

**SWP 57/91 "WORLD CLASS MANUFACTURING VERSUS
STRATEGIC TRADE OFFS"**

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INTRODUCTION

It seems to have become somewhat fashionable to abandon the idea of inherent "trade-offs" within manufacturing strategy which were first discussed in detail by Skinner [1],[2], in favour of "The World Class Strategy". This view has of course been most strongly espoused by Schonberger [3], [4] who has even refrained from using the term other than in the rather evocative "T-word" form. It would seem regrettable that little real research evidence has ever been offered in support of the wholesale abandonment of trade-off models other than in the form of case anecdotes almost universally taken from high volume, repetitive manufacturing engineering products. We attempt here to provide a rather more balanced analysis of this apparent dichotomy in the hope of providing a rational model for future investigation.

THE WORLD CLASS MANUFACTURING MODEL

The world class manufacturing model is perhaps best summed up by Schonberger's own 19 points [4] as shown in Figure 1. Although individual elements of this list might be questioned in terms of how they might relate to specific industries (for example the pursuit of item 18 in certain capital intensive industries) as a general list it is difficult to challenge such statements of obvious good sense.

The Cranfield Competitive Edge Manufacturing model [5] has identified what these often mean in terms of a challenge to transform the main performance characteristics of manufacturing systems (see Figure 2) through six fundamental objectives for step changes:

1. Reduce inventory investment by 50% or more across raw materials, work in process and finished goods stock.
2. Reduce manufacturing lead times by 50% or more: there is of course a one-for-one correspondence of lead time with WIP inventory so this goes hand-in-hand with (1).
3. In order to compete in world markets it will be necessary to move to a much faster rate of product innovation with two or three times the current rate of innovation and at the same time to do this on development lead times which are only half those currently available.
- 4/5. Reducing the overall cost base by 30% or more must largely be achieved by reducing the 'support' or facilitating labour - the hangers on (e.g. expeditors, coordinators, materials movement, cleaners, etc.) - by 50%.

Finally, while doing all of this companies must move to thinking in terms of Parts per Million defectives in the manufacturing process. 1% sounds good until you see it as 10,000 PPM.

One thing is clear and that is that you cannot expect to get such fundamental changes from tinkering with the existing manufacturing system - getting a 2% benefit here and a 3% benefit there. The only way to achieve this sort of step change is to think in terms of throwing the whole manufacturing system up in the air and making it land in a completely different way.

Viewed as a historical progression over the last 30 years (figure 3) there has been a major shift of emphasis in 3 key areas of manufacturing systems: inventory, quality and automation.

Inventory	The lot-sizing cost minimisation focus gave way to the MRP focus; make sure everybody knows everything in the hope that they can make better decisions. The current JIT focus is eliminate the causes which made you need the inventory in the first place.
Quality	Quality also started with a cost-value trade ff to give an "economic level" of quality. In the 1970s the market value of good reliable quality started to become apparent (with e.g. Japanese TVs, HiFi etc). The new view is however to use quality to achieve other objectives - as a means of improvement in itself. The new focus is again to eliminate the causes which got the bad quality there in the first place.
Automation:	For most of its history automation has concerned itself with the substitution of capital for labour. This has usually resulted in greater output rates at the expense of flexibility. For example a manual packing line was very slow, but was very flexible and could be switched from product to product with ease. A high speed automatic packaging line may run at up to ten times the speed but it might also take 24 hours to changeover to a new product. The new focus is a complete reversal: use technology to achieve flexibility.

When we ask what is different about the 1990's and the 21st Century it is clear that

eliminate the causes of inventory
eliminate the causes of quality problems
and grow flexibility

do not disappear. What we add to these, however, is putting in place the "Learning Organisation". That is, to understand that the world is changing in ways which we cannot predict and that the essence of future success lies in having an organisation which can self change and self improve continuously. this is rather more than Schonberger's prescription for continuous improvement alone (Figure 1. item 3) which actually has a very limited horizon: there is little call for even the most efficiently produced slide-rules and bakelite mouldings.

THE CRANFIELD MANUFACTURING STRATEGY MODEL (INCLUDING STRATEGIC TRADE-OFFS)

The initial version of the Cranfield Manufacturing Strategy model was first presented in New 1979 [6] and the development of the seven key Competitive Edge Criteria followed in New and Sweeney (1984) [7] and in its current form is represented in Figure 4 (from [5]).

We translate the question "What do you sincerely want to be good at" into the question "what could we try to be good at". We call these the competitive edge criteria.

