MANUFACTURING: COMPETITIVE EDGE OR CORPORATE MILLSTONE

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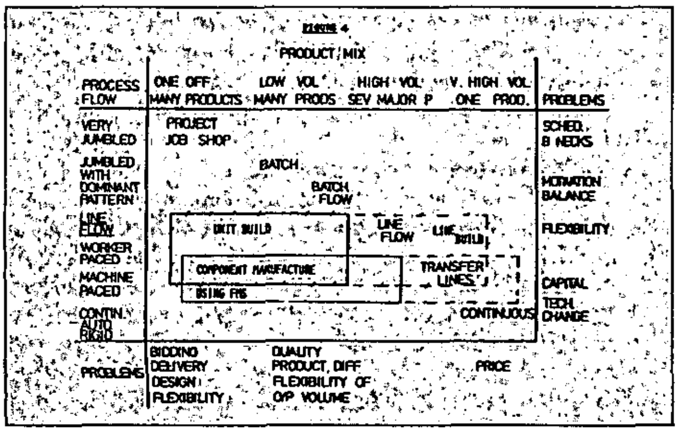
PART II

It is now appropriate to consider the relative importance of the other major attribute of FMS technology; that is its flexibility.

4. The Impact of New Manufacturing Technologies on the Product Process Matrix

The product-process matrix is a convenient way of describing the way in which certain types of manufacturing process match with the sort of market requirements which we discussed above. The simple matrix is shown in figure 4 in which the two axes describe the product mix characteristics and the process flow characteristics. At one extreme of the product mix we identify the plant manufacturing many different products most of which will be essentially "one-offs", that is, many product/low unit volumes. Moving along the axis the number of products tends to decrease while the unit volume increases until at the other extreme we find the high volume/single product dedicated plant.



At one extreme of the process flow axis we identify the highly flexible, jumbled, general purpose system where no clear flows are identified. Moving along this axis flows gradually become more defined until again at the other end we have a rigid flow pattern defined by the plant engineering itself.

It is not our purpose to discuss this concept in more detail here, suffice it to say that conventional wisdom has in the past dictated that *suitably matched* manufacturing system/market structures can be found along the downwards left — right diagonal: at one extreme we see the "job shop" at the other the custom built continuous process chemical plant.

Three general observations must be added to this:

(a) The technology determines the extent of the diagonal over which an *industry* can operate.

(b) Different companies/plants can choose to operate at different points along the diagonal.

(c) Different segments of the manufacturing process within a plant may operate using different segments along the diagonal — typically job shop component manufacturing with line assembly processes.

Finally, a major consequence of attempting to operate off the diagonal (e.g. by attempting to supply many different product variants from the same high volume line process) is significant inefficiency and cost penalties.

While all this has been demonstrably true for traditional manufacturing technologies in engineering the advent of FMS, automated assembly and robotics is likely to revolutionise this traditional thinking. In particular as is shown in figure 6.

FIGURE 6

SPECIFIC COMPONENT MACHINING

	TRADITIONAL DEDICATED LINE	AUTOMATED FLEXIBLE LINE	VARIANCE BETTER (WORSE)
CAPACITY (UNITS/DAY)	600	780	180
CAPITAL COST	100%	200%	(100%)
UNIT COST	100%	79%	21%
NO. OF MACHINES	42	27	15
FLOORSPACE (SQ.FT)	8022	6462	1560
HEADCOUNT	88	24	64
RETURN ON INVESTMENT	79%	29%	(50%)

(a) Component manufacturing using FMS technology makes it possible to cover an extremely wide range of the product mix variety/volume combinations, in the long term to even include the very high volume transfer line systems. At the lower end of the scale, short term flexibility is the key note since many varieties of components can be processed simultaneously. At the high volume end it is not short term flexibility which counts but rather long term flexibility. While the initial cost of setting up flexible systems to cope with high unit volumes will be higher than for equivalent output custom built systems, the demand for shorter life cycle products will increasingly make the customised system uneconomic — there is simply not enough life in the product to justify the investment required. In comparison the flexible system, although more expensive, offers a much longer useful life because it can be switched relatively more easily to new products/designs.

(b) Similarly in assembly processes the application of automatic sensing equipment and automated assembly will make it possible to cover the range of assembly volumes shown from low volume unit build systems based on single work stations to the multi station line systems typical of high volume production.

