incorrect. By this we mean

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[6] Several large industrial firms and consulting companies have developed extensive production models that allow for economic assessment under a number of different practices. In particular see SRI's Process Economic Handbook.

that the resulting estimate based on average parameters is not equal to the average that is expected from the distribution of values. From a strictly statistical basis when a function is upward turning (convex) then the average or expectation of the value always will exceed the function using the average values of the parameters. The reverse is true of the function is downward turning or concave:

$$\partial^2 f[x]/\partial x^2 > 0 \text{ then } E(f[x]) \geq f[E(x)] \text{ (convex)}$$

or

$$\partial^2 f[x]/\partial x^2 < 0 \text{ then } E(f[x]) \leq f[E(x)] \text{ (concave)}$$

This is referred to as the "Jensen Inequality"[7]. Only if the value model is a straight line, linear, expression will the average of the value distribution be the same as one obtains by using average parameters[8]. Economic models (as opposed to perceived value) are rarely linear and therefore, it is almost always recommended to undertake full scale modeling and simulation to compute characteristics of the value distribution.

7.5.3.1.2 Means, Medians, and Extremes

Most of the model parameter distributions are "skewed" and asymmetric. This is a natural consequence of being limited to zero value, but allowed to extend to high values. These distributions are discussed in more detail in the following sections. Because of the skewed nature of the input parameters, one expects the resulting value distribution will also be skewed and asymmetric. Under this condition, averages will not equal the medians or typical values. It is, therefore, important to differentiate between these two central statistics of the population.

Generally, we are more interested in either the typical values or alternatively the size of the market above some level. In the latter case, we are often examining the "extremes" of the value distribution. It should be noted that these extremes are less precisely estimated than the center of the distribution. The extremes are more sensitive to the underlying distributions that we select to represent the parameters. The quality of the fit between the data and the distributions limits the quality of the resulting value estimates.

7.5.3.2 Parameter Distributions

In the following sections preferred forms of distributions are discussed. Selection of the specific distribution should be dictated by the data. This discussion is based on

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[7] See William Feller, *An Introduction to Probability Theory and Its Applications*, Volume 2, 2nd Edition John Wiley & Sons, Inc. (1971) pg. 153

[8] It should be noted that perceived value techniques generally use a linear model and therefore the two estimates would be the same. This is convenient since we often do not have sufficient data to estimate the underlying value distribution precisely. But we can usually estimate the average values fairly well.

experience in this type of analysis. Often detailed data is missing and has to be estimated. These distributions are particularly useful in those cases.

7.5.3.2.1 Population and Wealth

Particularly for consumption side of analysis population data can be critical. Extensive demographic information is available for the United States and some other key countries particularly in Europe. General international data is far more limited in detail but general demographic information (by age and income) is available. Because of the availability of data, distributions can be computed directly. This type of "bootstrapping" allows for highly precise estimate of the present population. However, projections are more complex and distribution models[9] are usually used. For the United States the Census Bureau provides a fair range of these estimates.

7.5.3.2.2 Firm/ Operations Size

Typically for industrial applications, one needs to deal with a range of business sizes. There are usually two types of situations: (1) a few competing firms each with a sizable market share, and (2) a highly fragmented market with a large number of competitors though they may be locally concentrated..

7.5.3.2.2.1 Small Numbers of Firms

Large capital intensive industries tend to be highly concentrated. These are generally "oligopolies" where a few companies "lead" the market. While sales data can be obtained, it can be expensive and not particularly reliable. It is often as effective to estimate the share distribution based on a standard tool, the "Broken Stick Rule". This share distribution is also used in forecasting and is discussed in detail in that chapter under Equilibrium Share.

The Broken Stick Rule[10] is the result of a limiting (ergotic) random (stochastic) process where the resulting distribution of shares depends only on the number of competitors and their position. Below are the shares for up to 9 competitors.

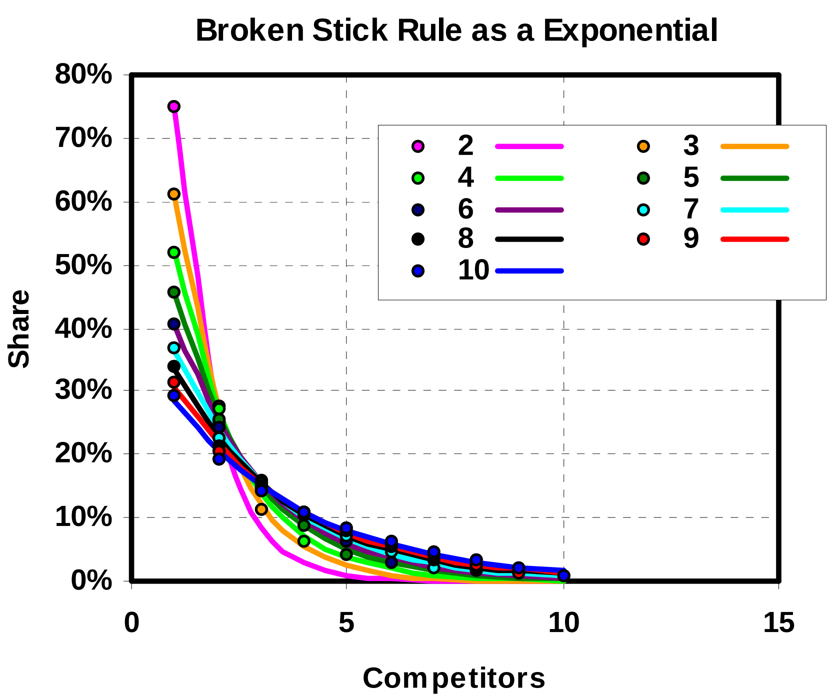
[9] Both the Log Normal and Weibull Distributions have been used in these models.

[10] The Broken Stick Rule is discussed in more detail in the chapter on data analysis.

Expected Market Share

Competitor Rank	Number of Competitors: 2	3	4	5	6	7	8	9
1	75.00%	61.11%	52.08%	45.67%	40.83%	37.04%	33.97%	31.43%
2	25.00%	27.78%	27.08%	25.67%	24.17%	22.76%	21.47%	20.32%
3		11.11%	14.58%	15.67%	15.83%	15.61%	15.22%	14.77%
4			6.25%	9.00%	10.28%	10.85%	11.06%	11.06%
5				4.00%	6.11%	7.28%	7.93%	8.28%
6					2.78%	4.42%	5.43%	6.06%
7						2.04%	3.35%	4.21%
8							1.56%	2.62%
9								1.23%

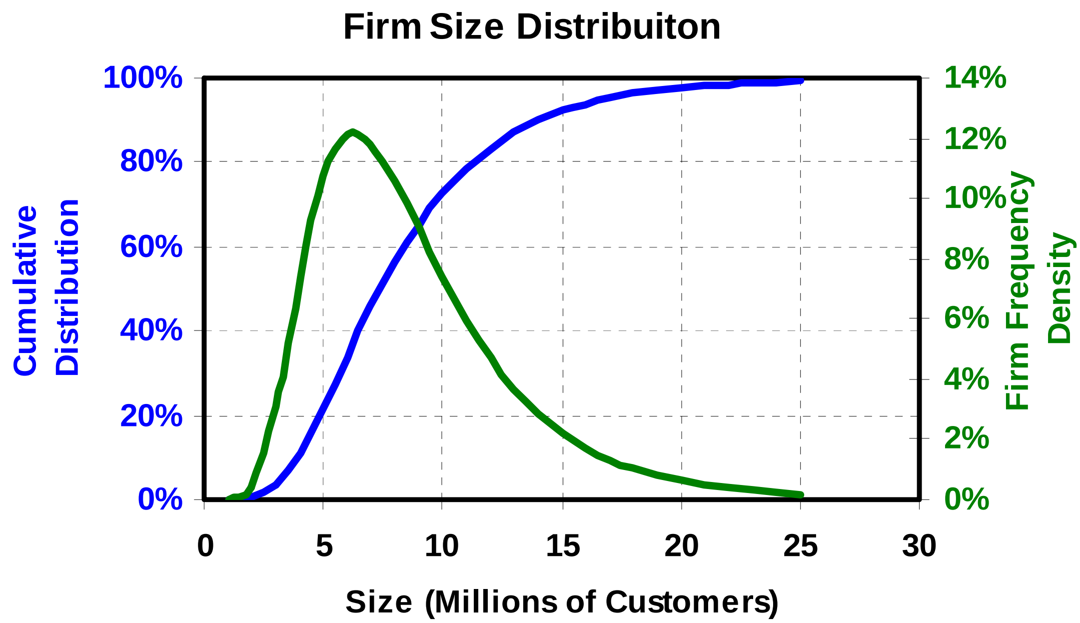
The distributions have an exponential shape as shown below. These indicate the values by the Broken Stick Rule and a corresponding exponentially fit distribution.



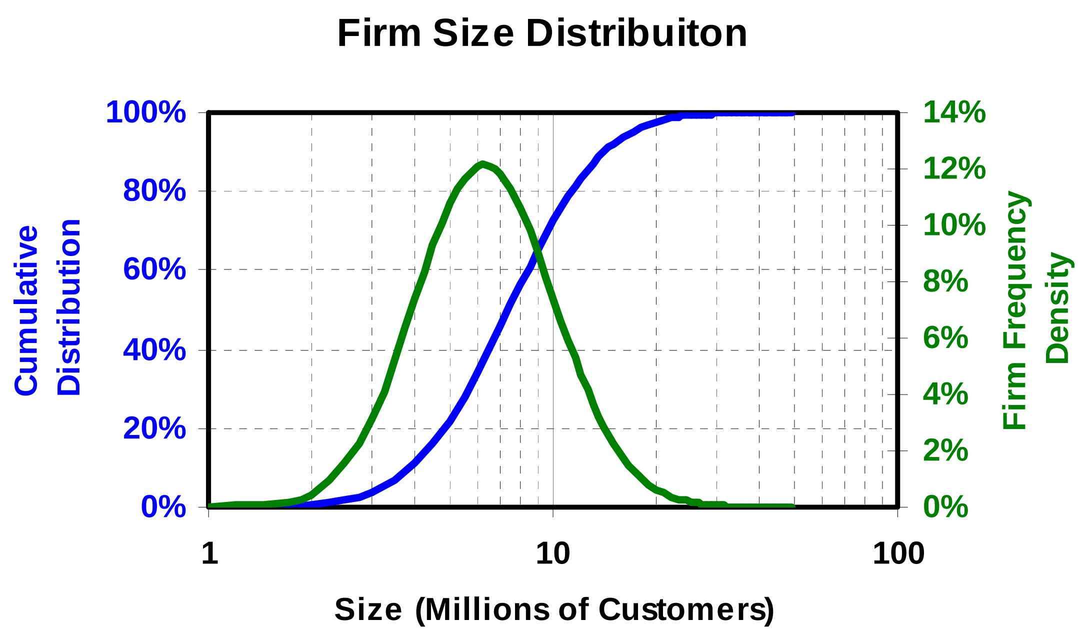
7.5.3.2.2.2 Large Numbers of Firms

With large numbers of firms, the Broken Stick Rule approach becomes difficult and is incorrect. A "log normal" distribution is typically used to describe the business sizes.

This distribution can be derived by assuming that the difficulty for a business to grow is proportional to its size. This is referred to as the "Law of Proportional Effects." The resulting distribution is shown below for both the frequency and cumulative forms.



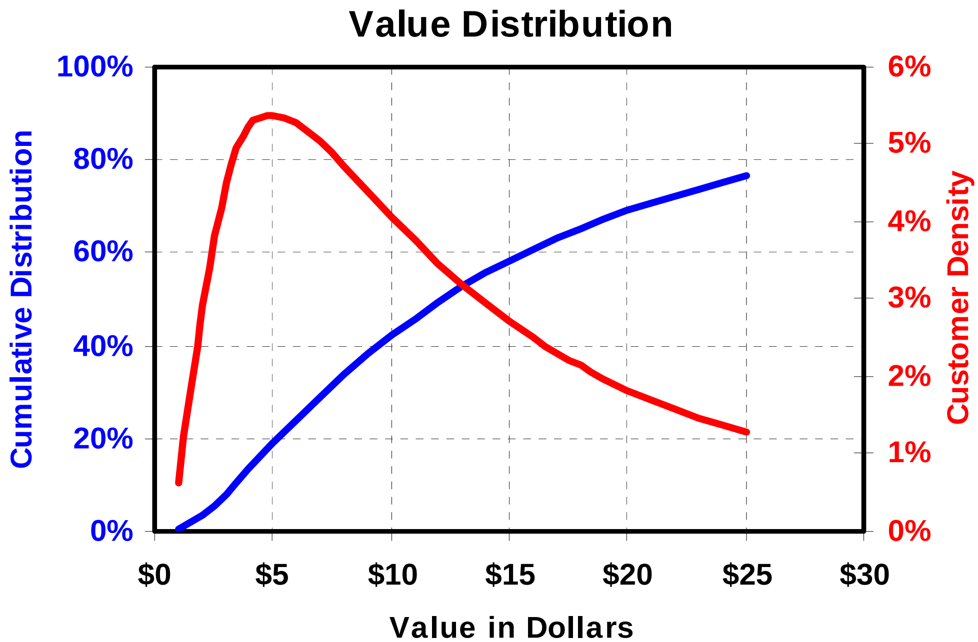
The "log normal" distribution appears as the standard "Gaussian" normal distribution when the logarithm of the size is used, as shown below.



7.5.3.2.3 Perceived Value Element Distributions

Similarly, the distribution of dollar value parameters also appears to be Log Normal, as shown below. This appears to be related to the concept of proportional perception. Psychometric measures indicate that people perceive value on a proportional or logarithmic scale[11]. That is, people react to a percentage change in price rather than the absolute value. This results in a log normal value and price distributions. This type of distribution is often used with price-point analysis.

[11] This phenomenon is often referred to as "Weber's Law." However, that "law" was based on psycho-physiological measurements not value perceptions.



7.5.3.2.4 Other Value Distributions

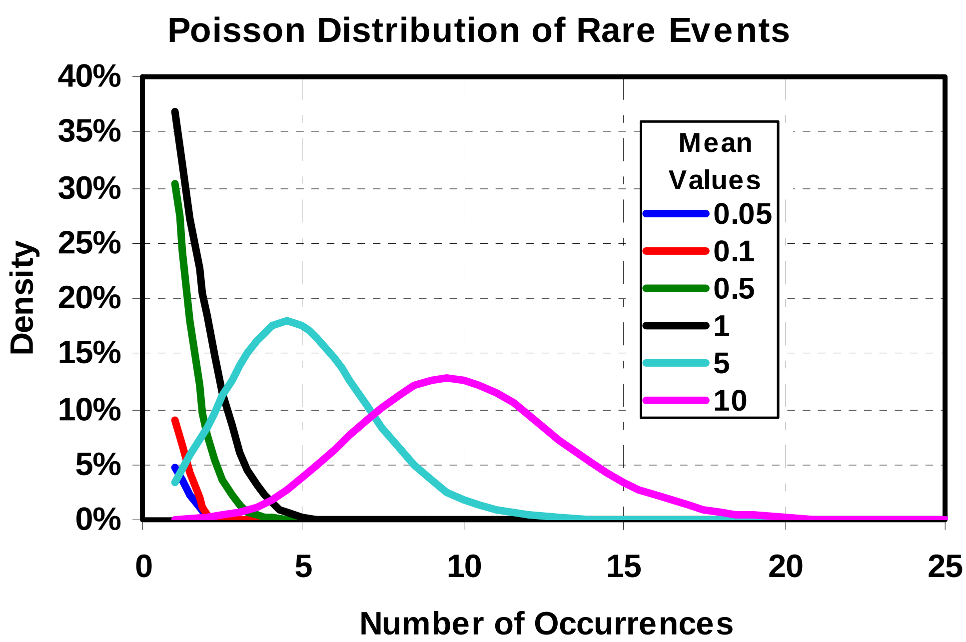
As mentioned earlier, the form of the distribution should follow the data. While the Log Normal is by far the most useful distribution of value elements, there are occasions to use the Normal Gaussian, Exponential, the truncated triangular and uniform distributions. However, special care must be taken using the truncated forms since it is highly unlikely that they would allow for adequate extrapolation of values.

7.5.3.3 Rare Events

Because of the short time horizons, most commercial type value analyses do not include rare events. However, technology assessment, public costs analyses and long term commerce analyses often have to consider these issues. Rare events typically involve things that very infrequently happen but when they do it can have a major impact. From a distribution and analysis perspective there are two types of rare events focusing on the information needed: (1) multiplicity of infrequent events and (2) very important unlikely events.

7.5.3.3.1 Infrequent Occurrences

There are conditions where while an event is infrequent there are a multitude of "trials." Our concern is the likelihood a number of "hits." The classic issue is what is the likelihood of sufficient number of problems of a particular kind to represent a disaster when there is a small likelihood of any single one happening. Things like product returns as well as public issues of injuries or occupational illness. These events are classical modeled as "Poisson Processes." Those distributions are shown below.



7.5.3.3.2 Catastrophes

Catastrophes are more difficult to model since they often reflect events that have never taken place. Basically, we generally assume that the catastrophes are part of continuum of events ranging of mild, that do occur occasionally, to severe, which hopefully we haven't seen before. Our problem is then to estimate the likelihood of exceeding a previous maximum event. Classically, this is referred to as "return periods[12]"

The underlying distributions for these types of events are usually not well documented. Data is rarely accurate and of sufficient quantity to handle truly rare events (with frequencies of less than 0.01%). Fortunately, there are a number of asymptotic distributions that allow for estimation with only limited data, (the Gumbel Distribution). This at least allows for rough estimates of the likelihood[13].

7.5.3.4 The Logistic Approximation

Because the Gaussian Normal and the Log Normal distributions are so important to analysis and so difficult to manipulate because of their complex form, an approximately is useful. The Logistic Distribution is often used as an approximation for the traditional

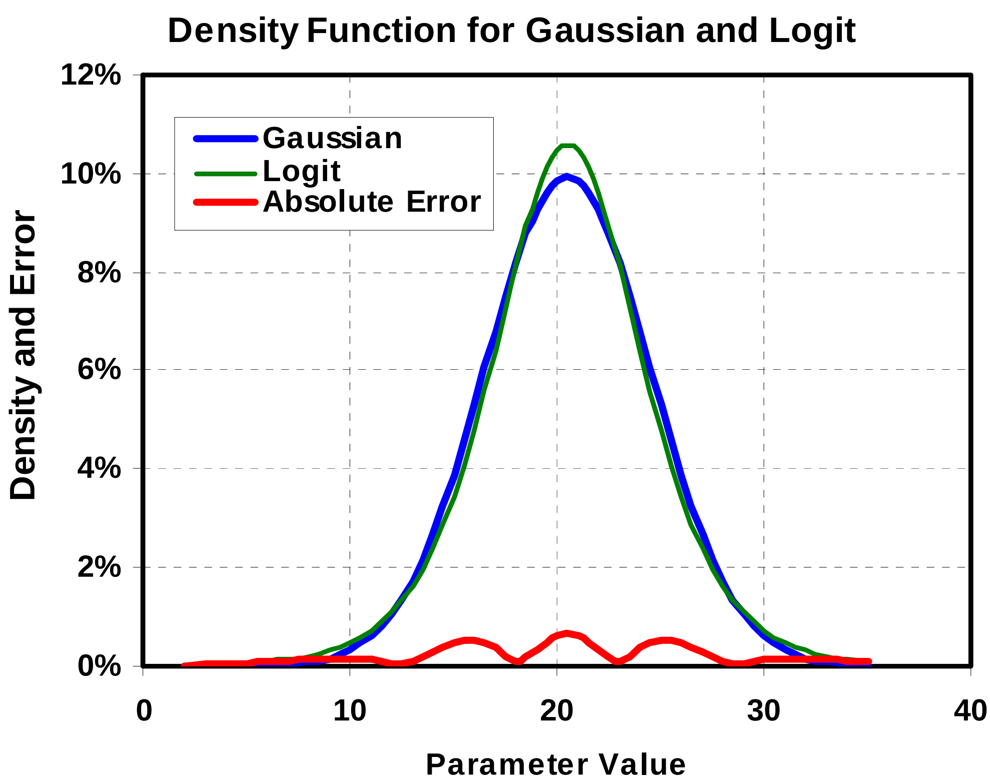
[12] Gumbel, E. J., **Statistics of Extremes**, Columbia University Press, NY pg. 26 (1958)

[13] Gumbel, E. J., **Statistics of Extremes**, Columbia University Press, NY pg. 156 (1958)

(Gaussian) Normal distribution. The cumulative form of this distribution is:

Logistic = 1/(1+exp(z))

which is far simpler than the Normal Gaussian Distribution. Below is a comparison between the two distributions[14].