A company must choose an appropriate set of competitive edge criteria - those things it plans to compete on. It does this against a background of the corporate strategy, the environmental pressures which act upon it, the characteristics of the market in which it operates and of course the strategies of the major competitors. This is the subject of corporate strategic analysis and is not our prime concern here. The important point is that a company must decide operationally how it is going to compete in a market and then translate that into appropriate marketing and manufacturing strategies.

The Competitive Edge Criteria are:

DELIVERY

Lead Time

- The time the customer must wait between order placement and receipt.

3 Policy Types

- Make-for stock

Customer lead time expected to be zero

- Make-to-Order

Customer lead time
= total manufacturing lead time + backlog

- Assemble to Order

Customer lead time
= part manufacturing lead time + backlog

Reliability

- How reliable the company is in delivering a customer's order on or before the quoted delivery date.

2 Policy Types

- Make-for-stock
Reliability = Availability ex stock
- Make/assemble-to-order
Reliability is measured as
lateness relative to promised
delivery date

QUALITY

Capability

- The quality capability of a product is a measure of its relative 'usefulness' to the customer. It includes product features which might differentiate it from competitive products, e.g. small size, weight, added functions etc. It may also include such features as after sales service.

Consistency

- Quality consistency is concerned with how well the product conforms to its specification.

FLEXIBILITY

Design

- Design flexibility is concerned with the ability to produce products to a customer specification, rather than supply from a standard range.

Volume

- Volume flexibility is concerned with the capability to supply customers with large variations in total demand without affecting the lead time. Variations may be seasonal, cyclic or random. We may be concerned with total volume flexibility or with mix flexibility within the total volume.

PRICE

- The money price actually paid by the purchaser

The money price may include both initial purchase cost and expected "lifetime" costs.

Manufacturing strategy is primarily about what a single plant is capable of doing successfully - a "corporate" manufacturing strategy would cover only those items which would be common across all plants (not very much generally).

When a company has decided which of the competitive edge criteria a plant is to compete on, this choice must be translated into an appropriate marketing strategy and a supporting marketing mix. This is often expressed in terms of the 4P's of the marketing mix:

Product: What you are going to sell
Promotion: How you are going to sell it
Price: How much you are going to charge for it
and Place: How you are going to distribute it.

It should also be translated into an appropriate manufacturing strategy and a supporting manufacturing mix. The dotted line in the model diagram indicates that this is rarely done in a coherent way.

There are also 4P's for the Manufacturing Mix:

Plant: The physical location itself
Process: The technology and flow organisation used
People: The employment policies used
and Product: The structure of the product in manufacturing terms

In order to deliver successfully a particular set of competitive edge criteria in the market place a plant must use an appropriate manufacturing mix. No marketing director would consider using the same marketing mix to sell: A standard product produced for sale ex-stock, As he would to sell: A customised high feature special product on a short reliable lead time at a price premium. Yet often we see orders for both flung into the same manufacturing mix with the expectation that they can be made equally well. It is appropriate to ask "if you need a different marketing mix what makes you think you don't need a different manufacturing mix?"

When we examine many corporate strategy documents the manufacturing strategy (if you can find it) often runs something like this:

Deliver on the shortest lead time,
always on time
A product with better features than the competition
made perfectly
to any design the customer wants,
in any volume he wants,
and by the way be the cheapest in
the business!!

This is not a statement of manufacturing strategy - more a set of pious incompatible hopes. Moreover there is no such thing as a non-decision in manufacturing strategy: make no mistake about it if you fail to set directions at the strategic level you will leave the definition of the actual (resulting) manufacturing strategy by default to operators, purchase clerks and schedulers - who will of course make local decisions which are unlikely to form a single coherent strategy at all.

Whenever the question of trading-off these competitive edge criteria arises the usual marketing response is: "Our business is different, in our business we need all the criteria". Before we consider this let us note that there are actually two qualitatively different forms of competitive edge criteria.

MARKET HYGIENE FACTORS (after HERZBERG)

Hygiene factors allow you to "play the game". They will never win you orders - though they lose you orders very rapidly if you cannot meet them. For example in some markets ex-stock supply is essential - customers will not wait any time at all for delivery, while in other markets standard products are useless and product customisation is essential even to be considered as a supplier.

COMPETITIVE EDGE FACTORS

Are those criteria on which you can compete, such as product features or by offering shorter lead times than the competition.