Both of these possibilities force us to consider the impact such moves are likely to have on the structure of markets. Will it mean that the current high volume/standard product producers will be able to take over the low volume/special product markets or that the special product producers will find it easier to compete on price with the standard product manufacturers? The one consequence which is clear is that the new technology removes the opportunity for achieving differentiation through manufacturing — though it will still of course be possible to achieve marketing differentiation.

5. Technology and Flexibility

Until the most recent developments in manufacturing technology conventional wisdom has equated increased levels of automation with higher up-front capital costs (but usually lower unit-costs) and reduced flexibility. This is

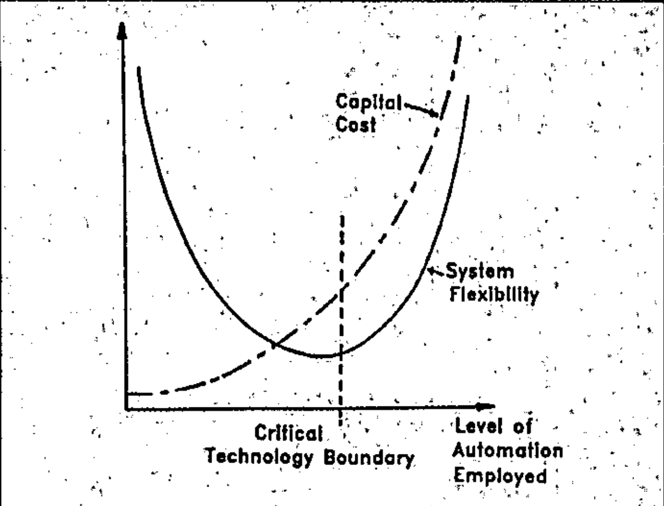


Figure 5.
CAPITAL/AUTOMATION/FLEXIBILITY TRADE OFFS

illustrated by the first section of the curves of figure 5 up to the critical technology boundary. However, the latest technologies in batch production have at last switched the flexibility curve around although the capital cost has continued to rise fairly steeply.

As we pointed out earlier in discussing the effects of FMS technology on component manufacturing this increase in flexibility is of major significance to the long run unit cost structure in high volume production systems. While it may well be considerably cheaper in up-front capital to build a dedicated system the uncertain product life with which many companies are now faced may well prevent adequate utilisation of the capital investment. However, this factor is extremely difficult to handle in traditional investment appraisal methods.

Figure 7.
MISCELLANEOUS MACHINING – 30 PRODUCT SETS/DAY

	TRADITIONAL DEDICATED LINE	FLEXIBLE LINE	VARIANCE
CAPITAL COST	100%	163%	(63%)
NO. OF MACHINES	16	3	13
FLOORSPACE (SQ.FT)	3333	1500	1833
HEADCOUNT	26	6	20
RETURN ON INVESTMENT	152%	63%	(89%)

6. Technology and Investment

Throughout UK manufacturing industry there has been a major failure to invest in new manufacturing and product technology which has given rise to a lack of competitiveness particularly against foreign producers.

Three major reasons for this are readily identifiable:

6.1 Inadequate Tools of Financial Analysis

Figures 6 and 7 show typical comparisons between the characteristics of dedicated and flexible manufacturing systems for the manufacture of a specific component and a set of different components (Hunter, 1984). In both cases we see cost increases of 2.0 x or 1.6 x for the capital costs and despite fewer machines and people and less floor space the apparent Return on Investment is considerably lower for each of the flexible systems. However, these ROI's typically reflect only those returns attributed to traditional costing elements such as labour and inventory costs, increased machine efficiencies and energy costs. They do not in general take proper account of a large number of other factors such as:

1. Higher Market Penetration due to Short Reliable Lead Times.
2. Repeatability of Quality and Decreased Waranty Costs.
3. Process Dependability Through Deterministic Scheduling.
4. Future Inflation of Labour Costs.
5. Volume Flexibility for Market Response.
6. Recruitment/Layoff Costs.
7. Increased Utilisation.
8. Life Span of Investment Due to Product Changes.

The truth is that while the costs and risks are readily identified the payoffs are difficult to quantity or include in the analysis.