It is heavily used for regression analysis in "Logit Regression" and in general modeling. It should be noted that with the inclusion of Normal and Log Normal distributions within EXCEL, it is usually unnecessary to use the Logistic approximation for business modeling, though occasionally it is useful.

[14] The parameter, z, is different in the two models. A linear scaling is needed to minimize the difference in the two distributions. However, most modeling fits the z factor for either model and is, therefore, not a problem in using the Logistic distribution in leu of the Gaussian.

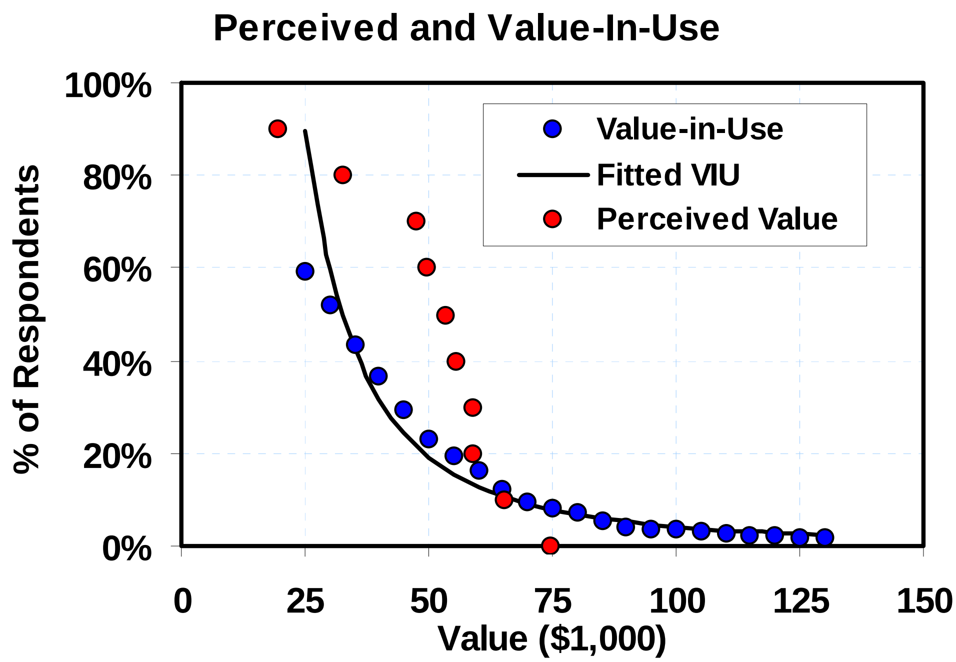
7.6 MARKET ANALYSIS

Economic value is used to estimate market opportunities and price sensitivity. To this point, we have only discussed estimating economic value and its properties. To do a market assessment we need to combine value models with other business issues. Assessment of short-term values is referred to as market analysis and longer term assessment as technology forecasting (assessment). This section deals with current estimates.

7.6.1 VALUE-IN-USE MODELING

Value-in-use is traditionally defined as the equivalent price of a product that would make its value equivalent to that of the best alternative. Using a value model it is evaluated algebraically by equating the value of the new situation to the best alternative and then solving for the price of the new product or element. While the calculations can be done using economic or perceived value information, "Value-in-use is traditionally associated with economic evaluation.

Below is an example of economic based Value-in-use (VIU) estimates compared to those estimated by perceived value technique. The VIU estimates were based on a distributed market model while perceived values are based on a small discrete sample. Notice that the perceived value is higher than the VIU in this case for the most of the population but lower for the extremely valuable upper end of the value curve. It is not unusual for perceived value to be an underestimate of value at the high end and VIU to be an underestimate at the low.

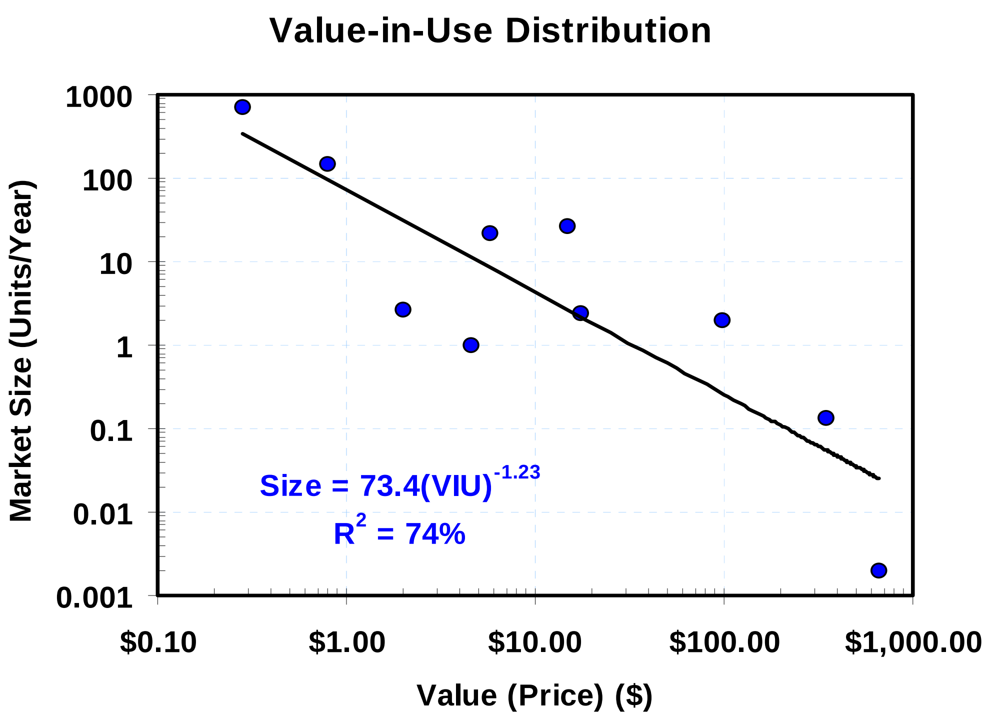


7.6.2 Opportunity Analysis

As previously noted, markets are made up of an ensemble of customers with differing values for products and services. As previously noted, to understand the market and evaluate opportunities it is critical to compute distributed value and display the results.

7.6.2.1 Segmented Value/Volume

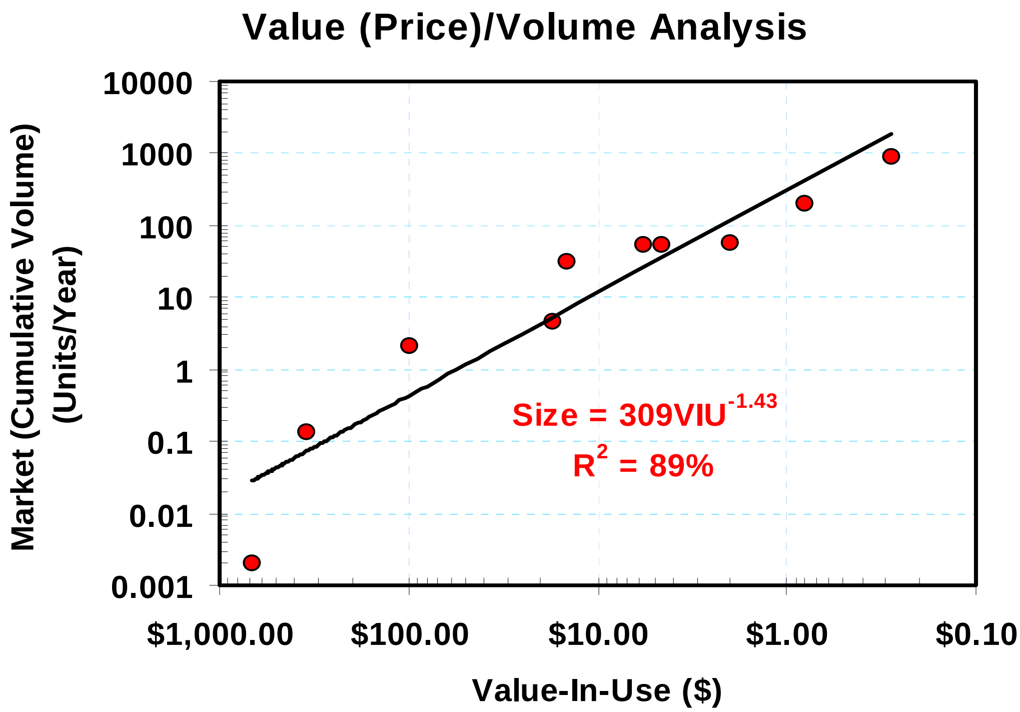
In many cases, data is compiled by market segment representing specific applications and operational scale. Below is an example of this type of analysis. Each point represents a specific application of new technology. Notice that the use of the applications decreases rapidly with increased value. This is important since analysis often focuses on high valued applications and large volume applications. These are usually very different. The actual realizable opportunities usually exist in the intermediate range of acceptable size and significant value.



It this point we need to differentiate between the cases of common markets and isolated segments. If market segments are isolated then one can employ market value pricing, where the price for each application can be different. However, if communication within a market is free, there are pressures to maintain a common pricing structure. In this case, the question is what price to charge which is determined by a balance between earnings and volume. That is evaluated with a cumulative Price/Volume curve as shown below. The size of the market is computed as that total volume whose application value is below a specified VIU. In this case, the market for devices valued at greater than $10 is 10 units/year.

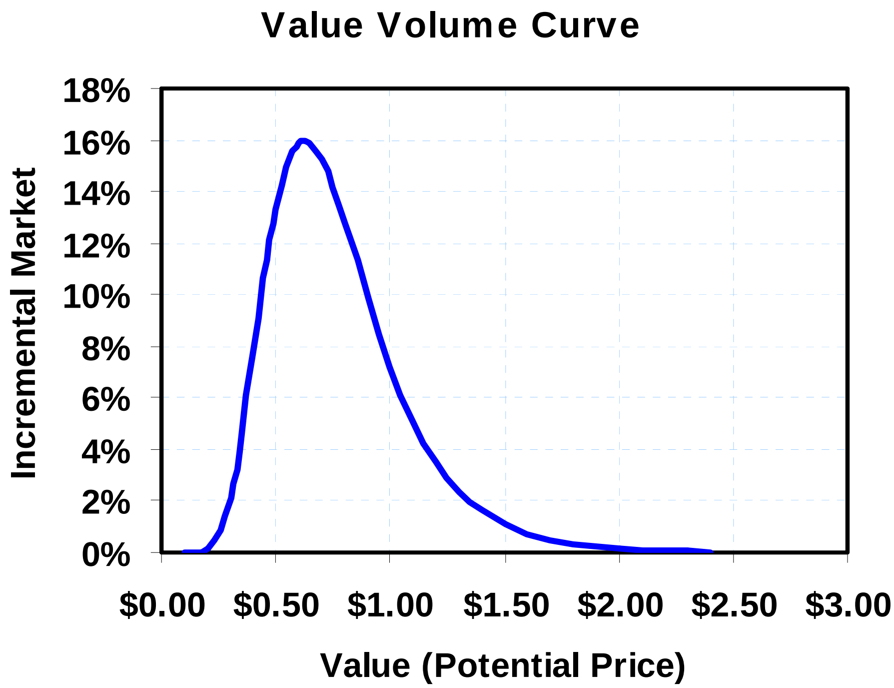
It must be noted that VIU is the upper limit of what the price could be. In reality some value will need to be given to the market to off-set transactions costs and to provide motivation.

Notice that the fit of the cumulative data to a curve is better than the VIU distribution (an R-Square of 89% compared to 74%). This is a result of the cumulative nature of data analysis. The variance in the data is reduced by using the cumulative distribution. This trick is routinely used in fitting distributed data. However, it does tend to overestimate the consistency and quality of the market models.

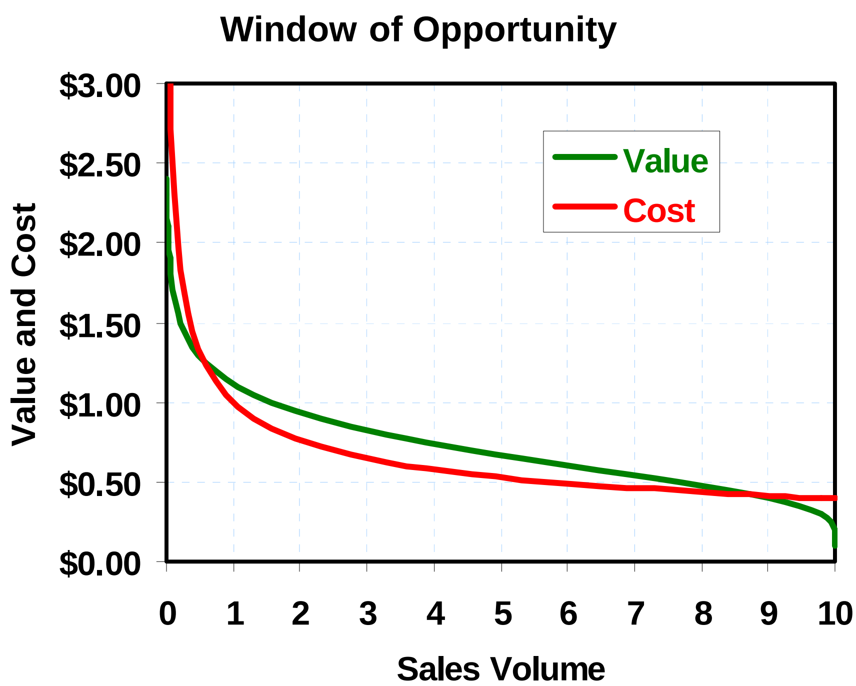


7.6.2.2 Distributed Value

In the previous segmentation analysis, it was assumed that each application within a segment was the same. Values within segments were not significantly distributed. Each segment was considered a discrete opportunity. However, in some cases, value is highly distributed and it is best to consider the opportunities continuous. Below is a typical example of model VIU based on log-normal distributed value elements. It is a skewed distribution with a long high value tail.



As in the discrete case, we assume that we seek a specific price to charge for the product and analyze the opportunity based on the cumulative distribution. As is typical for manufactured products, there is a high economy of scale with lower volume costing significantly more to produce individual products than at higher volumes. This analysis is shown below.



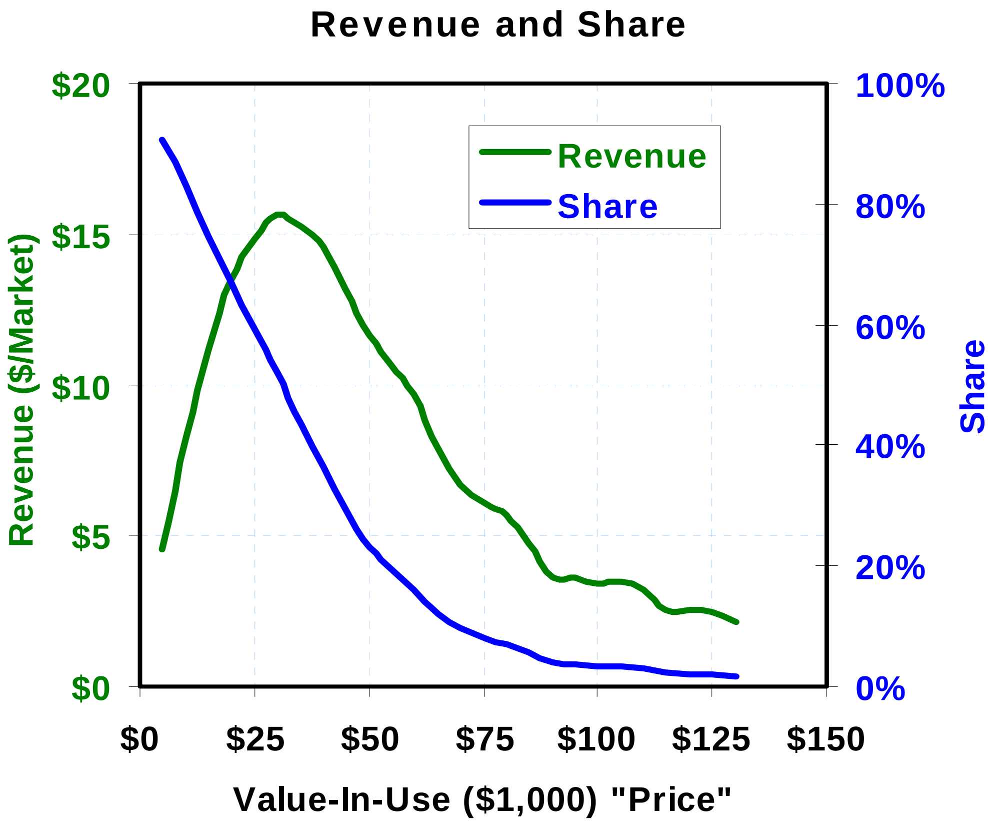
The costs on this curve are average costs since we are comparing operational conditions. Notice that costs are above value at both the extreme lower and higher volumes. This is typical for this type of analysis where products fit intermediate ranges in value. This range is referred to as a window of opportunity in that it represents the range of volume that is economically feasible. The size of the operations corresponds to the investment at risk. This represents a new venture's exposure. If it is too high, it may be infeasible to enter the market. (You just can't get there from here!)

7.6.3 Simulation and Optimization

In order to obtain an overall economic assessment, costs and share need to be computed. This involves merging additional operational factors into distributed value expressions. This involves developing a "market model" or simulator.