If you really do have a market which requires all the criteria then presumably all you need to do is be at least as creative as the competition - after all they must have the same problem. We should, however, ask what would happen in this market if one of the (probably small flexible) competitors decided to compete on quality features and design flexibility on a short reliable lead time - concentrating on the up-market specials, while another competitor (probably large and dominant) decided to compete by producing cheap standard products sold ex-stock and leave the specials to someone else.

Would the company sitting on the fence really be able to compete with either? Traditionally the manufacturing strategy model offers two solutions:

- (1) Change the strategy, rank the criteria and focus the plant on specific criteria
- (2) Use the marketing solution and segment the problem. The segments may be managed by using different manufacturing mixes in different plants (the Focussed Plant approach) or by segmenting the plant itself using a PWP or Plant-within-a-Plant approach.

In trying to assess its positioning against the market place a company must therefore ask three fundamental questions:

1. What do the customers want?
2. How does the company performance compare with the competition?
3. Does it matter?

In developing a manufacturing strategy we ask these questions in relation to the competitive edge criteria which we can influence through the manufacturing system (there are of course other factors such as distribution channels etc. which are not directly influenced by the manufacturing system). The basic proposition is that for every manufacturing mission there is a corresponding manufacturing mix that will help in delivering the competitive edge criteria. But every manufacturing mix is a set of decisions about trade-offs and however good you get at minimising the effects of the trade offs they will not all go away. You can certainly get better at everything simultaneously but some trade offs particularly those associated with levels of customisation/standardisation will not go away.

The levels of relative support which the manufacturing mix can offer have of course been discussed by Hayes and Wheelwright 1984 [8].

The Manufacturing Flexibility Model

The third major research area which is relevant to this debate would appear to be that related to manufacturing flexibility. Slack[8] and Chambers[9] have discussed the role of flexibility in the context of manufacturing strategy. In particular Slack's Range/Response dimensions model (Figure 5) is extremely useful in focussing attention on the four areas of flexibility identified:

PRODUCT
MIX
VOLUME
and DELIVERY

and also in distinguishing between possible(technological?) range and the ease with which changes can be made (response flexibility). This model has, as can be seen by comparing the variables considered, a close affinity with the Cranfield Competitive Edge Criteria Model.

World Class Manufacturing and the New Strategic Trade Offs

In order to understand the real and potential impact of the so called World Class Manufacturing Model on the traditional trade-offs associated with the manufacturing strategy model we will consider some of the classic trade offs and the ways in which these have changed over time, while taking account of the manufacturing flexibility model.

1. Lead Time v Delivery Reliability

Conventional: In the make to order business, quoting a short lead time puts you at risk in achieving this lead time.

New Wisdom: High process repeatability and low buffers can give short and reliable lead times

2. Quality Capability v Quality Consistency

Conventional: Very high quality/specification products are more difficult to make properly so consistency (conformance to specification) suffers accordingly.

New Wisdom: Attaining high quality levels is more difficult but quality consistency has become a market hygiene factor in most sophisticated markets (but see also 3 and 4 below)

3. **Quality Consistency v Price**

Conventional: Consistently good quality costs more to produce and deserves higher prices.

New Wisdom: Quality consistency is a hygiene factor in most sophisticated markets and actually costs less in total

4. **Quality Capability v Price**

Conventional: High quality features (high specification) in a product costs more to produce.

New Wisdom: BMW's still cost more than SKODAS!

5. **Design Flexibility v Leadtime**

Conventional: Customised products can only be made to order on long lead times

New Wisdom: Modular "mushroom" products allow very short response times but true customisation still takes longer to supply than an equivalent standard product

6. **Design Flexibility v Price**

Conventional: Customised products cost more to produce than similar specification standard products

New Wisdom: Modularity can give high variant flexibility, but unique customisation is still more expensive to produce unless the specificity is trivial.

7. **Lead Time v Volume Flexibility**

Conventional: If volume flexibility is low then lead times must vary in order to balance load and capacity in the make to order business

New Wisdom: WCM type plants give greater volume flexibility which in general reduces the effect of this trade off significantly

In general, while the pursuit of manufacturing flexibility in all its forms is obviously likely to be advantageous in any manufacturing system, there still remains the fact that a plant which produces a single product is capable of being more "efficient" than one which attempts to make 786 different variants.