6.2 The Communication Gap

The gap in communication between manufacturing engineering and senior management has always been a problem but the new technologies have brought this to a new level of significance. To be fair senior management have been right to be sceptical in the past and their faith has hardly been restored by the failed promises of the benefits from individual machining centres put into traditional environments. What is needed today is manufacturing engineers with vision and a wide market perspective who are not afraid to raise capital expenditure proposals for figures 10 or even 20 times the corporate norm. On the management side too we need a long term perspective, a commitment to major changes in organisational structure and the will to make it work.

6.3 Risk Aversion: Fear of Failure

Most European and particularly most UK managers suffer from a severe form of risk aversion. The reasons for this are complex and cultural but the underlying problem is fear of failure on the part of the individual. In the United States it is readily accepted that if you try lots of innovation some of it will fail but there need be no stigma attached to the individual managers involved in the failure (unless it is clearly caused by incompetence or mismanagement) — it is better to have tried and failed than not to have tried at all. In Japan individuals are perceived to be carrying through a consensus decision so that failure (or success) is shared by all and again no stigma attaches to the individual. In the UK however, two factors seem to govern many aspects of managerial behaviour particularly in manufacturing:

(a) Most managers see themselves as being in their current job for a very limited time span (2 – 3 years).

(b) Visible failure in their current position will prevent further progression whereas visible success will guarantee their onward progression in the organisation.

The snag with having these two factors together is obvious — it leads to short term decision making and strong risk aversion.

Of course there will be difficulties with implementing new technologies, of course there will be teething troubles and loss of output and of course there will be extra costs not known at the start of the projects. However, how many new investments can you think of that have not *eventually* met most of the initial objectives? Remember that even though the individual manager may only be in place for a relatively short period the organisation is intended to continue indefinitely — we are in this for the long term not for the 'fast buck'.

This problem lands us right back in the issue of manufacturing strategy with which we started — the reality is that the implementation of radically new technologies must be driven through the manufacturing strategy set by the senior management who do (or should) take the long term view.

Obviously there are companies who have solved some of these problems and many of them are no doubt with us today. I cannot but contemplate, however, a very large UK corporation sitting considerable financial assets that has virtually declared to its various operating companies. "Sure you can have the money but we hold you personally responsible for anything that goes wrong and of course you must continue to meet all the short term financial objectives". The result is inevitable: investment is of the 'tinkering' variety on cost-saving projects and the central cash mountain grows. If the corporate objective is to become an investment bank, fine, but if it isn't the long term prospects for manufacturing look bleak.

7. The National Competitive Stance

We have so far examined the problems of developing appropriate manufacturing strategies incorporating new technologies within companies. Let us return now to the second part of my original proposal, that is, that the same symptoms show up in our National Competitive stance.

It is my proposition that decisions have been made without reference to overall national goals or world market strategy which have tied our manufacturing industries into facilities, personnel policies and systems which are totally inappropriate for a developed economy. This is in sharp contrast to the Japanese experience. By this I certainly do not mean to imply that all individual UK manufacturing companies are poor performers in world markets. Some UK companies are indeed amongst the best in the world in particular sectors. The tragedy is that they seem to be becoming rarer.

The driving force behind the UK's need to prosper in world markets is that there is no real alternative. Despite having one of the most efficient agricultural sectors in the world the UK still has to import about half of its total food consumption. The only way in which this can be paid for is through the sale of manufactured goods or services. In theory some would claim that a service based solution exists for the UK. I do not propose to discuss this alternative now but it is not to my mind a practical solution.

With the emergence of the advanced developing nations in the world economy the strategy of being a low unit cost producer of relatively standard products has become increasingly untenable in most industries for plants situated in the developed countries. It follows that such plants must move up-market in terms of features or quality or must move to produce different product sets. Does the current content of the UK's manufactured exports support this view? Let us examine the evidence.

7.1. Value per tonne of Engineering Exports

Value per tonne is a fairly crude measure of the technological content of manufactured goods — the higher the technology the higher the value per tonne. It is not a perfect measure but it does provide a reasonable indication of *relative* sophistication — within a particular product group.