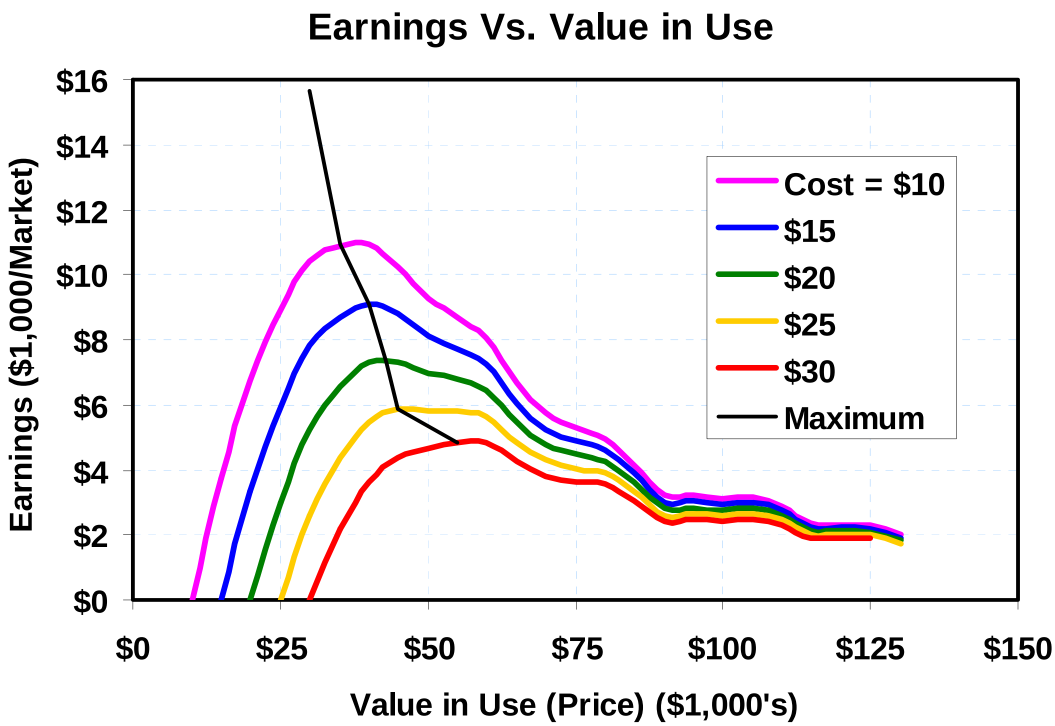
7.6.3.1 Optimizing Price

The tools for market modeling for price based on marketing research data is covered in a separate chapter. Those basic techniques are also applicable using the more complex VIU expressions. An example of this type of analysis is shown below where the expected revenue and market share have been computed based on a value-in-use model. As in the case of perceived value estimates, share is typically expected to decline with price while revenues have a local maximum. This maximum is a balance between low volume at high prices and high volume at low prices.

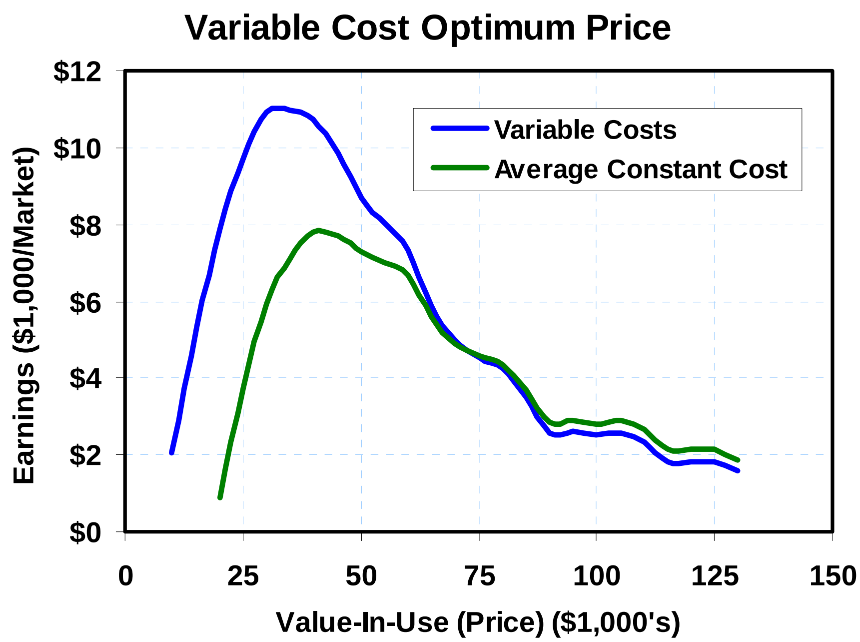


The maximum revenue represents an “optimum” price where there are no costs of manufacture. However, this may not be the “best” price even under this condition since it may be strategically useful or necessary to seek larger or smaller share of the market. This will result in some sacrifice of revenue and earnings. It should be noted that there is also a great deal of uncertainty involved in these estimates.

The effect of cost is shown below where we assume constant costs across the range of prices and corresponding volumes. Notice that as the cost increases the optimum price also increases but not to the same extent.

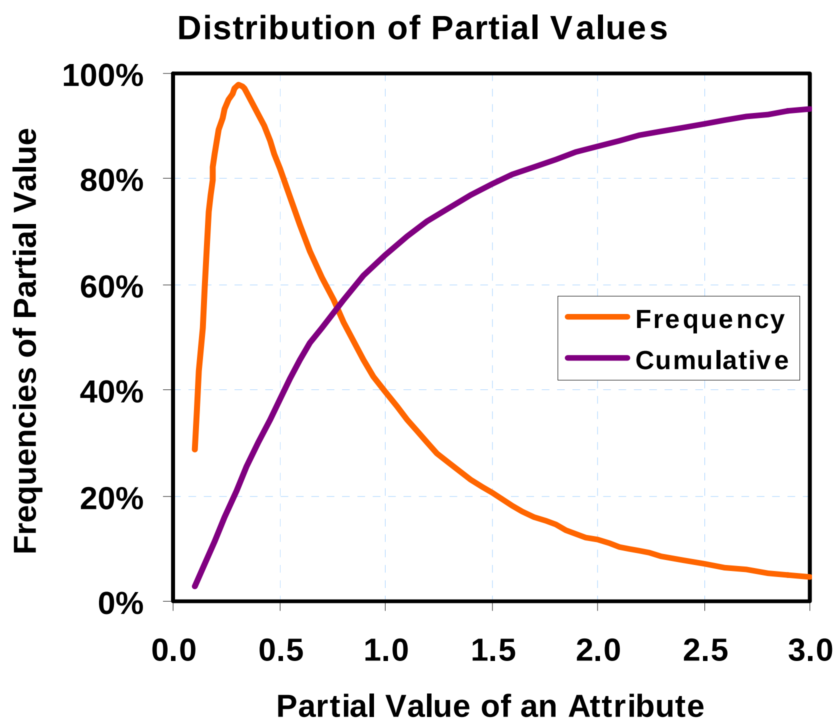


As previously noted, there are often economies of scale with costs declining with volume. This can also be modeled with the results shown below. In this case the same average costs model are used as above. The variable cost model gave a 6/10th decline in total manufacturing costs with volume (share). While total earnings near the optimum is significantly different in the two cases the optimum prices are similar.

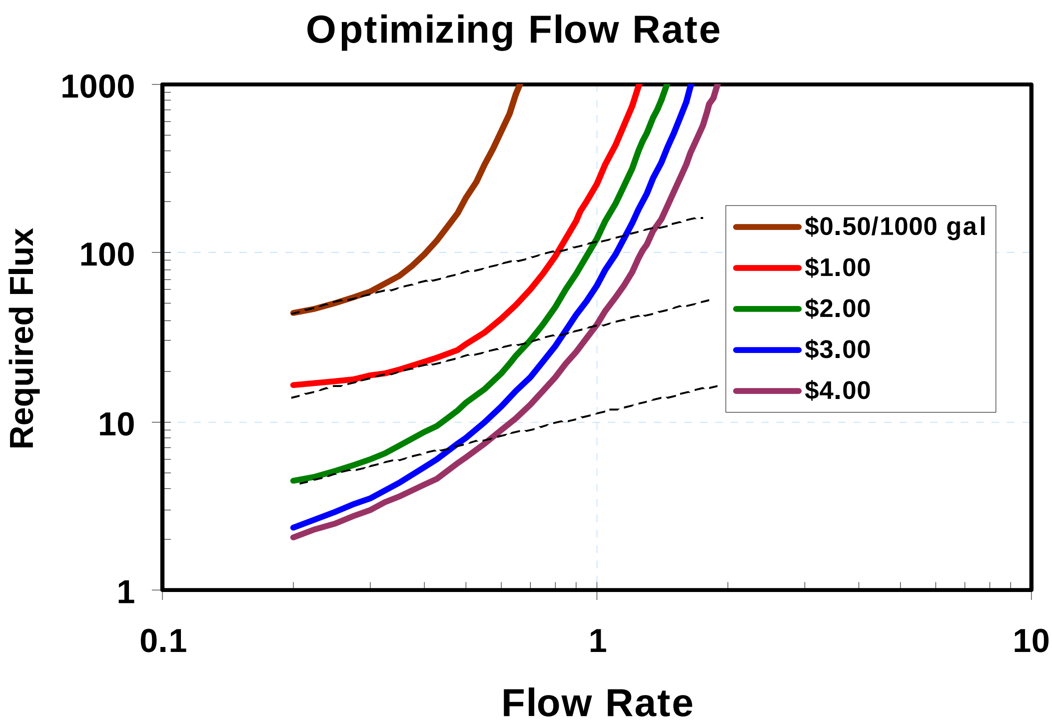


7.6.3.2 Optimizing Design

The value models can provide a means of estimate optimum product and process designs. While value model typical are developed around user benefits, for design purposes these models are extended to connect attributes to the benefits that they generate. That connection is often required since products are envisions in terms of their attributes and features rather than in terms of benefits generated. With this type of extended model the partial value of the attributes can be computed in terms of their impact on value-in-use. A typical distribution of this type of partial value is shown below.

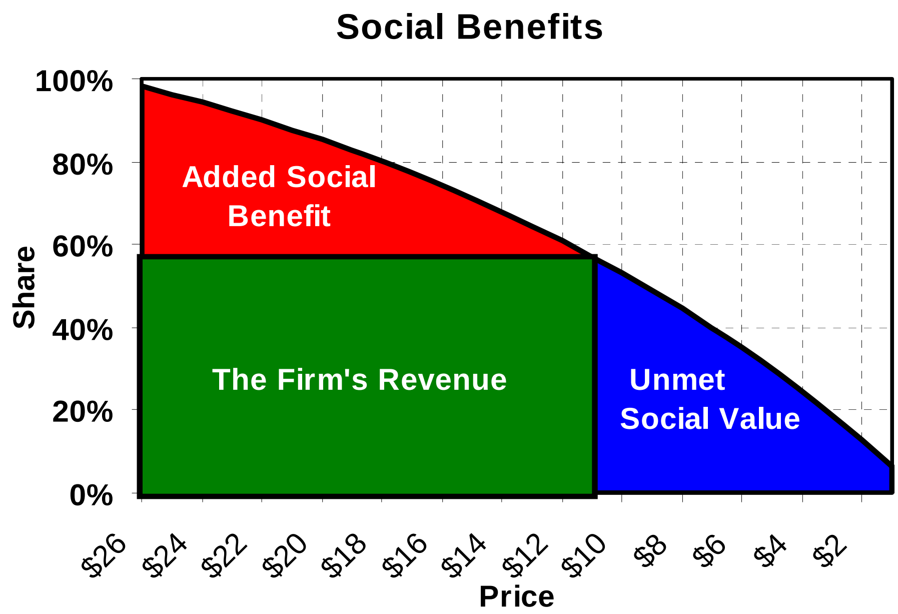


For process based designs where operational and physical constraints are imposed, optimum conditions can be identified. In the example below, the product is a new form of separation process where the optimum flow rates are computed in terms of the end value conditions. In this case, operational economics (Value-In-Use) relationships combine with the physics of the process (dotted lines) to determine optimum operating flow rates (tangent points).

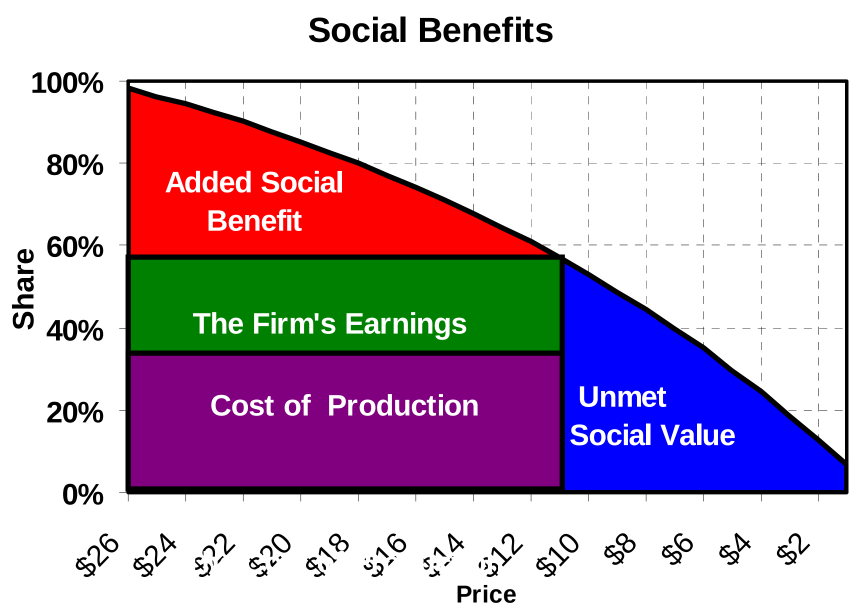


7.6.3.3 Social Benefits

Social benefits capture the value from a public prospective. For example, in setting a socially acceptable price by regulatory or governmental organization for a legal monopoly, such as a power utility, we need to understand the total value of the product to society. This is different from the firm selling products in a competitive market. Under competitive conditions, the value to the firm is derived from the revenues that it can obtain. For society as a whole, there is additional value obtained for providing products at prices below those that some customers are willing to pay. This is referred to as social benefit and is illustrated in the chart below.



Government and political agencies focus on the additional social benefit. Optimizing social benefits can be used to justify pricing below that suggested by the free market model. The total social benefit can be defined as both the firm's earnings and the added social benefit as shown below. However, it should be noted that since most of the cost of production goes into wages, sometimes these costs are also included.



The social benefits are computed within the market simulation as the totals of the individual values up to the targeted price.

7.6.4 ANTICIPATED DEMAND

Analysis of market value generally reflects the only current situation. In most cases, however, we need to explore at least changes within the near future. There are two issues here: (1) the changes in the future and (2) the power of expectations.

7.6.4.1 The Future Conditions

Operating conditions and constraints change. Some of these changes can be anticipated and captured in the value models. These include expected changes in regulations and prices. For example, new government emission regulations or safety standards may go into effect at a known future time. Future prices of fuels or utilities like waste disposal are often set by long term contracts. Each of these can have a great effect on the future value and demand of products. These effects normally can be accounted for within the value model.

However, there are other effects that tend to be uncertain and unspecified that influence future demand. These are captured not in the individual values but in the collective anticipation of demand.

7.6.4.2 The Power of Expectations

In the intermediate period there is much truth to the concept that the future is a "Self-Fulfilling Prophecy." By this we mean that behavior is dictated by what is expected to happen. On the industrial marketing (business-to-business) activities this follows from the planning imperative. Modern planning activities are integrated into the budgeting process. The process of anticipating change drives the allocation of resources. As such, it may be critical to capture, at least from a capacity perspective, these expectations.

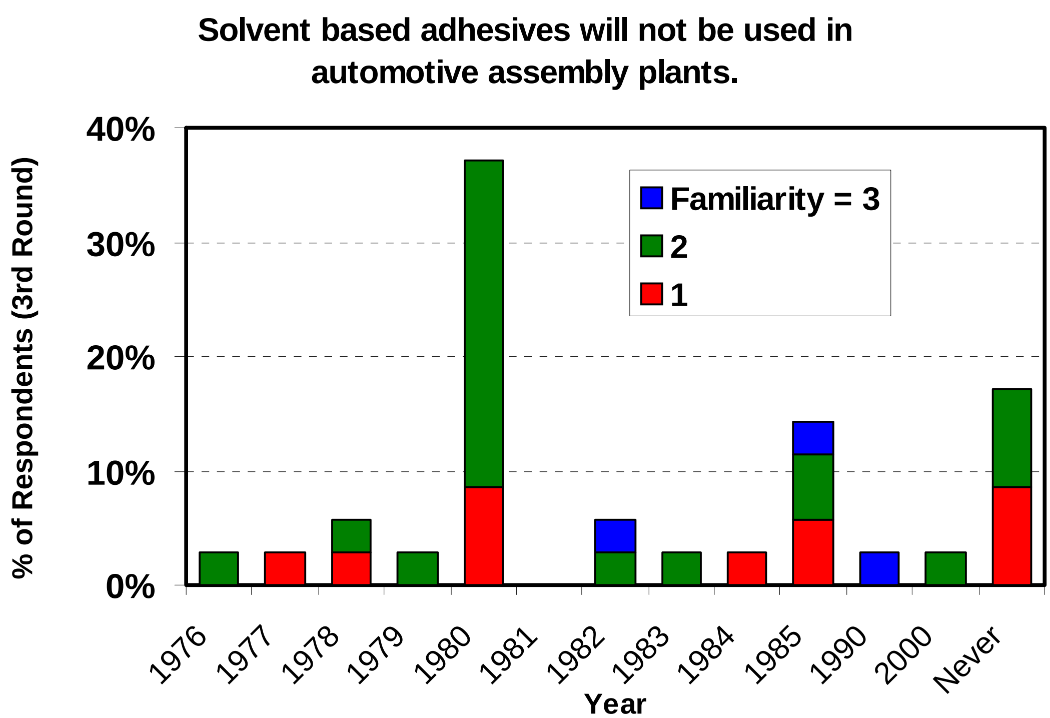
7.6.4.3 Replacement Cycles

A particular element in this planning process is the replacement cycle. Many items are periodically replaced. On the consumer side this involves everything from new clothes, new carpeting to new cars. On the industrial side, production machines as well as office equipment are replaced either due to wear and to maintenance requirements or to obsolescence. This cycle can be highly predictable. For example, office computers often are replaced every three to four years which corresponds to a major new generation of hardware and software. Residential carpets are replaced on average every eleven years.

7.6.4.4 Measurement

Measurement of anticipated demand can be tricky in that we can only measure the expectation of change. It is usually as critical to measure change in these expectations and to capture the reasons for the changes as it is to understand the present estimates. Rapidly changing expectations, such as what happen during the early 1990's regarding the Internet, reflect a dynamic in the perception of value.

Measurement of anticipated demand is usually done by surveying the market decision-makers. This is often done by trade associations as measures of business activities. However, detail studies are required to capture specific product and brand interest. Over the longer time frame it is often critical to rectify differences of opinion within customer organizations or within industries. An iterative process known as The Delphi Method can be used to compile differences in opinion, regress estimates, and to capture the reasoning behind dissent. The process involves iteratively collecting opinions on the date of an event. After each iteration, the statistics of the estimates are returned to the respondents and they are asked to justify they extreme responses. The justifications are returned to all respondents and a reassessment conducted. This process is repeated two or three times until the distribution of results is stable. Below is an example of the results[15].



[15] This is an example from "The Future of the Adhesive Industry", A Delphi Forecast, 1975, E. I. du Pont de Nemours, & Company, Inc.