We have discussed here some of the most obvious single trade offs and these are summarised in Figure 6. A tentative conclusion from Figure 6 is that while several of the conventional trade offs have been eliminated there are just as many which remain while others have been affected in degree but not in substance. In particular we note that those trade offs which are concerned with

QUALITY CAPABILITY and true DESIGN FLEXIBILITY

are still highly relevant to the choices which companies make in relation to the most appropriate Manufacturing Mix for their Competitive Edge Criteria.

The key manufacturing strategy issue of the Competitive Edge Criteria is "can you be the best in the world at all seven criteria simultaneously from the same manufacturing mix?". We believe that the answer to this question is still NO and that this is supported by the case examples (disguised to avoid embarrassment to the companies concerned) summarised in Figure 7, and discussed briefly below:

Babcock & Wilcox

A familiar case in manufacturing strategy: the key trade off is Quality Capability v Price (via the cost structure) and the issue the cost of achieving the appropriate level of technical quality. The achievement of nuclear quality standards is still more expensive than the achievement of standard pressure vessel standards.

Multichem Corporation

A multinational chemical corporation asked its process/product engineers to build it the lowest unit cost plant in the world to produce a certain type of plastic. Two and a half years and \$1000million later the plant was delivered to manufacturing: a 27 stage synthesis continuous process plant with a 60 day cycle time. They then discovered that they needed to make 70 different product variants! The only solutions? Limited range supply- not acceptable to the market, or run it with a different variant in each synthesis stage. They currently have the highest unit cost plant in the world for producing 70 variants and are stuck with it for the next 20 years!

Eurofoods

Have had a 5 million pound high speed glass jar bottling line mothballed for the last four years because 6 months before product launch marketing announced that the product had to be sold in a composite pack not a glass jar. Unfortunately in order to keep the capital cost down the installed line could not be used to pack other products as it did not have the required size flexibility.

Electrocon Ltd.

A producer of highly customised electronic connector products had just had a one hundred thousand pound capital equipment purchase authorised by head office (justified on a unit cost reduction basis) before they realised that its installation would have completely ruined their high customisation/rapid response market strategy. The technology was totally inappropriate for their market place, though of course all the high volume low cost standard connector producers used the technology very successfully. Fortunately they had not actually ordered the machine.

Food Coolers Inc

A world leader in industrial cooling equipment produces both standard climate control systems and highly customised systems for specific food manufacturing plants. Many components are common but because of the nature of the manifold connections which are required to achieve certain design characteristics it is impossible to use modular solutions. Moreover the custom portion is a critical manufacturing process which cannot be started in advance of the product specification. Custom coolers are more expensive and take longer to supply than standard coolers of an equivalent capacity.

Cigo Filter International

Cigo Filter manufacture a multitude of cigarette filters for world markets. They initially dismissed the manufacture of a polypropylene filter as too cheap and nasty for people to consider. Unfortunately a competitor undercut them dramatically on price in supplying the enormous Chinese market with a filter which was impossible to sell in western "sophisticated" markets.

These case examples illustrate only a sample of the range of trade off decisions with which companies are faced. The World Class Strategy approach purports to claim that no such trade offs exist and that it would have been possible to solve the problem another way. However in the case of Cigo Filter for example it is a little difficult to see how; the company produces filters faster than anyone else in the world on the same machines that the competitors use with a raw materials cost of around 70%. Unfortunately for them polypropylene costs only about half of the cost of the normal raw material of the filter!

We would suggest that it is time to stop indulging in emotive attacks on the T-word syndrome and return to a reasoned rational approach to the analysis of real manufacturing strategy issues. It is, moreover, appropriate to note that Schonberger's own arguments in relation to this issue have become at the very least confused not to say totally inconsistent in [4]. In chapter 2 "Universal Strategy: The Shattering of Strategic Business Thought" we are invited to believe that:

"World class(WC) business strategies may be reduced to a single set,applicable to all businesses", I wonder what happened to competitive advantage? The author continues with the "myth of trade offs" and of course the "dreaded T-word". However the same chapter simultaneously assumes "economies of scale" in manufacturing processes and recommends us to "rank, don't trade". We are left wondering exactly what the difference is. In chapter 3 we are further presented with the focus factory model and the example of Copeland Corporation's restructuring along classic manufacturing strategy lines. Presumably there are no trade offs to be made in choosing the appropriate Copeland manufacturing mixes? Perhaps it would be a good idea for journalists to stick to journalism rather than indulge in gross simplifications for the sake of sensationalism without any research basis.