One of the things I keep noticing when I visit manufacturing plants in a number of different industries, is the origin of recently installed equipment. I thought therefore that I would take as my example the machine tool industry — many will accuse me of being deliberately unfair to the UK. My point, however, is that it is merely the forerunner of the route others will follow if we don't see some action soon.

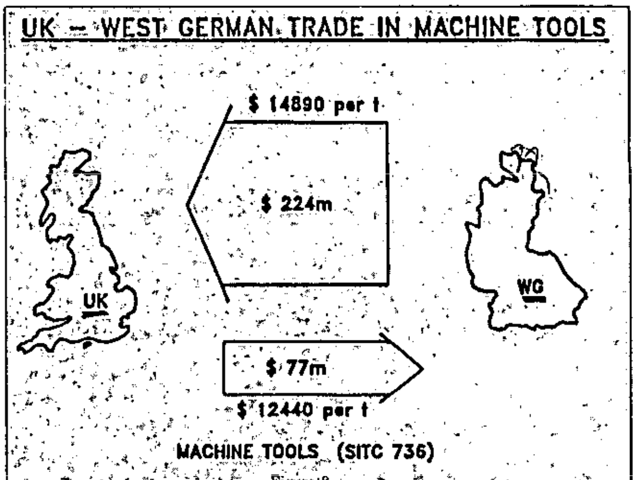


Figure 8

Looking first at West Germany as being our most obvious comparison country. Figure 8 shows the balance of trade between the UK and WG in terms of total $ value and value per tonne. Apart from the obvious trade deficit, note also that the equipment the UK buys from WG has a value/tonne 20% higher than that which UK sells to WG.

If we extend this to world markets we see that the UK has a small positive trade balance of around $90M against WG's balance of $2320M. The more worrying aspect is that in the UK's case the average export value per tonne ($8800) is only 73% of the import value per tonne whereas for WG the export value per tonne is 140% of the import value per tonne.

For a highly developed economy our expectation might be that exports would be of a higher 'technology' than imports and the ratio should therefore be greater than one. Within a particular narrow product group this argument becomes complex: for example a country capable of exporting highly sophisticated numerically controlled machines should surely be able to produce standard machine tools for home consumption without having to import these low technology products. But this argument brings us back to our original proposition: a plant capable of producing the high technology product will not be suitable for producing the standard product as well and high labour costs and resource constraints will probably lead to concentration 'up-market'.

Before we get too depressed let us just consider the WG/UK/Japan trade in machine tools. This shows, as we would expect, that both WG and UK are in deficit to Japan ($35M and $71M respectively) in this trade category but what is really quite interesting is the characteristic of the exports to Japan in both cases. The values per tonne ($23,000 and $19,000 respectively) of the goods shipped into Japan are significantly higher than the value per tonne ($12,000) of the Japanese exports. The West German volume ($77M) and value per tonne ($23,000) above all else shows that if you can make a better mousetrap you can sell it *even to the Japanese!!* Moreover, as the Japanese are now discovering to their cost in industries such as steel and shipbuilding they cannot stay at the low value per tonne figures in the long term either. Given the success which the Japanese have had in penetrating consumer markets the writing is already on the wall for the capital goods industries which do not put their house in order.

The same story is true across many other sectors of our manufacturing industry and the overwhelming conclusion is that relative to our close competitors the UK exports at the low technology end of many markets and imports at the high technology end. The practical consequences of this are readily visible in our own manufacturing plants: from where does one buy high speed packaging machinery or sophisticated high speed production machine tools? The appropriate machinery is either not available from UK suppliers or the foreign equipment is simply more advanced or provides better performance.

7.2. Criteria for Success for UK Engineering Exports

Returning to the criteria for success with which we started, the criteria for exports from a developed economy which must earn enough to pay for its food requirements are probably:

- Reliable delivery
- Short delivery times
- High product quality and reliability
- High design flexibility
- Volume flexibility
- Premium price

In short: High technology products competing on design, special features and short reliable delivery at a price premium.

In comparison the current apparent market characteristics for many UK exports are:

- Uncertain delivery
- Long delivery quotations
- Low level (but not necessarily poor) quality and reliability
- Low design flexibility
- Low price

In short: Low technology products competing mainly on price.