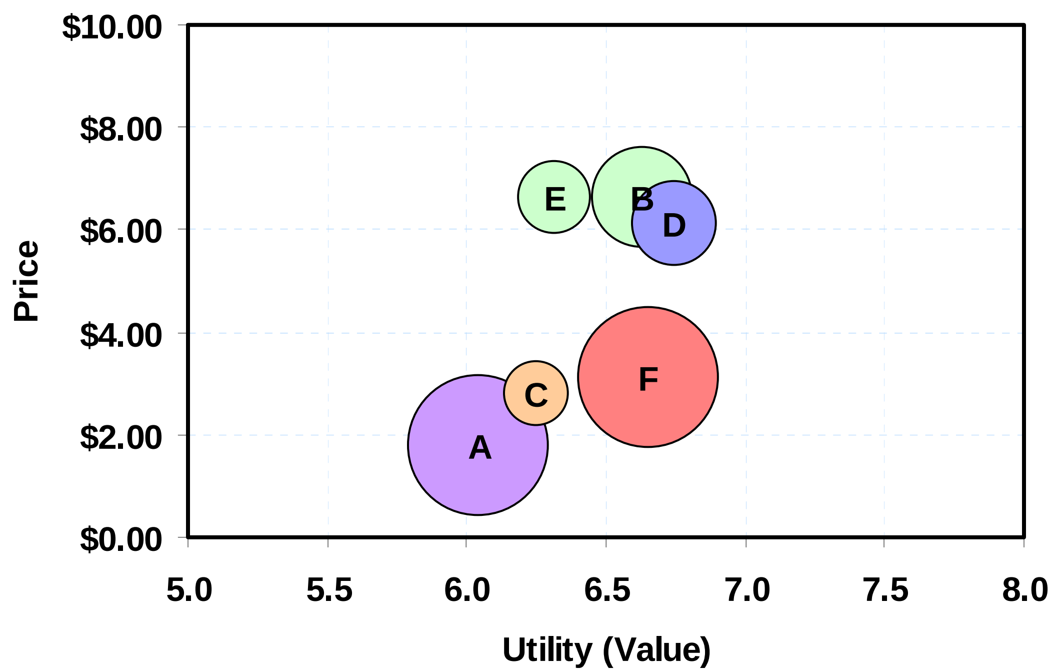
7.7 VALUE MAPPING

Value maps consist of various ways of displaying average competitive product value against measures of price. The general purpose of this type of analysis is viewing the "position" of products within their "consideration" set of competitors. There are three specific uses of this analysis: (1) determining the price structure with the goals of "improving" the price position of specific products, (2) examining the overall value position with the objective of improving the product value, and (3) discovering new product opportunities.

Because of the limitations in measures and theory, this method is not the best or most realistic tool for pricing or value position analysis. For pricing the measurement of the demand curve or function produces more accurate and valid measures of desired price (discussed in the chapter on pricing). Perceptual and quadrant maps discussed in the chapter on attribute analysis are usually the preferred tools for product positioning. However, since value maps can be constructed based on internal data and assessments by sales and management personnel, they may be the only tools available.

7.7.1 THE MAP AND ITS MEASURES

The value map is basically a display of value and price. On the following map a set of competing products is shown given the total value of each product and its price. In this case, the share is also shown as a "bubble." As we will see later, share is a major problem in this type of analysis.



The colors of the bubble are usually used to show competing sources. This may be important if firms are offering a number of products into a common market. As noted in the chapter on pricing, joint price strategy can offer a significant opportunity.

7.7.1.1 Total Value

There is any number of methods for measuring overall average value or utility of a product. While economic and perceived value techniques provide a dollar value, typically simple rating models are used. This is because this type of data is usually available either from customer satisfaction studies or from internal evaluations. It should be noted, that rating scale data can be obtained using inexpensive research techniques (telephone or mail surveys).

Total "utility" is typically obtained with competitive rating data by using a weighed average of the benefit values. The importance of each of the benefits is used as the weights.

$$\textbf{Total Utility}_j = \sum_i \{\textbf{Importance}_i \bullet \textbf{Rating}_{ij}\}$$

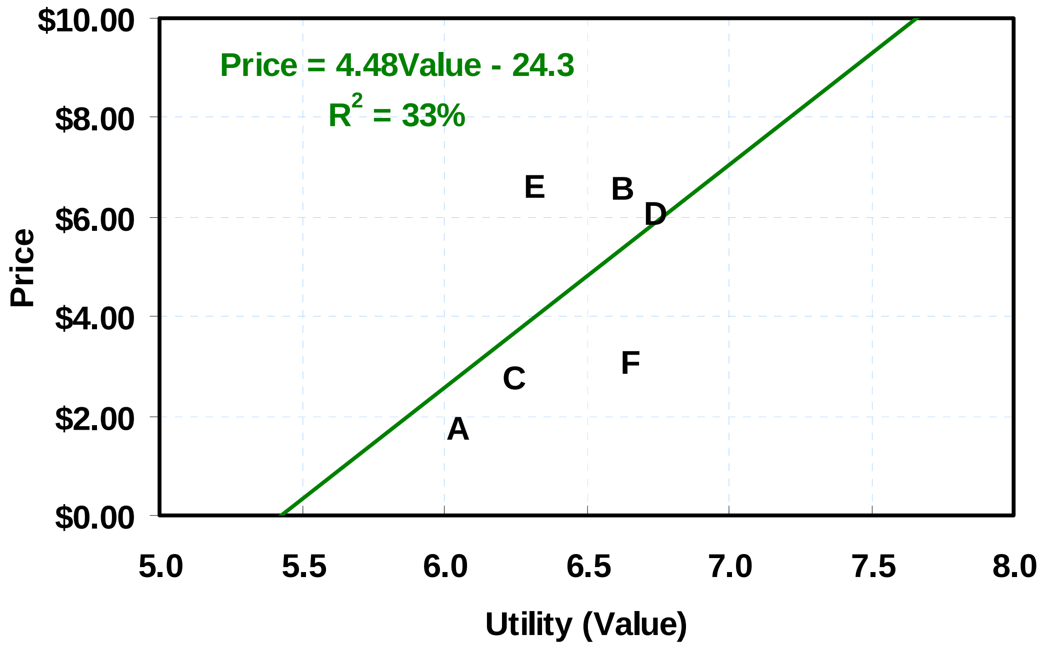
Where the total utility of product **j** is the weighed average of its ratings across the various benefits, **i**.

7.7.1.2 Price Measures

While there are a number of different price measures that are used in value maps, the standard (and most useful) are the average market prices. These are either obtained from the sales force or from syndicated services by industry. We will discuss using revenue and price satisfaction later.

7.7.2 "Fair Pricing Models"- Regression

The simple display of product position is interesting; however, it doesn't suggest specific changes. Typically some normative reference line is imposed. Below we see the position and a regression line based on the data included in the graph.



This line suggests that products above the curve are over-priced while those below are under-priced. It is often referred to as the “fair-pricing. However, it must be noted that no consideration of submarket needs or manufacturing costs have been considered here. Optimum price may exist either above or below the line. What we can say, however, in most well behaved markets, products positioned above the curve should have lower market shares than those above. We will use this concept later to suggest an alternative reference structure.

7.7.3 Underlying Assumptions for the Value Map Approach

Before discussing other approaches, it is useful to review the underlying assumptions for using a reference type analysis.

1. Effectively all sources of value have been included in the computation of utility. This is a critical assumption, in that if board categories of value have been excluded, the positions may be incorrect and artificially scattered.

2. The demand distribution will depend only on the desire for total value. That is that the market is dispersed around how much value customers are willing to purchase. There is a commonality of needs and perceptions by the customers. There is an implicit assumption we are dealing with a highly uniform market segment with common values. Unfortunately, this is rarely the case.

3. The products are truly competitive and do not interact. This usually requires that there is a complete trade-off between products. Usually, this requires a single purchase, discrete, purchase situation. While this is a good assumption for capital goods purchases,

it does poorly for mixed specialty products where multiple sources are used.

4. There is a positive relationship between the average price and average importance of competing products. If the above assumptions are met, this is probably not a problem. However, in many cases it is. As we will see the Bradley-Gale approach tries to get around this problem.

7.7.4 Alternative Methods

There are a number of alternative ways of constructing the value map. The basic problem is that the relationship between price and value is often complex. Strictly linear relationships are rarely seen. As such, it is difficult to develop a predictive relationship. The various methods are intended to try to overcome this difficulty.

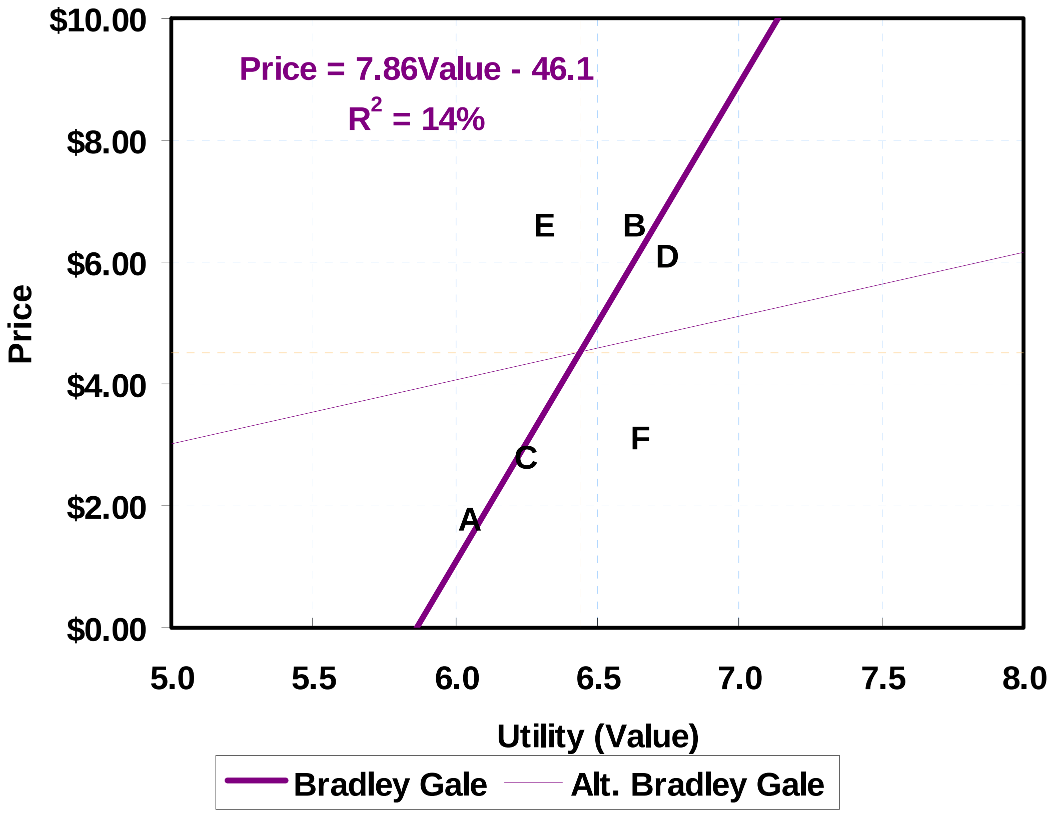
7.7.4.1 Bradley-Gale Approach

Bradley Gale has been attributed as a pioneer in using value maps. To avoid the problem of low or negative correlation between total value and average price in proposed using two models: (1) based on the standard deviation of the prices and values, and (2) if the correlation is low or negative based on a ratio of the averages.

If the correlation > 10%, the slope of the line equals the ratio of the standard deviations and the intercept is computed so that the line goes through the average point of the products.

If the correlation < 10% or negative, the slope is set equal to 3/2 of the ratio of the average total value and prices. Once again the intercept is set to allow the line to go through the grand average.

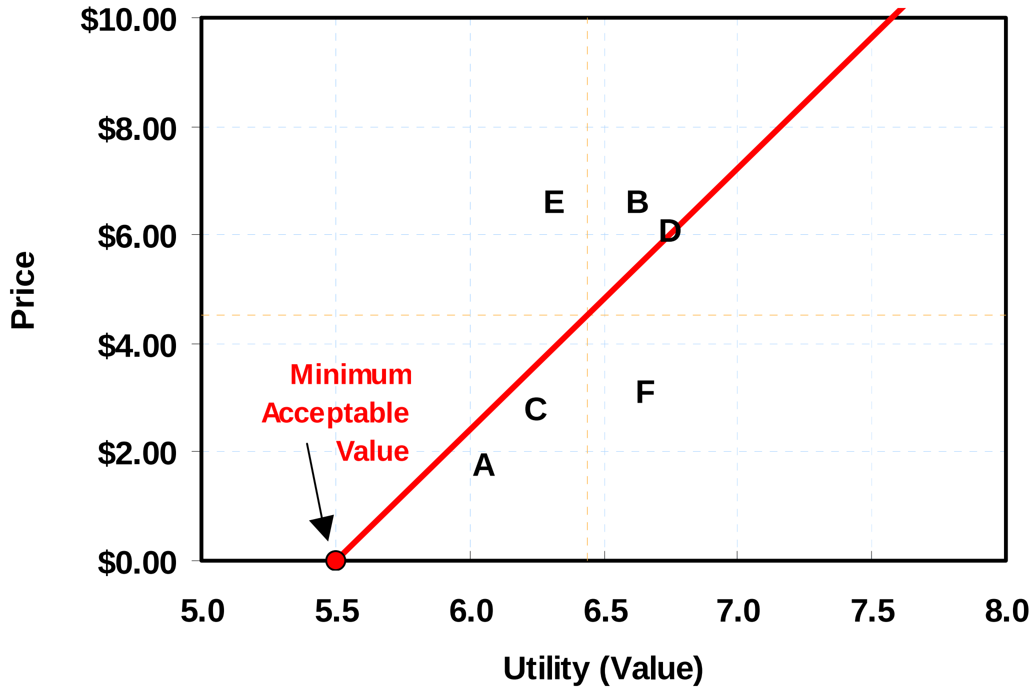
These are shown on the following chart.



The two models assure that there will be a positive slope to the reference line. The first Bradley Gale model is similar to the regression case, but gives a poor fit (a lower R-Square), but is usually only marginally poorer. The second model, however, has no theoretical justification and has no basis.

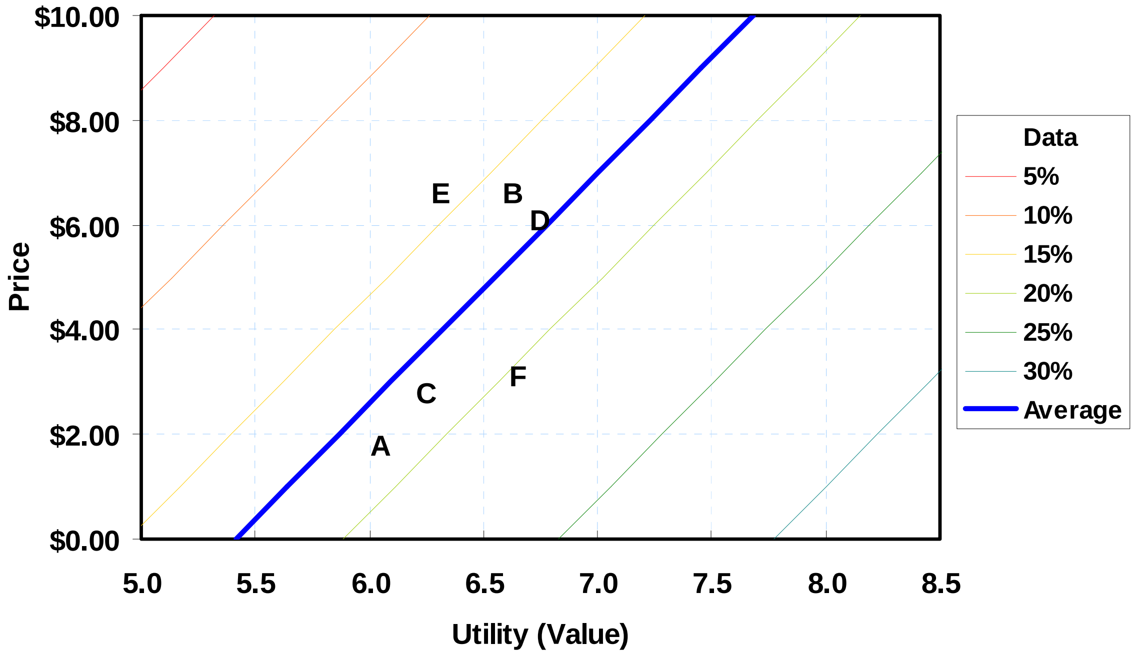
7.7.4.2 Standard Reference Approach

If data is being obtained from users for this analysis, a standard reference point may be solicited. This point represents the lowest average total value that customers would consider purchasing any product irrespective of price. This allows for a good theoretically based line that will always have a positive slope. The line is then constructed from this average minimum accepted point through the grand average.



7.7.4.3 Share Modeling

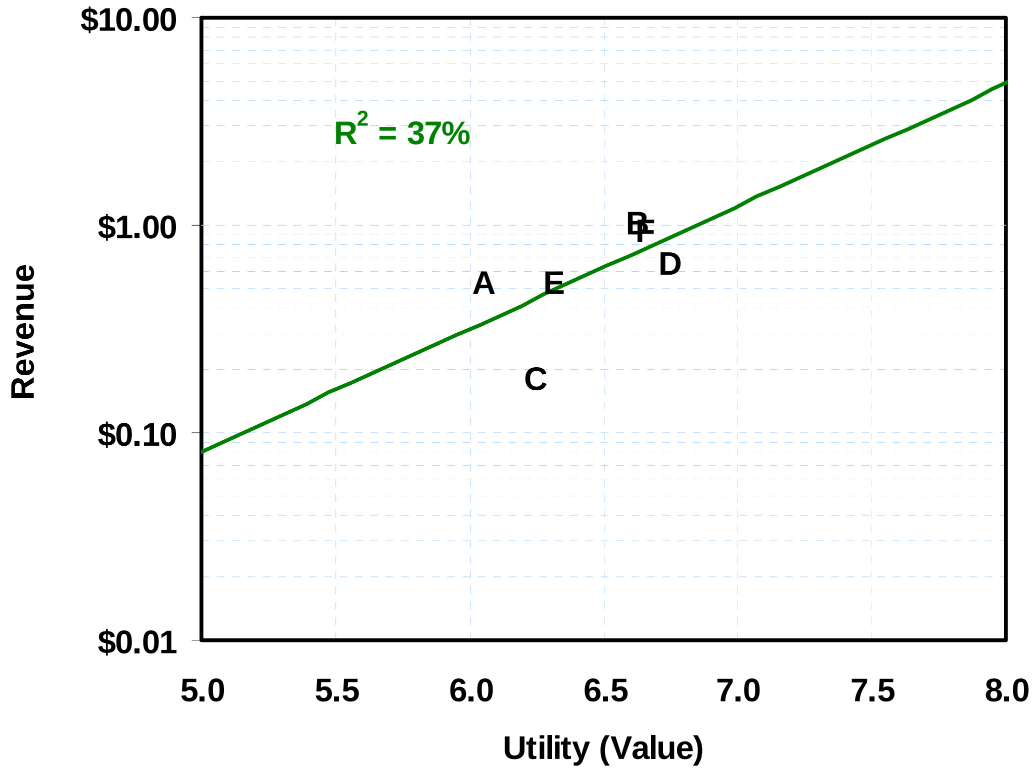
Notice that none of these models take into consideration the change in share with price and value. If sufficient data is available on an individual basis a regression share model can be constructed. This again assumes that the value elements are all encompassing. The model forecasts share given price and overall value. The reference line is then constructed through the grand average as in the previous cases. Below is an example of that analysis.



It should be noted that a log-normal model may be a better description of the purchase process. However, this would make the analysis much more complex.