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General

1. Get to know the next and final customer
2. Get to know the competition
3. Dedicate to continual, rapid improvement in quality, cost, response time, and flexibility

Design and Organization

4. Cut the number of components or operations and number of suppliers to a few good ones
5. Cut the number of flow paths (where the work goes next)
6. Organize product- or customer-focused linkages of resources

Operations

7. Cut flow time, flow distance, inventory, and space along the chain of customers.
8. Cut setup, changeover, get-ready, and start-up time
9. Operate at the customer's rate of use (or a smoothed representation of it)

Human Resource Development

10. Develop human resources through cross-training (for mastery), continual education, job switching, and multiyear cross-career reassignments
11. Develop operator/team-owners of products, processes, and outcomes

Quality and Problem-Solving

12. Make it easier to produce or provide the product without error (total quality)
13. Record and retain quality, process, and problem data at the workplace
14. Assure that line people get first crack at problem-solving—before staff experts

Accounting and Control

15. Cut transactions and reporting; control causes not costs

Capacity

16. Maintain and improve present resources and human work before thinking about new equipment and automation
17. Automate incrementally when process variability cannot otherwise be reduced
18. Seek to have plural instead of singular workstations, machines, and cells or flow lines for each product or customer family

Marketing

19. Market and sell your firm's capability and competence

**FIGURE 1 PRINCIPLES OF WORLD-CLASS, CUSTOMER
DRIVEN PERFORMANCE**

FIGURE 2

THE CHALLENGE OF

TRANSFORMATION: STEP IMPROVEMENTS

1. REDUCE INVENTORY INVESTMENT BY 50% OR MORE
2. REDUCE MANUFACTURING LEAD TIMES BY 50% OR MORE

MONTHS -> WEEKS
WEEKS -> DAYS
DAYS -> HOURS

3. INTRODUCE NEW PRODUCTS AT TWO/THREE TIMES THE EXISTING RATE ON 50% OF THE CURRENT DESIGN/DEVELOPMENT LEAD TIMES
4. REDUCE COSTS BY 30% OR MORE
5. REDUCE "SUPPORT" LABOUR BY 50% OR MORE
6. IMPROVE QUALITY TO PARTS PER MILLION
1% = 10,000 PPM

FIGURE 3 KEY SHIFTS IN EMPHASIS IN 3 CRITICAL AREAS

	LOT SIZING	MRP	JIT
INVENTORY	FOCUS: <u>MINIMISE COST</u>	<u>MAXIMISE DATA FLOW</u>	<u>ELIMINATE CAUSES</u>
QUALITY	ECONOMIC QUALITY	MARKET VALUE	MEANS OF IMPROVEMENT
	FOCUS: <u>COST-VALUE</u> <u>TRADE-OFF</u>		<u>ELIMINATE CAUSES</u>
AUTOMATION	MACHINE-LABOUR SUBSTITUTION		TECHNOLOGICAL FLEXIBILITY
	FOCUS: <u>STANDARDISATION</u>		<u>FLEXIBILITY</u>