I realise that this is a gross oversimplification and is very unfair to many UK manufacturing companies but we cannot escape the inevitable conclusions inherent in the overall picture. The UK is still exporting far too much in relatively low technology products to developing and advanced developing countries which will soon be able to produce such products for themselves.

It *is* possible to pursue the low cost producer route in some industries (particularly those requiring little unskilled labour) but again only if the investment is made in the necessary technology now, and only if the company has the appropriate market share — if you are not already the dominant low cost producer in the world market, it's a bit late to start!

8. Conclusions

I would like to leave you with a task to take home. As an academic at the last session of the conference it would seem appropriate to leave you with some homework — please come back next year and tell us all how you have solved it. As a public servant of course my salary depends on it — at least until the Business Schools are privatised!!

Question One is easy because I am going to give a hint at some of the answers:

The question is:

"Why do Plants Get Closed Down?"

The answer in outline is spelled out in figure 9 (Schmenner 1983) which is fairly self explanatory in manufacturing strategy terms.

The corollory to our first question is of course

"How Many Such Features do you Recognise in your Plant?"

Question two takes us back to our definition of Manufacturing Strategy.

"What do you want to be Really Good at?"

and Question three follows on from this:

"What does that mean in Terms of Manufacturing Strategy?"

Figure 9.

WHY DO PLANTS GET CLOSED ?

THEY "SLIDE INTO MEDIOCRITY"

1. PRODUCT VARIETY CONTINUALLY INCREASES
   - HIGH INVENTORY
   - PONDEROUS, ERROR PRONE PRODUCTION CONTROL
   - LOSS OF FOCUS
   - INAPPROPRIATE INFRASTRUCTURE
   - LOSS OF COMPETITIVENESS IN ANY MARKET
2. REPEATED EXPANSION ON THE SAME SITE
   - CAPACITY SHORT, SPACE ON SITE, EXPAND
   - POOR MATERIALS HANDLING
   - NO CENTRAL CONTROL OF OPERATIONS
   - TOO MUCH WIP
   - VAST MIX OF SKILLS - WAGE CHAOS
3. TOO MANY PEOPLE ON ONE SITE
   - TOO MUCH BUREAUCRACY
   - LABOUR UNREST
   - WORK FORCE SEPARATED FROM SENIOR MANAGEMENT
4. GRADUAL SOURING OF LABOUR RELATIONS
   - DIFFICULT TO REVERSE
5. IGNORING CONTINUING TECHNOLOGICAL DEVELOPMENT
   - NOT INVENTED HERE SYNDROME
   - GRADUAL LOSS OF COMPETITIVENESS

SOURCE - SCHMENNER HARVARD BUSINESS REVIEW
MARCH - APRIL 1983

In answering question three it is worthwhile to remind ourselves that (Hayes and Wheelwright 1984):

(a) A manufacturing strategy is determined by the pattern of the decisions actually made (that is, by what managers do), not by what the business says its manufacturing strategy is.

(b) The more consistent those decisions are, and the extent to which they support the SBU's desired competitive advantage (business strategy), the more effective the manufacturing strategy is likely to be.

(c) Although individual decisions are usually driven by, and in support of, specific products, markets, or technologies, the primary function of a manufacturing strategy is to guide the business in putting together the set of manufacturing capabilities that will enable it to pursue its chosen competitive strategy over the long term.

Finally, by far the most important question for all manufacturing management is:

"What are You going to do to Implement a Workable Manufacturing Strategy in your Business?"

Make no mistake if the drive doesn't come from manufacturing, it won't come from anywhere.

So make it happen, use all the tools at your disposal whether they are called Just-in-Time, MRPII, Systems Engineering, KANBAN, OPT, Flexible manufacturing systems, CADCAM or whatever. If *you* don't make it happen nobody else will.

References

Hayes, R. K. & Wheelwright, S.C. (1984) *Restoring our Competitive Edge, J. Wiley, NY*

Hunter, A. A. (1984) *Investing in Flexibility for the Future, NEDO Conference Proceedings: Manufacturing Technology: The Implications of Change June 1984, London*

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Summary

In many companies manufacturing is still seen primarily as a cost sink. For the advanced, developed economies this view has become untenable. Advanced manufacturing technology is not an option but a management obligation. World markets of the future will go to those companies in which manufacturing is seen as a major weapon of corporate competitiveness, not as a financial millstone.