7.7.4.4 Revenue Maps

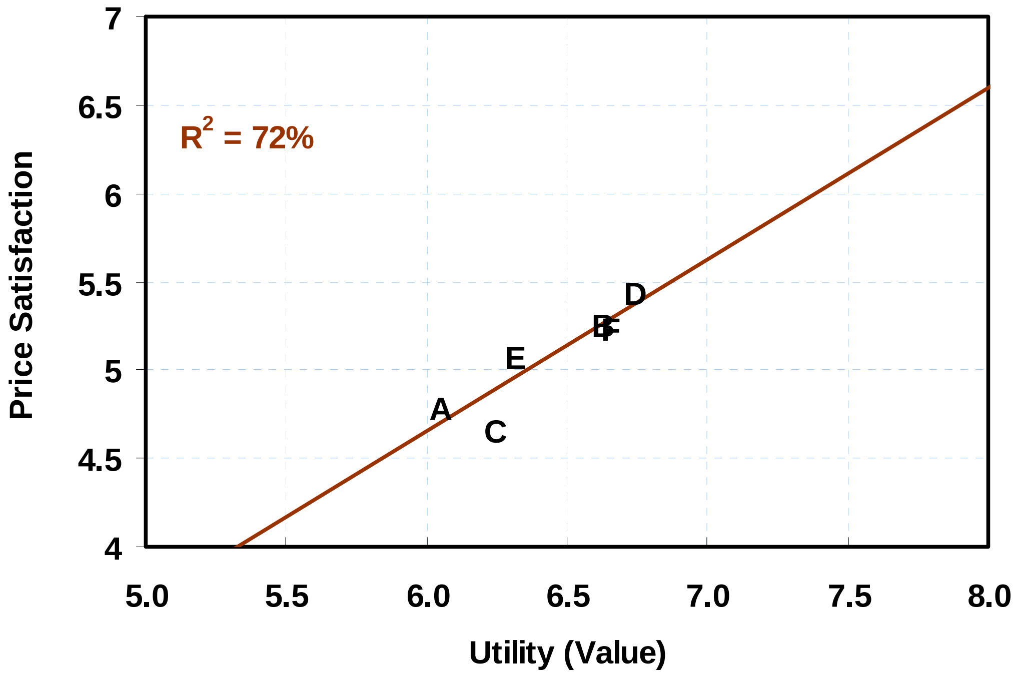
An alternative to handling the share is to include it as part of the price measure. This is based on the idea that there is a trade-off between share and price that is under the control of the seller. As such, we would expect that the revenue would be a function of value. This shown in the following chart:



Notice that we have used the logarithmic function. This attributed to the improved fit of the data and the resulting curves. However, in almost all cases the revenue map gave an improved reference fit over the value maps. However, since revenue is really not under the control of management, only price is, this map is of limited use.

7.7.4.5 "Price Satisfaction"- ValTec Group Approach

An alternative has been suggested of using a measure of "price satisfaction" rather than price. The argument goes that if customers are dissatisfied with price, it represents an over-priced situation. However, we can expect a halo effect between product satisfaction, value and price satisfaction. As such, the price measure is likely to be highly confounded. Below are the expected results for such analysis.

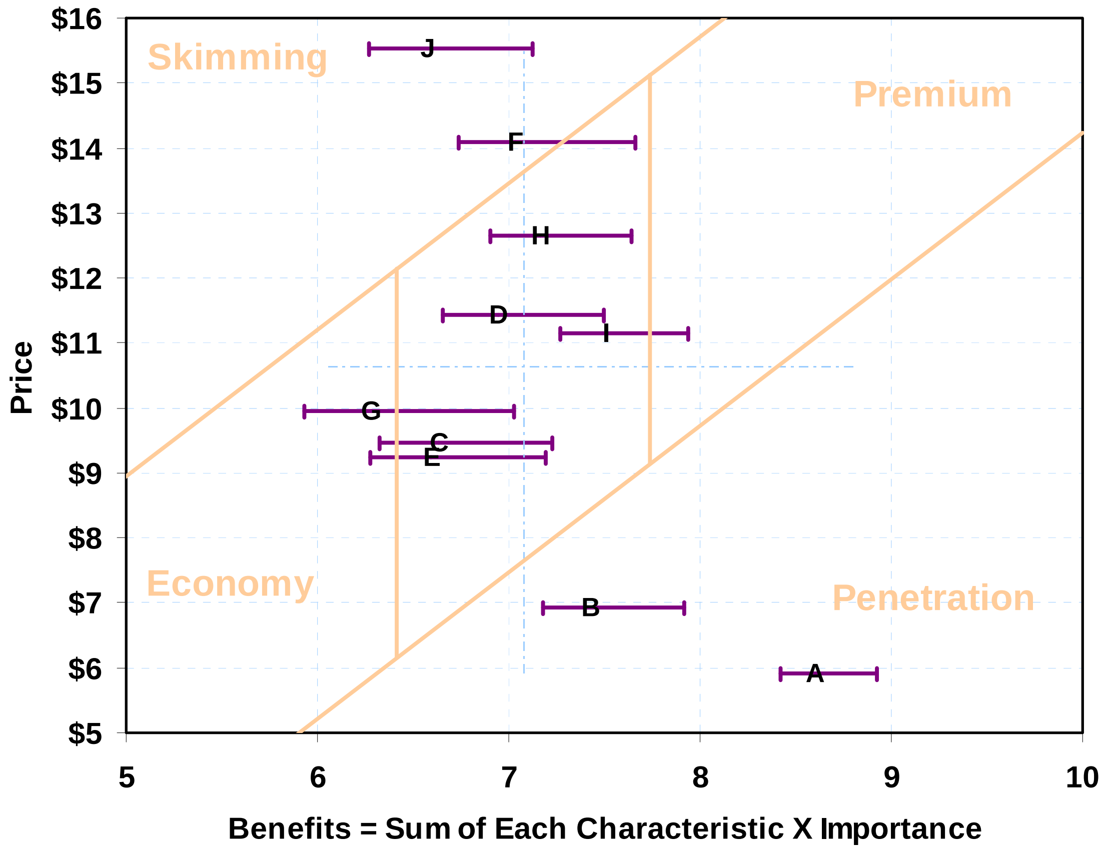


The second problem with using this approach is that it does not read directly on price. As such, it unclear what action should be taken. However, we do expect a much higher fit between its reference line and the data.

We need to state, however, that none of these methods appear superior to standard pricing modeling for getting a quantitative view of price sensitivity. As best, it is a reasonable approach if other data is not available.

7.7.5 Indicating the Range of Value

Horizontal "error" bars on the value-map, as shown below, indicate the range or confidence interval around the market values or utilities of the individual offerings. For non-dynamic value-maps these are computed either from market data (in the case of utility or perceived value measurements) or from stochastic economic models used with value-in-use estimates. In all cases, however, these error bounds should be determined by the nature of the underlying value distributions.



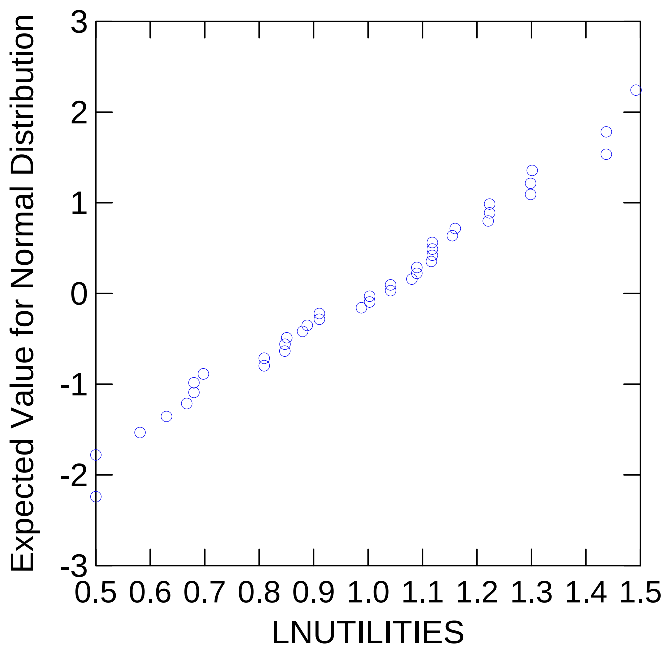
For dynamic value-maps the positions of the offerings are allowed to change with modifications of price and value. The ranges of value need likewise to be adjusted to reflect these changed conditions while meeting underlying constraints and expected market behavior. In fact, we need to estimate the modified value distributions that result from changes in the new expected value of the products. In the case of detailed perceived value and value-in-use modeling sufficient respondent information may be available to fully describe the changes in the value distributions. However, for the more frequently used utility models this is not feasible and assumptions need to be imposed to allow for the recomputation of these ranges.

7.7.5.1 The Utility Model

The utility approach is widely used to estimate the value of products and brands. It assumes that the overall value of a product is the sum of the importance of the features or benefits times the perception of the performance of the product on those features. Typically eight to thirty features or benefits are used. The importance estimates (preferably gathered using some type of constant sum or ranking procedure) is normalized. The measures of performance are typically rating scales, from 1 to 10, for example. This results in measures of utility between 1 to 10. This makes the distributions of utility bounded by 1 and 10. Usually, the lower bound is not a problem since average utilities tend to be between values of 7 and 9. However the upper boundary is a real constraint.

7.7.5.2 Utility Distributions

As previously noted, the utility distributions should be bound at some upper limit, $\mathbf{X_{max}}$, which is typically valued at 10. It is, therefore, anticipated that the distribution is backward skewed. Most of the common skewed distributions are skewed in a forward fashion with zero as the limit. For convenience, the utility is transformed to a forward skewed distribution by subtracting the value from the maximum ($\mathbf{X_{max} - X}$), where **X** is the value of the utility for each respondent. We would then expect the new transformed utility to be distributed by some standard skewed distribution. The *Log-Normal* or *Log-Gaussian* distribution is particularly appealing since it represents a stochastic process which is both random and provides increased difficulty when approaching the limit. A test of utility data against this model is shown below. The closer the points are to a straight line the better agreement there is with the *Log-Normal* fit.



The *Log-Normal* distribution represents a case where the logarithm of the transformed utility form a traditional bell shaped Normal distribution. It is well recognized and is fully supported as a function in *Microsoft Excel*.

The parameters in these distributions are the average and standard deviation of the logarithms of the transformed utilities. For the purposes of our discussion we will refer to the transformed utility as **Y**, which equals $\mathbf{X_{max} - X}$. The average or mean of the transformed utility is **E(Y)**. The average of the (natural) logarithm of the transformed utility[16] is ξ**(Y)**, and the standard deviation of the logarithm[17] is ρ**(Y).** Note that the

[16] The average of the transformed utility is also equal to the **exp[Geometric Mean(Y)].**

parameters of the *Log-Normal* utility distribution, ξ**(Y)** and ρ**(Y)** and the average value **E(Y)** are single fixed values**.**

7.7.5.3 Ranges and Confidence Bounds

The confidence bounds can be computed directly using the *Excel* function as ***LOGINV*[Confidence Percent, ξ(Y), ρ(Y)]**. The average utility value is of particular importance here in that we wish to be able to change it arbitrarily within the appropriate range and compute the confidence interval around it. It should be noted that for *the Log-Normal* distribution, the average of the logarithm of the transformed utility is a function of the average value and the standard deviation of the natural logarithm of the transformed utility. That is for the *Log-Normal* Distribution:

$$\xi(Y) = Ln[E(Y)] - 1/2 \bullet \rho^2(Y)$$

The initial values of these standard deviations, ρ**(Y)**, are computed from the respondent data. If we <u>assume that these standard deviations are constant</u> we can readily recompute ξ**(Y)** and thereby the confidence bounds using this relationship. And by using the *Excel* function, the interval can be computed for any changes in the average utility, **E(Y)**.

Constant Coefficient of Logarithmic Variation

Note that there is no basis for assuming that the standard deviation is constant[18]. We could assume that the coefficient of variation, ψ**(Y)**, which equals ρ**(Y)/**ξ**(Y)** is constant. A relationship for the average of the logarithm of the transformed utility is obtained by substituting this relationship into the above equation and solving for the average log utility as[19]:

$$\xi(Y) = \{-1 + \sqrt{1+ 2\bullet\psi^2(Y)\ Ln[E(Y)]}\ \}/\psi^2(Y)$$

The impact of the two types of assumptions is shown below, based on a hypothetical case, though one based on data. On the first chart we see the change in the logarithm of variance with changes in average utility.

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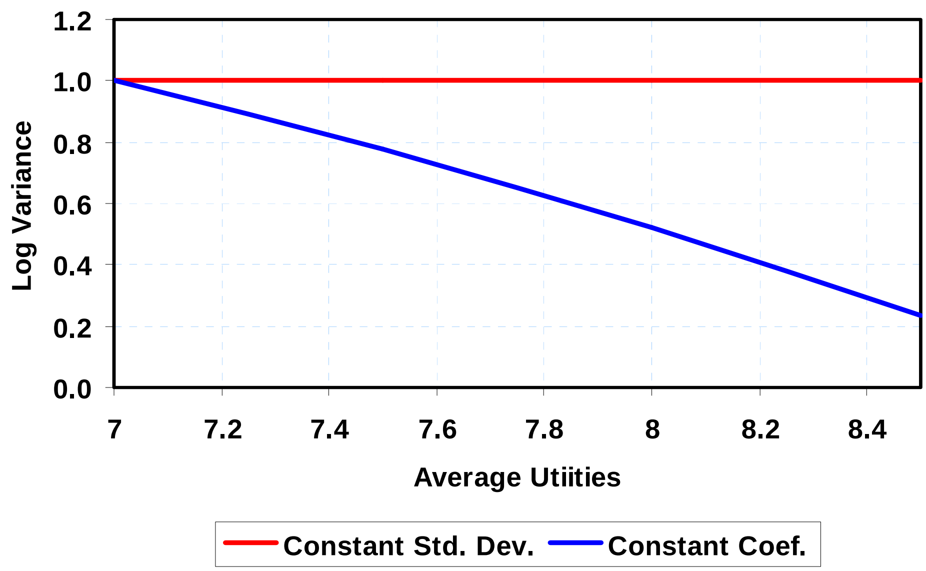
[17] Note that the standard deviation of **Y**, σ**(Y)**, will not be used in this discussion. It does not enter in the computation of the range.

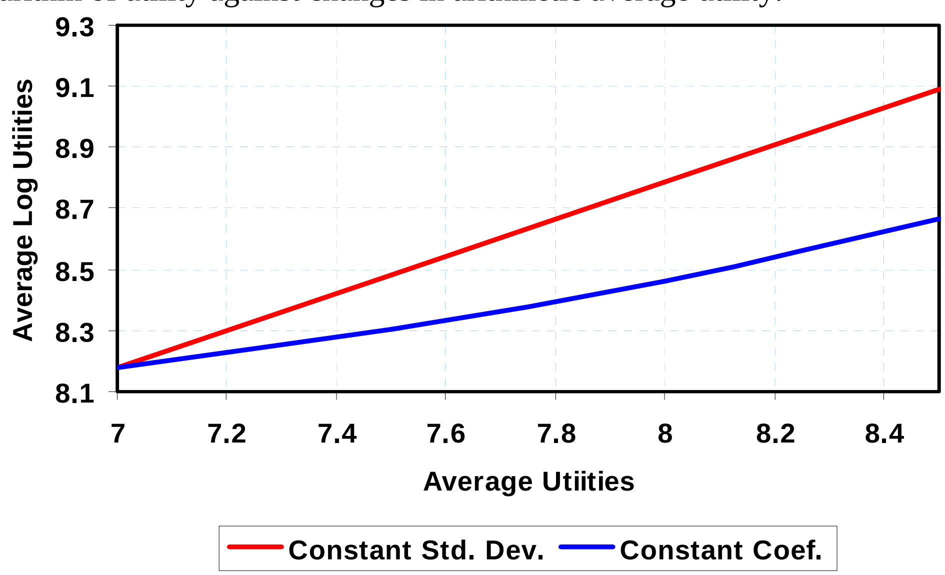
[18] In fact, at this point there is no evidence to support any assumption regarding the impact of changes in averages on the distribution of values. However, some set of assumptions is necessary to compute the effective ranges.

[19] Substituting the relationship results in a quadrant function, which can be readily solved.



As one would expect the variance of the logarithm of utility with constant coefficient of variation will decline. Note that we are again dealing with the transformed utility. As the average utility increases the average transformed utility will decrease with the corresponding variance. However, if we assume constant standard deviation, in this case at 1.0, the log variance must remain constant.

The next chart is more interesting in that we are looking at the changes in the average logarithm of utility against changes in arithmetic average utility.

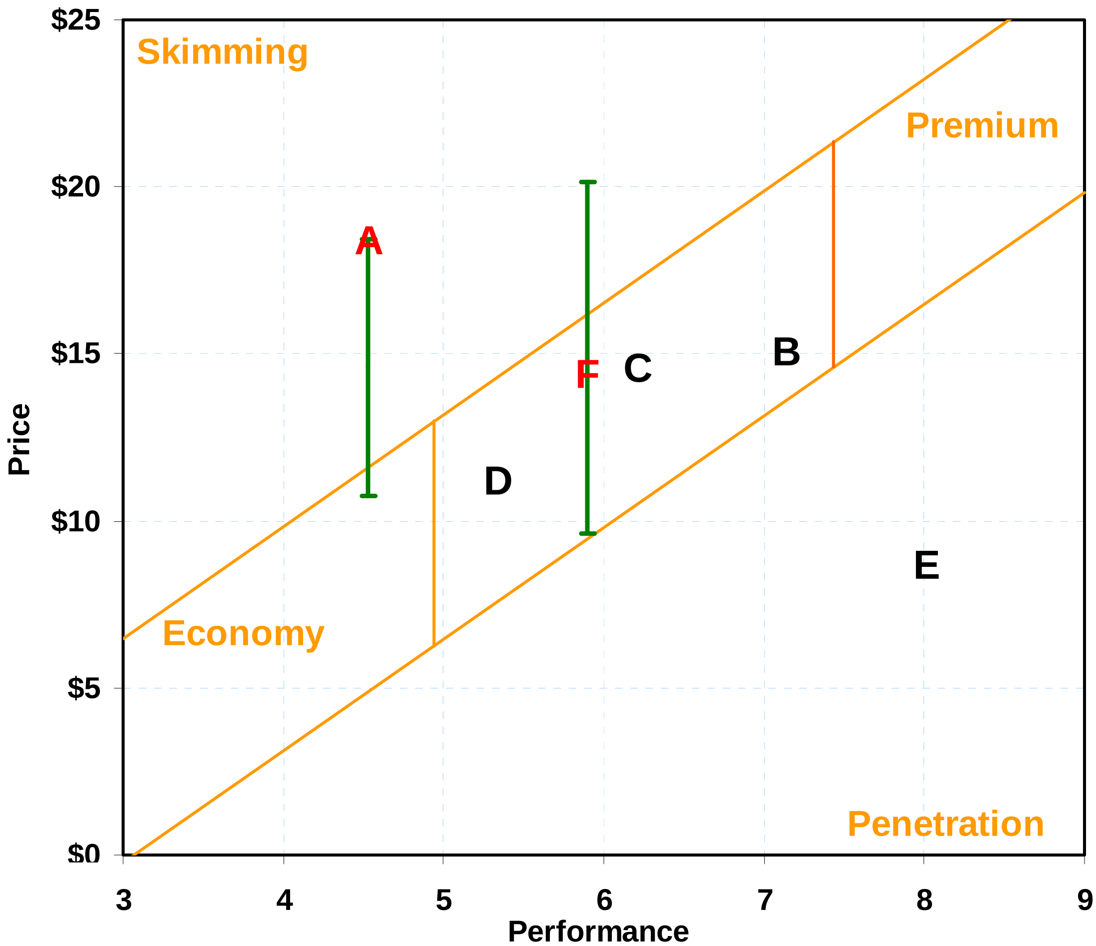


Here we see that using the constant coefficient of variation gives much less range in the logarithmic average than does assuming constant standard deviation. The average of the logarithm of the utility represents the mode or typical value. As such, it would probably be useful to have a larger range produced. As such, we typically use the constant standard deviation assumption. This produces more stable ranges when changing the average utility values.