60'S

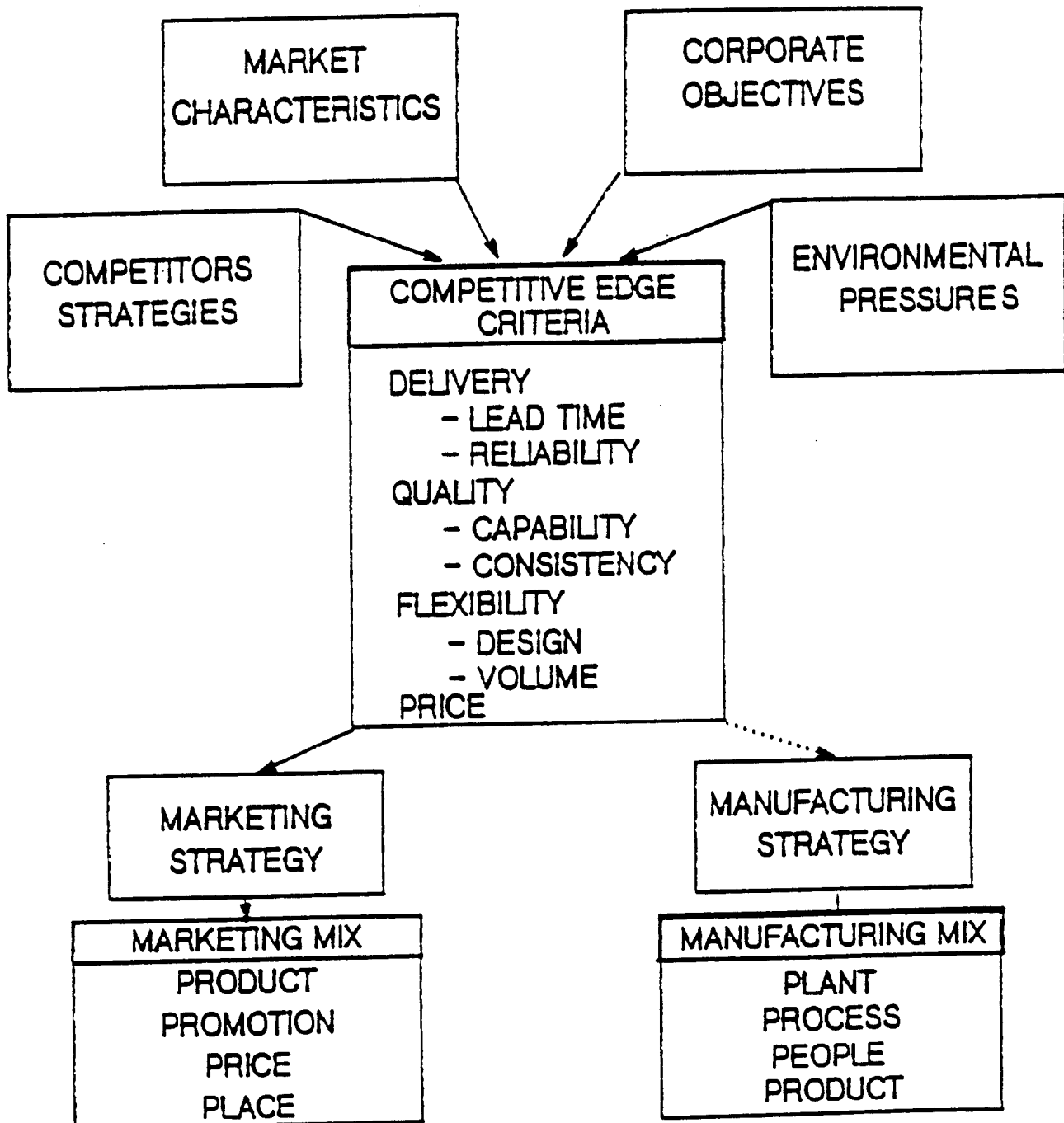
70'S

80'S

FIGURE 4

MANUFACTURING STRATEGY

FRAMEWORK FOR ANALYSIS



	RANGE	RESPONSE
PRODUCT		
MIX		
VOLUME		
DELIVERY		

FIGURE 5:

**THE RANGE/RESPONSE
FLEXIBILITY MODEL (SLACK) [9]**

TRADE OFF?	TRADITIONAL	NEW WISDOM
LEAD TIME V DELIVERY RELIABILITY	YES	NO
QUALITY CAPABILITY V QUALITY CONSISTENCY	YES	NO
QUALITY CONSISTENCY V PRICE	YES	NO
QUALITY CAPABILITY V PRICE	YES	YES
DESIGN FLEXIBILITY V LEAD TIME	YES	YES
DESIGN FLEXIBILITY V PRICE	YES	YES
LEAD TIME V VOLUME FLEXIBILITY	YES	REDUCED LEVEL

FIGURE 6. TRADITIONAL AND NEW MANUFACTURING WISDOM TRADE OFFS

COMPANY	KEY TRADE OFF	ISSUES
BABCOCK & WILCOX (NPV)	QUALITY CAPABILITY V PRICE (COST)	COST OF ACHIEVEMENT
MULTICHEM CORPORATION	MIX FLEXIBILITY V PRICE (COST)	COULD IT BE DIFFERENT
EUROFOODS	MIX FLEXIBILITY V PRICE (COST)	SHOULD IT HAVE HAPPENED
ELECTROCON LTD	LEAD TIME V PRICE (COST)	APPROPRIATE TECHNOLOGY
FOOD COOLERS INC	DESIGN FLEXIBILITY V LEAD TIME & PRICE	MODULAR SOLUTIONS IMPOSSIBLE
CIGO FILTER INTERNATIONAL	QUALITY CAPABILITY V PRICE (COST)	PRICE SENSITIVE CHINESE MARKET

FIGURE 7. CASE EXAMPLES: WORLD CLASS MANUFACTURING VERSUS STRATEGIC TRADE OFFS