7.7.6 Strategy Use of the Value map

The value map reveals the relative price-value position of competing products. While there is some evidence and logic indicating that pricing trends can be derived from these maps, the results are quantitatively unreliable. We can assume that a decrease in price usually results in an increase in share. And we can assume that a recently repositioned product to a lower price, therefore, should have an increasing share. The quantity of share is not determined. Tools for seeking short-term optimum price are discussed in another section of these notes. However short-term optimum price is usually not the total goal of pricing. Strategic positioning is usually critical for long-term profitability. It is here where the value map is useful.

To construct a strategic value map we extend the concept by constructing a grid based on the fair price line, as shown below.



The orange lines form the strategic grid. The two diagonal lines have the same slope as the fair price line but are one standard deviation above and below the average. The two vertical lines represent a band around the average performance at one standard deviation above and below respectively. This divides the space into five strategic areas, three present fair pricing strategies for: (1) Economy products, (2) Premium products, and (3) Average products (in the center). The two extreme strategies are (1) skimming where the seller is trying to sales products significantly above their perceived value and (2) Penetration, which is the reverse. In the above case, the red lettered positions are the products that the firm is offering into this market. The green lines represent the corresponding range of prices that could be offered that would result in 90% of the best earnings. In this case, the product A is viewed as having a "Skimming" strategy. It is probably advisable here to decrease the price. The other firm's product, F, is probably well position in regard to price.

7.7.6.1 PIMS Comparisons

The PIMS (Profit Impact through Marketing Strategy) database is a collection of operational characteristics and profitability compiled on a business unit basis during the 1960's through the 1980's and consists of over 5,000 business units. A summary of the results of the analysis of that data[20] is shown below.

Pricing Strategy	Cash Return on Investment	Percent of Businesses
Economy	11.6%	19%
Average	13.4%	14%
Premium	18.8%	16%
Skimming	11.8%	23%
Penetration	16.8%	28%

It should be noted, however, that the definitions of participation in the strategies are not identical to those used with value mapping but is very similar. Also the definition of Return on Investment is somewhat different than the typical accounting approach and should be viewed as a relative value. It is interesting though that the Premium and the Penetration strategies give then highest returns while Skimming is among the poorest.

[20] These results were compiled by Jack Frey, formerly of Dupont. A summary of his and his colleague's analyses of the PIMS data can be found at:

http://www.lieb.com/Documents/BusinessBehavior.pdf

7.8 TECHNOLOGY ASSESSMENT[21]

Technology development and utilization takes time. As such, technology assessment focuses further out in time than typical marketing studies.. The drivers of technology development are the potential for new capabilities and the value that those capabilities can deliver. It is a two-sided interconnected issue. The speed that technology can develop depends to some extent on the resources allocated to it. The resources allocated are a reflection of the assessment of the capturable value that those capabilities could deliver. In this regard, assessment may drive capabilities. As in the case of market analysis, the future may be a self-fulfilling prophecy if that prophecy is doable.

7.8.1 OBJECTIVES

There are generally three objectives to technology assessment, which result in different approaches and methodologies:

7.8.1.1 Technology Forecasting

Technology forecasting is an attempt to capture the risk associated with technology development by understanding the expected performance and industry characteristics in the future. The term “technology” is somewhat open in this case, since technology forecasting often involves estimating business conditions and demand as well as the inherent technology performance. Trend extrapolation, modeling and opinion surveys such as the Delphi Method are used to accomplish this objective. Usually, technology forecasting is only a part of a broader program of opportunity analysis and concept assessment.

7.8.1.2 Opportunity Analysis

The purpose of opportunity analysis is to identify potential business and research areas that are likely to become important in the future. This involves a number of steps:

- Trend Analysis (both social “Meta-trends” and technology trends are considered);
- Identification of gaps in associated and facilitating technologies, infrastructure and commerce;
- Associating those gaps or opportunities with the clients’ potential core competencies; and
- Grouping and prioritizing opportunities based on their relationship using relevance trees and influence diagrams.

[21] The concept of technology assessment is derived from the formation of the now defunct Congressional Office of Technology Assessment. This organization focused on both technology forecasting and economic evaluation.

The results of the analysis are a list of potential projects and programs for the client. These may be new technologies, products or businesses to explore for future commercialization. Ambitious programs of this type will also attempt to prioritize these opportunities and set development goals and milestones.

7.8.1.3 Concept Assessment

Technical research programs can focus on products that are likely to materialize decades into the future. These often involve major developments with very large potential returns but must be considered risky. Concept assessment is an attempt to capture the risk associated with the potential outcomes of such programs. Because of the long time horizon for this type of assessment it is most often commissioned by government, utility industries, pharmaceuticals and health care product manufacturer, automotive and aerospace manufacturers. Concept assessment of this type is usually “stochastic” or probabilistic in that the likelihood of events is sought and usually requires some type of value or event modeling.

7.8.2 Technology Application Life Cycle

Technology has two edges. It is the promise and opportunity for the future; but also threatens the present world. How to respond to technology is the ever present dilemma. Too early adoption results in high costs and low performance often without any compensating reward. Too late and we lose any competitive advantage. The appropriate choice of when to adopt depends on the specific needs of the organization and the speed of change in that technology. We have found it useful to think of applications of technology as going through four phases; each with specific advantages and costs for the adopters.

1. Innovation - The innovative phase of new applications is the most exciting for researchers, but very expensive. This is the world of the pioneers. There are few standards and development tools are primitive or non-existent. The value of adoption during this phase is the command of technology. If the technology and the application are within the core competency of the organization then it might be worth the risk to become a pioneer.

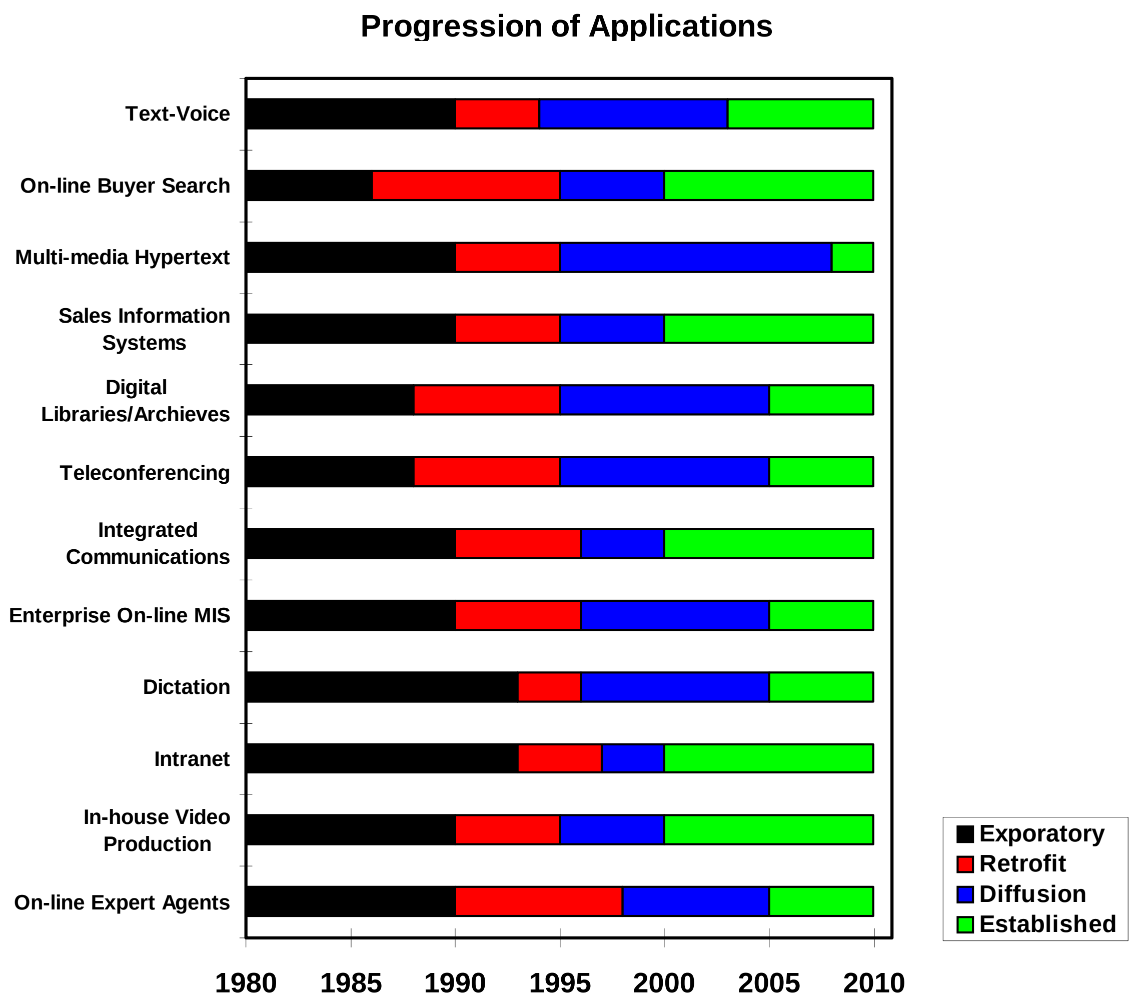
2. Retrofitting - At some point, applications become well identified and early adopters can implement the technology. Characteristically, technology is applied to existing problems. Here the technology is "retrofitted" onto the present world. Technology is still expensive but for critical tasks it is usually affordable. Competitive advantage can be obtained by providing quality and services that competitors can not match. However, return from the technology is limited by the installed base of resources and people.

3. Diffusion - With a large installed base of the technology, there is a diffusion of new applications. The cost of the technology decreases significantly with increase scale of use. The value of the technology expands with applications; inducing early followers to adopt the technology. There is commercial support for the applications as well as strong competition among vendors.

4. Establishment - Eventually the technology becomes ubiquitous; it is everywhere. It becomes so well established that it can be assumed that it is always used. Not to adopt the technology is to become non-competitive. Here even the slowest adopters eventually adopt the technology.

Application Stage	**"Science"/ Fundamentals**	**Infra-structure/ Support**	**Opportunity**	**Competition**
Innovation	Little	None	Unknown	Technical Leaders
Retrofitting	Some	Some	Defined	Commercial Leaders
Diffusion	Expanding	Well Supported	Expanding	Competitive Participants
Establishment	Well Established	Established Industry	Constrained	Everybody

While we think of these phases as being sequential, in reality they overlap. The accompanying figure shows our estimates of the timing of phases of some information technologies.



7.8.3 Technical Performance

Technology capabilities are measured by improvements in attribute performance. These are levels of properties, speed, or efficiencies. The technical measures may be intrinsic to the structures or integrated into processes. However, the bottom-line is how the attributes effect benefits.

Attributes ⇒ Features ⇒ Benefits ⇒ Value

7.8.3.1 Measurement

Measurement of technical performance is generally given either in terms of attributes for processes and intermediate materials or benefits in final products. The meaningful definition of attributes depends on the use and benefits that are to be derived. Because there are a large range of uses, there is a large range of defined properties. The bottom-line is how the technology performs within the context of use. The ultimate measurement, therefore, is in the application of interest. However, in tracking and assessing technology development standard measures and properties are used as indicators of technical performance.

7.8.3.2 Interrelationship of Attributes

Attributes generally are derived from fundamental characteristics of materials and processes. As such, there is usually a trade-off among them with some fundamental principles dictating the observed characteristics. In the case of isotropic materials, chemical and crystalline structure dictates the physical and process properties[22]. Single characteristics typically can be derived from manipulation of a number of underlying properties. As such, there are usually a number of different routes to produce the same small set of properties and characteristics. While the totality of properties of a material may be unique, those that are of application importance, and therefore delivering value, usually are not.

7.8.3.3 Extending Range

The technical properties can be improved by extending the "state-of-the-art" into new regions of performance while functioning with in the existing physical relationships. These extensions of capabilities may represent significant benefits. Furthermore, these extensions to higher temperature, for example, may be difficult to achieve and could represent a major technical accomplishment.

7.8.3.4 New Performance Classes

Occasionally, a major "break-through" is made generating a new class of technology that changes the fundamental relationships. These represent new capabilities and are often thought of as "Quantum Leaps". However, it is important to differentiate between "hype" and real changes. Examples of real changes include:

1. A new class of photographic emulsions that have a higher fundamental "speed/grain" ratio which reflect the "quantum efficiency" of the silver grain (T-grain).

2. The introduction of the turbojet aircraft engine produced over an order of magnitude improvement in power/weight.

3. The transistor and later the integrated circuit.

4. Aramide Anisotropic fiber (Kevlar®) had several times higher specific strength and modulus than conventional fibers.

7.8.3.5 New Properties

Beyond the scope of extension of existing properties, new materials and processes can generate new properties that produce unique benefits. Conductive polymers, room

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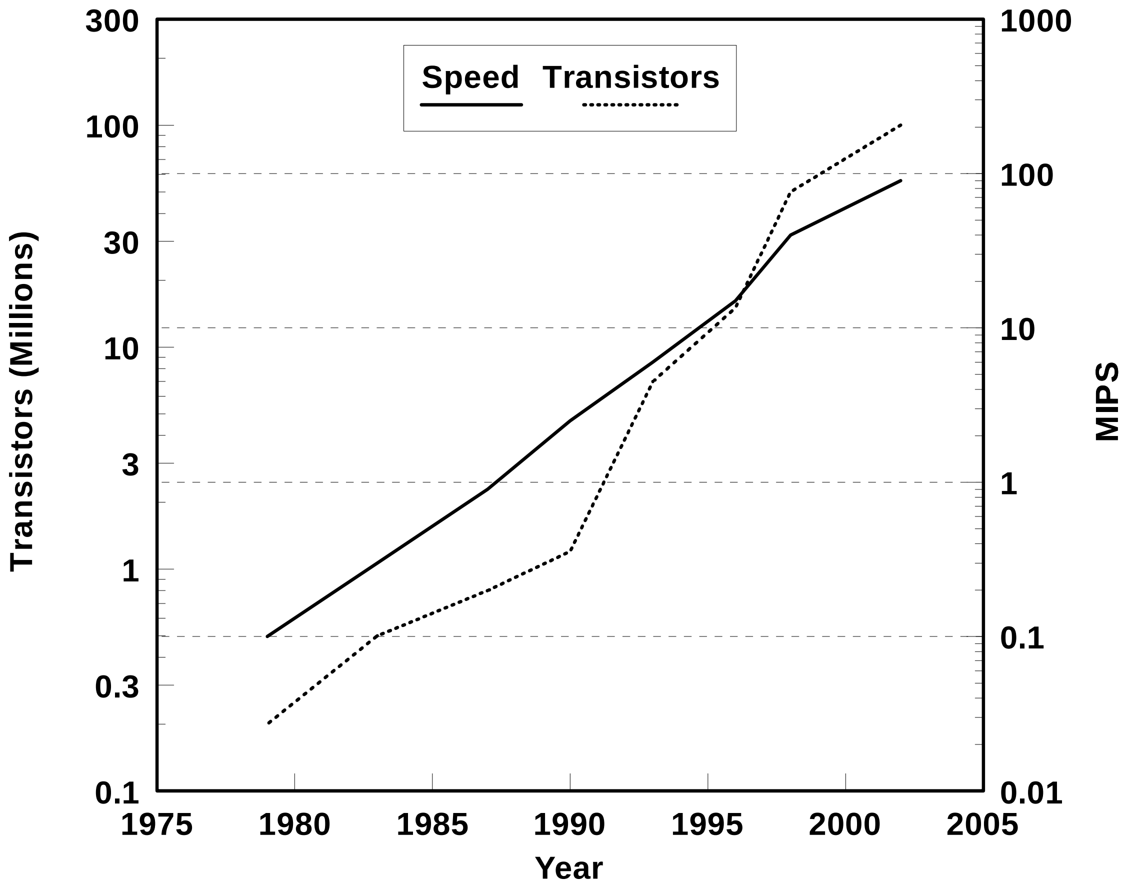
[22] Proprietary factor analysis of materials has indicated from resins and elastomers that three dimensions are able to capture most of the variation. In metals analysis, likewise has indicated only a few underlying factors determine significant properties.

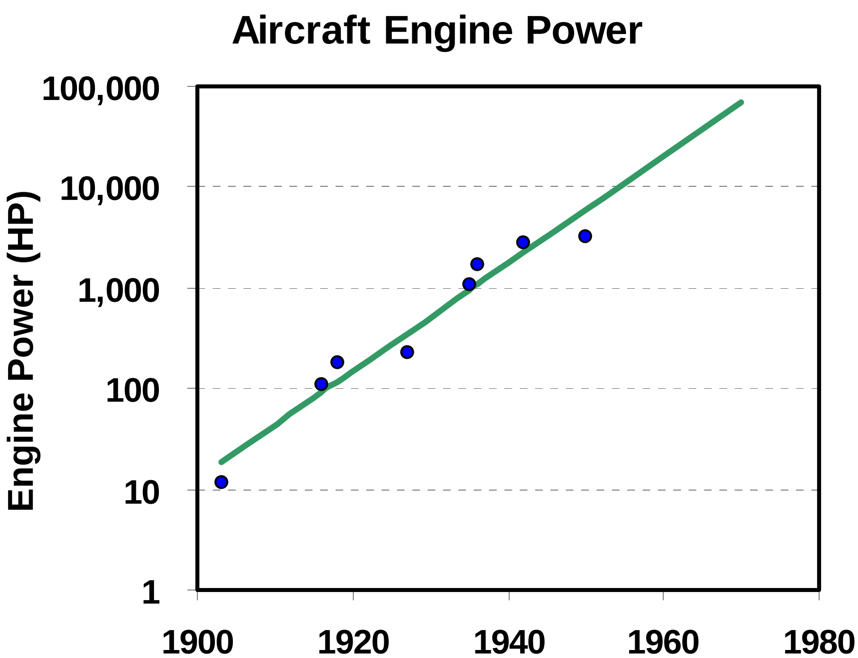
temperature super-conductor, classes of bioactive materials would fit into these categories.

7.8.4 Capability Forecasting

All capabilities improve over time. This improvement may be sporadic or continuous. In some cases, there has been a long stable history of change that has become an anticipated process. "Moore's Law" is a well-documented example of this phenomenon. In its traditional form, it indicates that on average the maximum number of transistors in an integrated circuit doubles every eighteen months. However, that description looses sight of the value driving this process. We can convert the statement in terms of computer process capabilities which rough follows the transistor density. The speed or capability of computers has also doubled every eighteen months. This is shown on the following chart.



What is interesting here is that that form of Moore's Law has been, more or less, valid since the 1950's. While the severe nature of change in electronics is somewhat unprecedented, in the past, similar processes have been observed. Below is a history of aircraft engine power. This roughly tracks military aircraft speed and to a lesser extent reduction of commercial passenger-mile cost. Here we see a similar 60 year exponential capability growth. However, the rate of this growth is significantly slower than has been recently experience with computers and electronics.



The question naturally arises as to what would limit this growth. It is interesting to notice that in both of these examples capability growth was continuous even though several major technology (quantum) changes have occurred. This would indicate that in this situation, these changes or some equivalent ones are anticipated to allow continued growth. To a certain extent, the expectation of growth forces these limits. However, one could expect economic and value restrictions to apply even if physics doesn't impose limits. At some point, there is likely to be a reduction on the return for the effort to continue this momentum. It is of course difficult to foresee those changes.

7.8.4.1 Technology Substitution Curves[23]

Traditionally new technologies are considered to be replacements for older technologies. The technology penetration is measured by the substitution of use. Substitution continues to its maximum levels along some dynamic curve. These methods are widely used and should be consider. However, we have found them somewhat unreliable. A number of mechanisms[24] have been proposed giving rise to a linear differential growth[25]:

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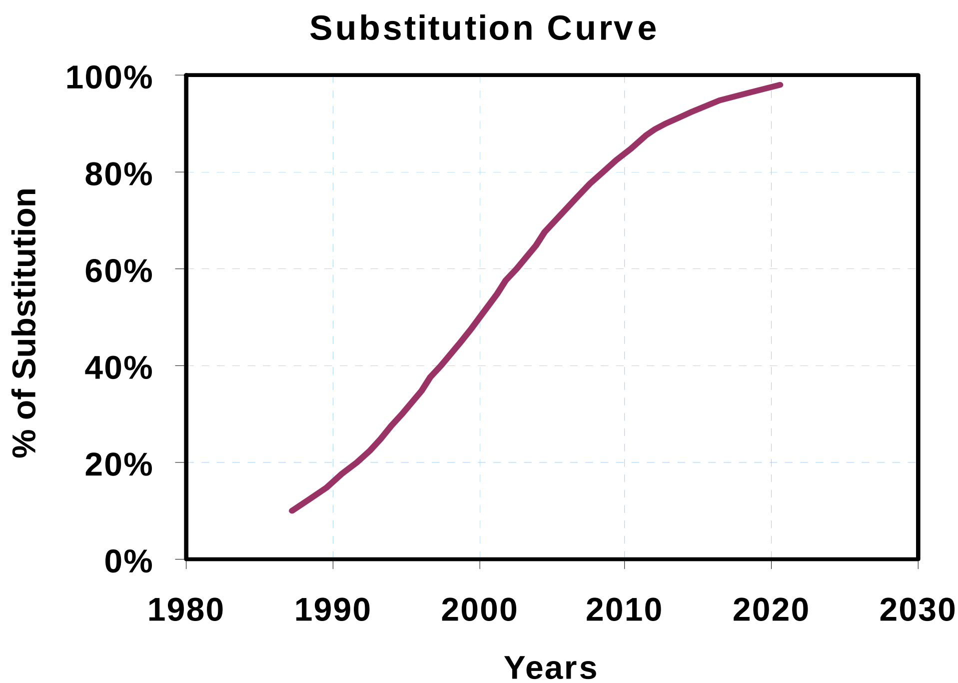
[23] Detail discussion of various forms of substitution curves can be found in the classic reference: Erich Jantsch, *Technology Forecasting in Perspective*, OECD (1967)

[24] In the technological forecasting literature this is referred to as the Fisher or Pearl model. In marketing

$$\text{Growth} = dQ/dt = -A(Q-Q_\infty)$$

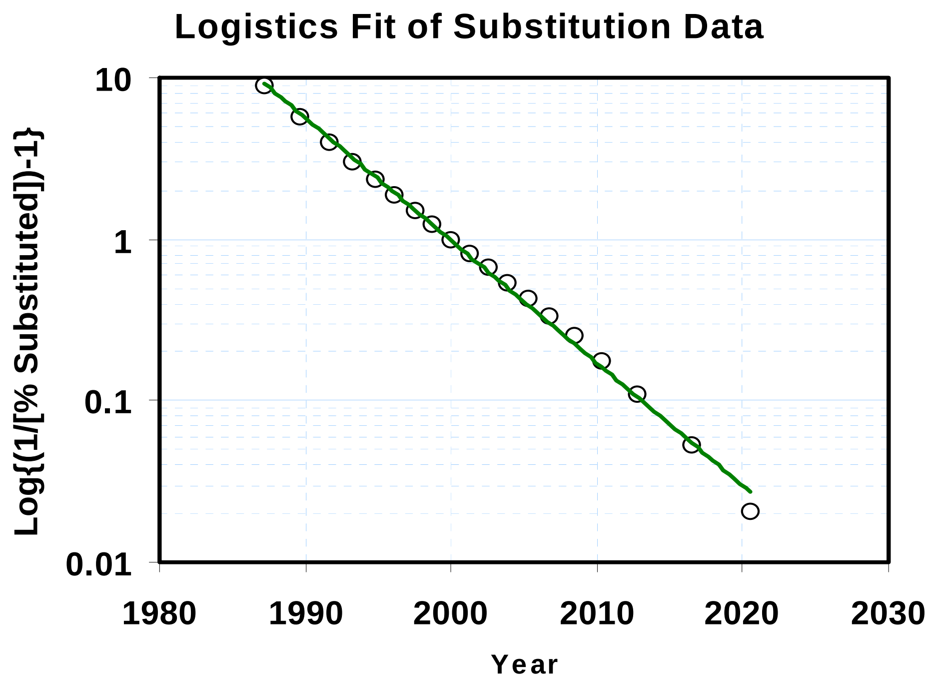
where **Q** is the penetration and $\mathbf{Q_\infty}$ is the limiting penetration. Typical percent substitution is used which is $\mathbf{Q/Q_\infty}$. The solution of this equation is a logistic curve that is shown below.



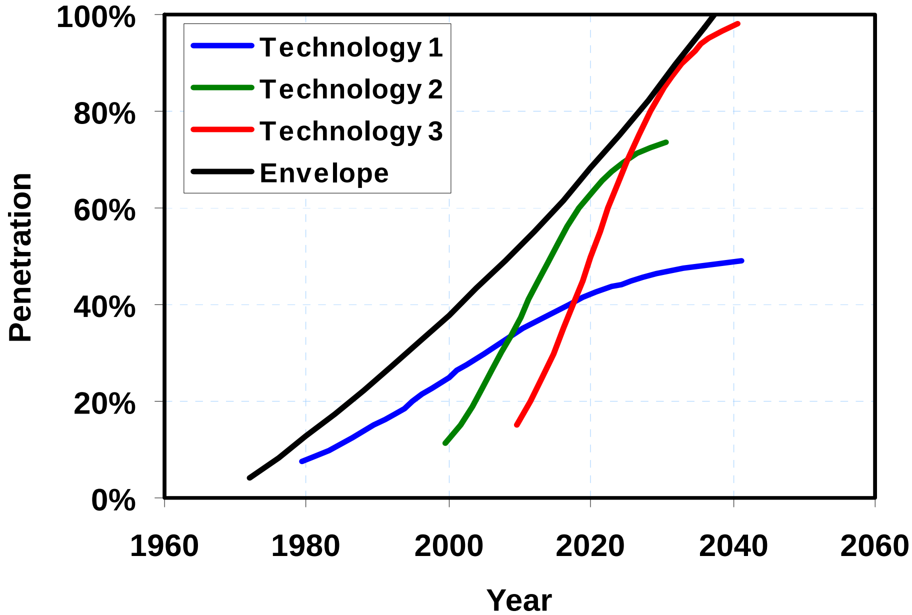
The curve is fitted to data by using the classic process of plotting the inverse percentage substitution minus 1 against the year as shown below. This is a straight line on a logarithmic scale. Among the problems of using logistics curve fitting is the evaluation of $\mathbf{Q\infty}$. Reasonable estimates are possible only well beyond the inflection point.

the same form is attributed to Frank Bass.

[25] Several other forms including the Gompertz curve have been proposed for technology substitution, but rarely used, Erich Jantsch, *Technology Forecasting in Perspective*, OECD (1967)



As we have seen technologies do not have short-term limits. Moore’s law, for example, has proceeded though several short term technologies and has grown much faster than would be expected from traditional logistic predictions. Traditional methods handles this issue by assuming an “Envelope of Growth” where the individual technology follow the sigmoid logistics curve but the long-term growth may be exponential. This is shown below. Unfortunately, these methods have tended to be far better in describing past behavior than in forecasting future conditions.



7.8.4.2 General Sales Growth Curve

An alternative procedure is using the General Sales Growth Curve. This curve has been shown to give good predictions for new technology driven products as long as the sales growth remains faster than 8% annually. Since it is such a powerful technique it is discussed in detail in the chapter on Sales Forecasting. At this point, it is worth noting that the General Sales Growth Curve provides estimates of penetration and of the sales market potential. However, it focuses only on the physical sales of products not the growth of technical performance or technology substitution.

7.8.5 Anticipated Price

While exact estimates of future prices are always questionable, there is a consistency in prices that allow for a degree of prediction.

7.8.5.1 Exclusion Curves[26]

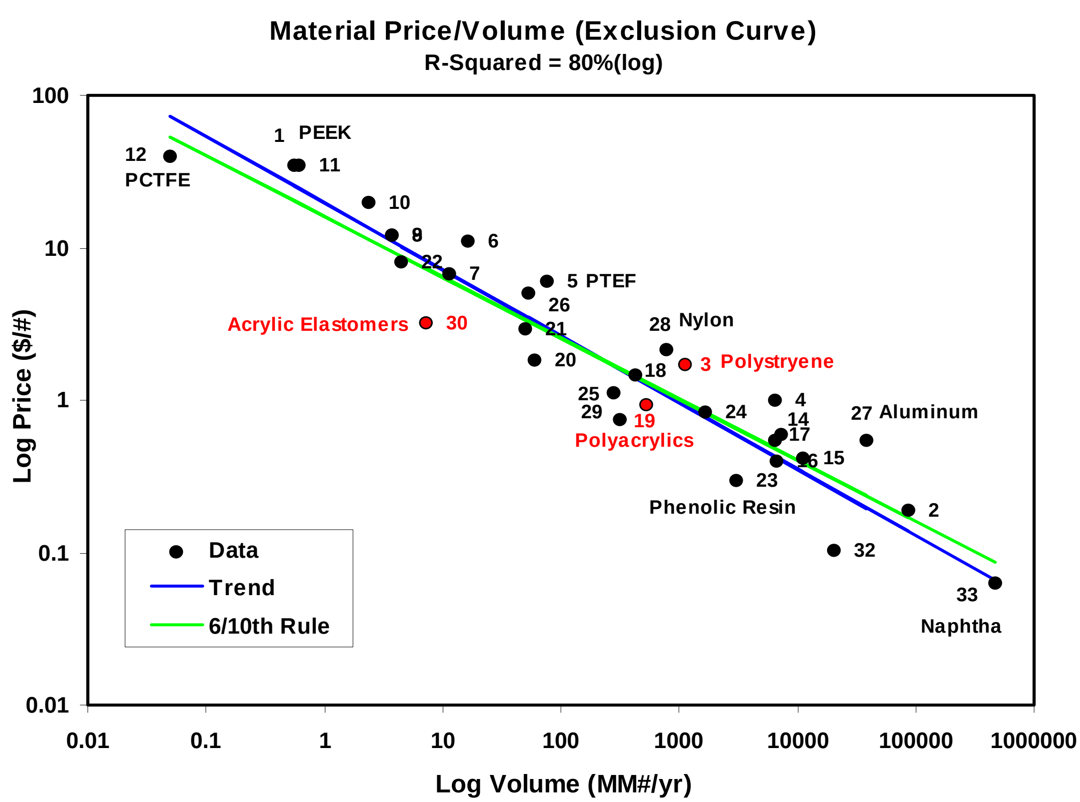
Prices tend to decrease over time. This decrease has been associated with economies of scale and with production experience. However, for materials and products, economies of scale have been shown to dominate. In fact, in materials there appears to be a direct relationship between volume and price as shown in the figures below. This is referred to as the “exclusion curve” since it excludes a host of possibilities in the expected price of products at various volumes. The shape of this curve (at least for polymers and ceramics)

[26] Details on the analysis of data using the exclusion curve is covered in the chapter on data analysis and forecasting.

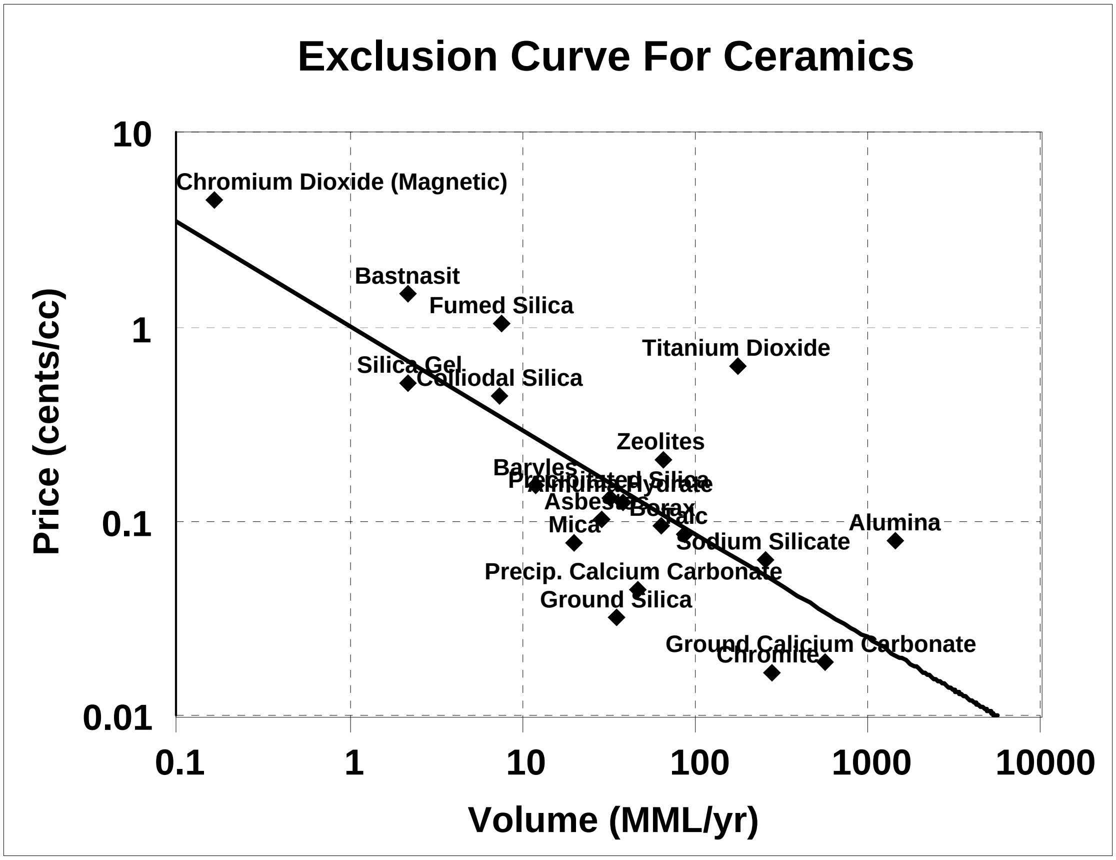
has been stable since 1947 and there is no reason to expect it to change.

The first figure shows this trend for polymers and selected materials. The second figure shows the curve for ceramic materials and inorganic pigments. The curve can be used to estimate what the price of a product **might be** at a given volume. Or, alternatively, what the volume might be at a price. However, it must be noted that neither event is determined. The market may not exist at that volume and it may be infeasible to sell the product at the projected price. What the curve implies is that prices or volumes significantly away from expectations are unlikely.

This exclusion curve approximately follows a six-tenths rule where the total revenues increase with the total volume raised to the 6/10 power. This is the same relationship used to scale manufacturing investment with volume and suggests that plant investment and costs dominate pricing. If so, one should expect that the prices of individual products should decline by the same scale rule. This is typically used in estimating anticipated prices and costs.

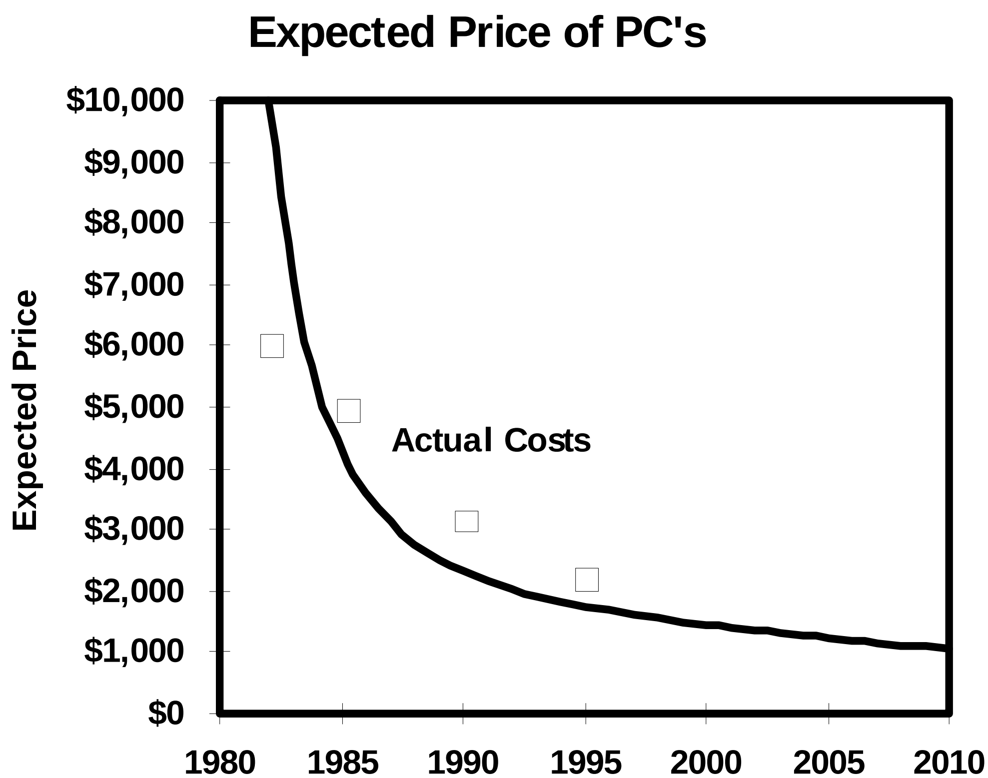


Number	Material
1	PEEK
2	Propylene
3	Stryrenic Polymer
4	ABS
5	PTFE
6	FEP
7	PVDF
8	ETFE
9	ECTFE
10	PFA
11	CTFE-UDF
12	PCTFE
14	PET
15	HDPE
16	LLDPE
17	LDPE
18	Epoxy Resins
19	Polyacrylics
20	CMC
21	HEC
22	Liquid Crystal Polymers
23	Phenolic Resin
24	Urea Resin
25	Melamine Resin
26	Organo-tins
27	Aluminum
28	Nylon
29	Activated Carbon
30	Acrylic Elastomers
32	Propane
33	Naphtha



7.8.5.2 Time Series Extrapolation

Some product categories the extent of price reduction can exceed scale. In electronics, in particular, increased yield and integration combined with fierce competition has driven prices rapidly downwards. This is shown on the following figure. It should be noted that in many cases only price history data is available. Production data is often suspect. Under these conditions, even if traditional scaling rules apply, they are likely to be inaccurate. It is general preferred to use extrapolation from historical data. In these cases we often use a modified exponential curve.



7.8.6 LONG TERM TRENDS (MEGA-TRENDS)

As previously noted qualitative trend analysis is a traditional starting point for identifying potential opportunities. Analysis usually also consists of both trend extrapolation and dynamic modeling. The goal is to determine the extent of a trend and how it will influence the distribution of wealth.

7.8.6.1 Demographics

Far and away the most powerful factor in trend analysis is demographics. Extensive data including economic and regional factors are available for the United States through the Census Bureau. Trends are available in terms of conditions and subpopulations. Specific country information is also available particularly in Europe and the Far East. World wide demographic information is far less accurate since recent population census is unavailable in most areas.

7.8.6.2 Economic Trends

Apart from demographic trends, international economic projections tend to be far less accurate and often suffer from "conventional wisdom" effects. Economic philosophy tends to muddy the waters in projecting trends. However, some general long-range macro-economic trends are stable enough for projection.

7.8.6.3 Infrastructure Changes

The infrastructure is a key major social investment and includes not only the highways and communications networks, but the buildings and the military industrial, education and medical support complex. Historically, infrastructure needs have driven technology implementation.

7.8.6.4 Commercial/Organizational Practices

Commercial practices tend to change slowly but represent major new opportunities. These include the "ways" business is done. In addition, changes in military doctrine and organizational operations likewise produce major changes in needs and products. These changes are technical such as no-till farming; economic such as consolidation of industries and operational such as continued cost cutting.

7.8.6.5 Social Trends

Social changes and roles also effect growth, products and opportunities. While these trends are often folded into the organizational practices they usually involve much longer time frames and can constitute more radical effects. These include the increase in working women and the roles of minorities in the past. In the future, the maintenance of working seniors may well constitute a major change.

7.8.6.6 Geopolitics

Global politics has always represented opportunities and threats for technology and business development. These involve the continuous economic development in various sectors and the stagnation of others. While much of this has been in the hands of governments in the past, more is becoming a part of the "free market" of labor, capital and demand. The potential impact of the Chinese and Indian economies are obvious, however, less obvious is the impact of regional economic agreements.

7.8.6.7 Technology Trends

Traditional technology assessment focuses on technology and its long-term trends. Previously we have discussed quantitative trend extrapolation of performance. However, that only covers those areas amenable to quantification. Many technology trends are qualitative in that they represent a general tendency for which data is often difficult to obtain.

7.8.6.7.1 Scientific Trends

Scientific research and trends in patent activity reveals the direction that science results can be expected in many cases. Scientific trends tend to follow what Thomas Kuhn[27]

[27] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, The University of Chicago Press (1970)

referred to as "normal science." Trends in areas such as pharmaceuticals and materials research are fairly stable. However, for truly break-through discoveries this is tricky. The problem here is differentiating between that which is truly new and useful from that which is "hype." Typically truly revolutionary discoveries take decades to generate useful products. As such, this problem is more theoretical for technology assessment than practical.

7.8.6.7.2 Manufacturing Trends

Changes in the methods of manufacture are more subtle and often more powerful than those from fundamental sciences. These trends are often stable over a considerable time frame. Things like continued electronic integration and use of digital solutions to mechanical problems fall into this category.

7.8.7 THE UNCERTAIN FUTURE

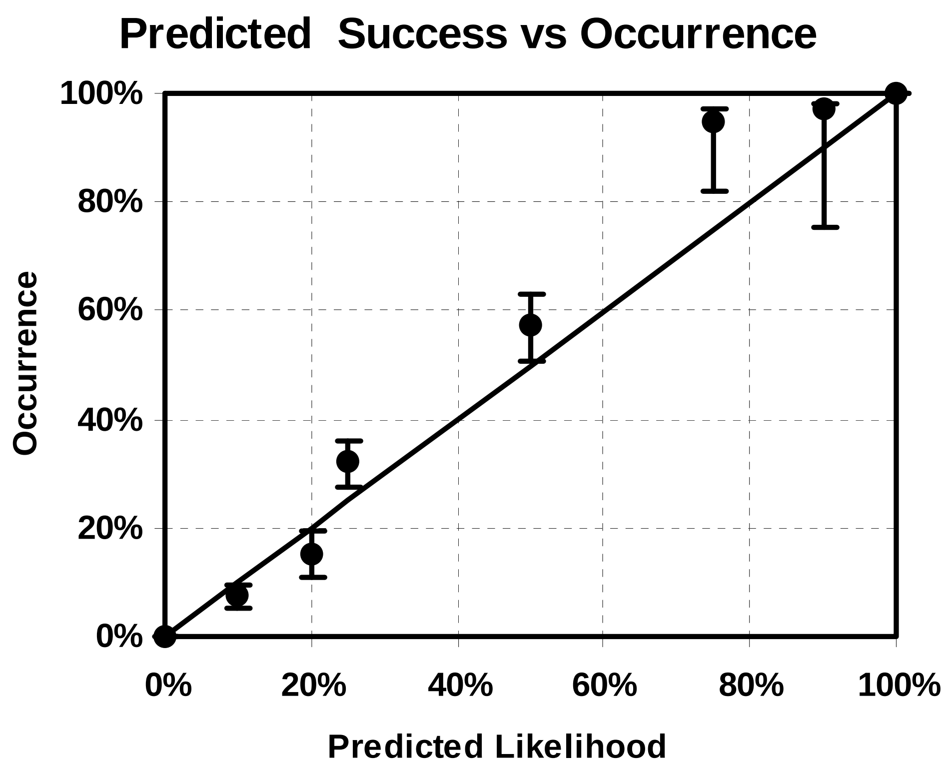
A key issue in effective technology assessment is estimating the uncertainty of events and results. This has always been a difficult and tricky activity. The goal, however, is not really a forecast but an estimate of riskiness.

7.8.7.1 Subjective Probabilities and Actual Occurrences

A fundamental problem with the future is that it has never happen before. Applying traditional probability estimates to such events is always presumptuous. If the future-events belong to a well establish family of occurrences, then we can apply standard stochastic modeling procedures to estimate future events. However, that is not usually the case. Typically, we rely on researchers and industry participants (experts) to estimate the likelihood of events. These are referred to as "subjective probabilities." In reality, they represent confidence that an event will take place. If the event is somewhat repetitive, these estimates can be fairly accurate at least as a general trend.

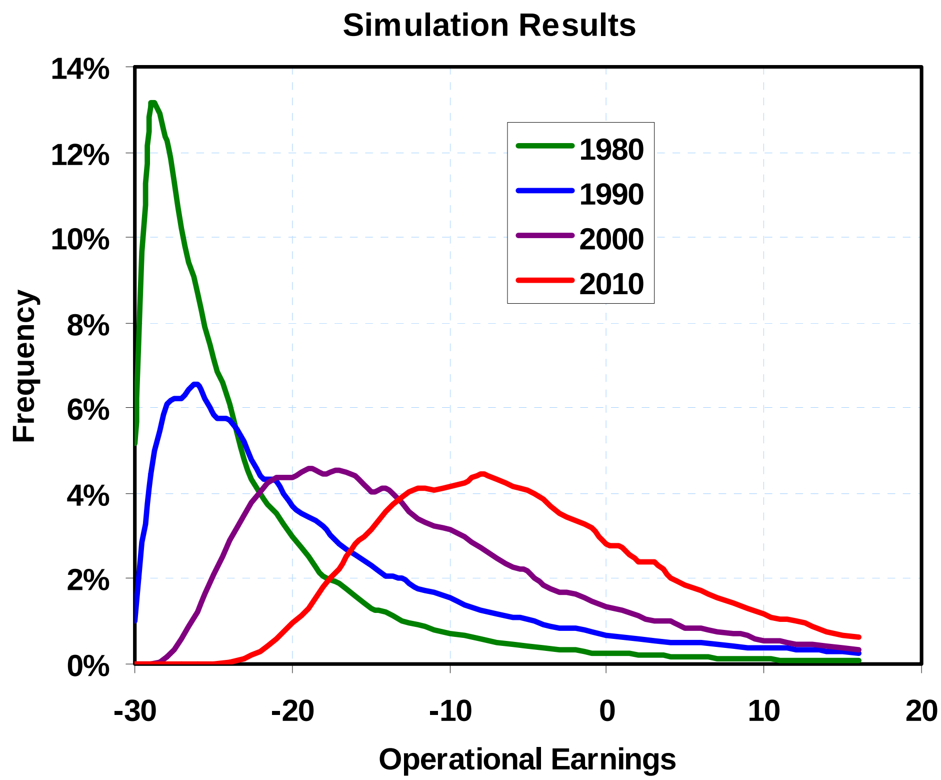
The chart below shows the results of subjective estimates of the likelihood of the success from the screening of pharmaceutical candidate compounds against the actual occurrences. Notice that the subjective estimates are low for highly occurring events and high for lower occurring events. This is typical for measures of confidence that tend to be logarithmic against the actual occurrences[28].

[28] This is similar to the effect on price based on Weber's Law of geometric perception.



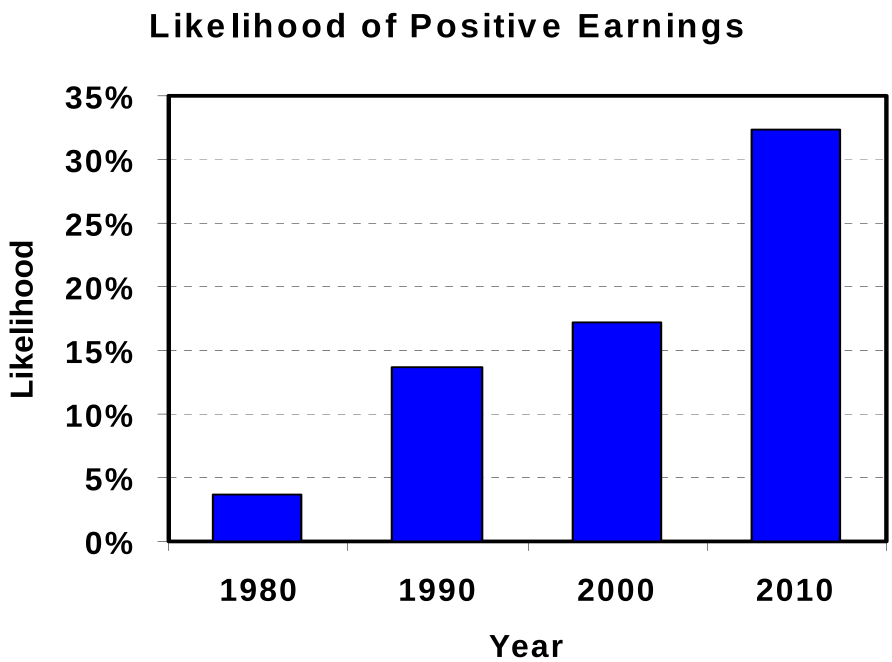
7.8.7.2 Latent Value Projection

Value dominates the acceptance of new technologies. Future value, however, is uncertain, That uncertainty is tied to the unknown future technology performance and market demand. If we can assume that the basic value relationships will remain intact for the foreseeable future then the uncertain lies in the parameters and value elements of those relationships. Value models can be used then to estimate future worth of technology concepts within the constraints and scope of those models. An example of this type of analysis is shown below. Each curve represents the probability distribution of value, in this case, for nuclear fusion power utility facility compared to a fossil fuel plant at a point in time.



The trick with this type of analysis is to estimate the probability distributions of the model parameters. It is necessary to distinguish between the distribution of opinions and the distribution of the likelihood of values. It is therefore, important to measure the range of values rather than relying on the distribution of expected values. In this case, the general range of likelihood of values far exceeded the differences of opinion.

Typically, the results are displayed in terms of the likelihood to meet some criterion. In this case, the issue was the likelihood of positive earnings over time. As can be seen in this case, there are usually to effects going on: (1) shift to higher performance and (2) the dispersion of the likelihood of performance. Both of these factors influence the final results. However, the broadening of the distribution reflects additional risk not captured by the simple likelihood of overall results.



7.8.8 Barriers and Accelerators of Expansion[29]

Forecasting and assessment based on opinions and general trends while involved are not structurally complicated. The problem lies in being "blind-sided." That is, ignoring the impact of events and conditions that make those trend irrelevant or, at least, those things that will postpone or accelerate change.

7.8.8.1 The "Killer Applications"

The software market has developed a concept of the "Killer Application" or "Disruptive Technology," which refer to products in such demand that they drive the market for all facilitating products and technologies. An example of this includes introduction of electronic spreadsheets and word processing, which then drove the market for of personal computers. However, the concept extends well beyond the personal computer market and covers all types of end-use products and services. The existence of such a "killer application" may be a prerequisite for the replace of old technology with new. The problem is that killer applications are not easily discovered. There appears to be two conditions that need to be met in addition to high value: (1) a moderate minimum market coverage and (2) low minimum acceptable performance.

[29] The important barriers of entry are discussed in detail by Michael E. Porter, *Competitive Strategy*, The Free Press (1980)

7.8.8.1.1 Minimum Market Coverage

While a significant market for the killer application must exist, only a small fraction needs to be in place for the application to have value. For example, e-mail has a much higher minimum market coverage requirement than did word processing. However, neither was low. For word processing, the minimum was driven by training and support requirements. For e-mail it is fundamental to its effectiveness. If the requirement is extremely high, the application may not be able to "get there, from here." It will be too high a hurdle. Technologies such as High Definition Television may have a relatively high minimum market coverage making it difficult to penetrate.

7.8.8.1.2 Minimum Acceptable Performance

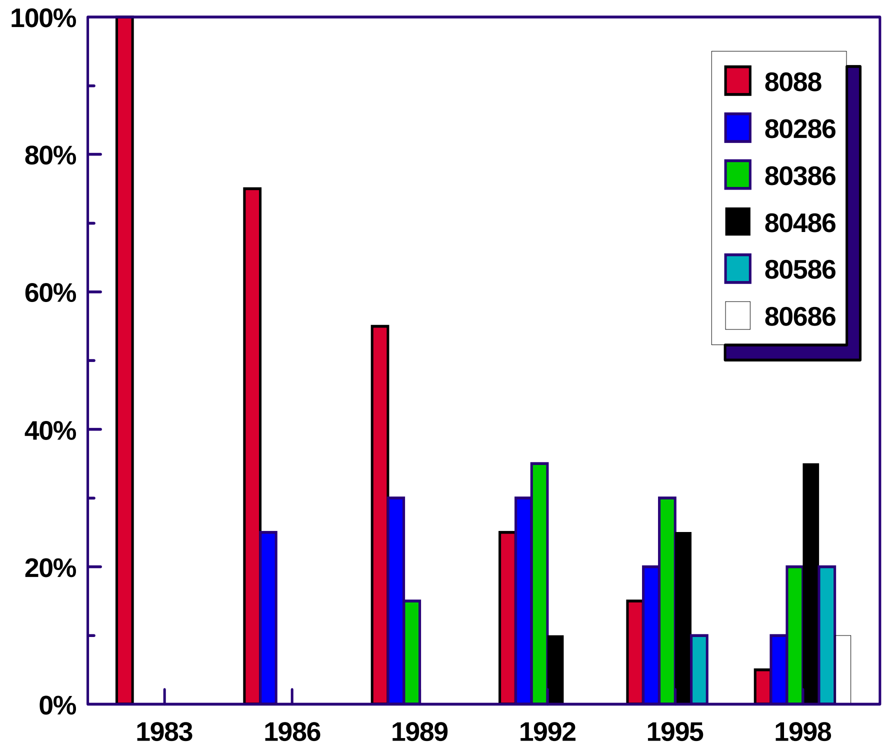
A less recognized constraint is the acceptable performance. Performance here refers to the ability of the user to use of the potential capability of the product. Traditional "Killer Applications" (Lotus 1-2-3 and Word Star) both had a very low acceptable performance. The product was only required to provide a minimum of its capabilities for the user to be satisfied. In fact, for most of these killer applications the limitation is on the user side rather than on the product. That is that the user need only be able to utilize a small fraction, typically less than 10%, of the packages capabilities to be satisfied. Applications such as voice-to-text (dictation), however, have a minimum acceptable performance probably greater than 98%. This is going to make this application difficult to effect the market.

7.8.8.2 Infrastructure Limitations

Lack of infrastructure has historically limited technology change. However, the reverse is also a major effect. Strong infrastructure has accelerated technology adoption. Most technologies rely on the available support and the existence of enabling infrastructure. The classical example is the US interstate highway system. Shortly after the Second World War, the United States government decided to invest in the interstate highway system. These infrastructure decisions affected thereby the expansion of the suburbs and the reliance on the automotive transport (cars, buses, and trucks). The downside was the weakening of rail transport. Europe had made different priority decisions and the resulting in a delayed expansion of automotive transport but the acceleration of rail.

7.8.8.3 The Installed Base

Old products do not disappear; they persist. As such, products that require recent supporting technologies can have a highly limited market. Below are estimates of the substitution of various generations of Intel type personal computer. While the total market expands, the diversity of system in use also increases. Software designed to take advantage of the newer capabilities will be itself be limited by the install base. Similarly, while broadband Internet service is "coming", for most private users, services is still limited by conventional modem speeds. This would limit the effectiveness of web site utilizing the new technologies.



7.8.8.4 Competitive Alternatives (Older Technologies)

Older technologies improve. This is a truism that has blind-sided assessment for years. The demand for new integrated circuit substrates has been based on the supposed limitations of silicon. However, designers and innovators have found ways around those limitations and silicon still dominates the substrate market. In general, the greatest strides in older technologies take place with the introduction of new “improved” technologies. It is therefore, critical to examine and track the capabilities of established technologies to determine potential competitive forces.

7.8.8.5 Competitive Innovations

While old technology represents barriers, new innovations represent threats. New technologies both real and promised can postpone the expansion of established technologies. However, unless the new innovations are readily converted into commercial products, they are likely to be only temporary restraints.

7.8.8.6 Environmental Constraints

Environmental constraints have been separated from other political issues because they are likely to be fundamental and not merely an issue of policy. While environmental constraints will materialize as regulations they represent an inherent challenge. Regulations are likely to follow rather than lead the environmental issues. It must be noted, that these environmental constraints are as likely to spawn opportunities and accelerate growth as they are to be barriers.

7.8.8.7 Social/Political/Legal Constraints

Governmental constraints involve both regulations as well as other “encouragements” such as tax law and public spending. It should be noted that direct and indirect public spending is a major portion of the total US GNP and even larger elsewhere. It should be noted that major changes in these policies are generally slow in developing. Trend analysis as well as opinion studies are widely available addressing these issues.

7.8.8.8 Social/Political/Economic Events

Within our communal memory, we have experienced wide spread war and devastating economic depressions. These are not merely minor events but can be catastrophic both has barriers and as accelerators of change. However, even less catastrophic and temporary effects such as natural disasters and run-up of prices such as with petroleum can have long term technology consequences.

7.8.8.9 Change in Orientation/Priorities

Much subtler are changes in social orientation. What is viewed as important will dictate to a great extent, how disposable funds are allocated. The changes in attitudes after the Second World War fueled the customer economy. But once again, such changes are usually caused by major events, but otherwise changes occur slowly.

