HONDA'S GLOBAL FLEXIFACTORY NETWORK

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ABSTRACT

Flexifactories, where the product made can be changed at low cost and quickly, constitute an important aspect of manufacturing flexibility. Examination of Honda flexifactories worldwide reveals how models are changed over, the model mix altered, and whole factories switched to making new types of products.

Flexifactories are logically operated as networks, constituting a bridge between "micro" flexibility of people and machines and overall corporate flexibility, resulting in improved mass production. Flexifactories tend to be locationally stable, with flexibility linked to long-term employment and internal corporate culture. There remain limits to product-change flexibility to be borne in mind.

INTRODUCTION

What do we mean by "flexifactory"? A flexifactory is a factory capable of changing the product it makes with relative ease, at low cost, and great rapidity: whether changing production volumes, changing models, or changing the nature of the products made. The phenomenon is closely related to other aspects of flexible production which attracted attention during the 1980s: flexibility of people, of automation, of product development. Yet it cannot be reduced to them, for it forms a vital bridge between "micro" flexibility (relationships of individual employees with each other and with technology) and the corporate strategies of some highly successful companies for coping with rapidly shifting markets. But what does a flexifactory do in practice? What is the logic of the flexifactory? How does it fit into the other forms of flexibility? Finally, what are its limitations?

Honda is a leader and master at developing and utilizing the flexifactory. Honda's network of flexifactories (and we shall see later that the network aspect is central to their effective management) plays a key role in its successful global corporate strategy. In this paper we examine the phenomenon empirically at Honda factories in Japan, North America and Europe, before analysing its logic and its limitations.

1. HONDA'S FLEXIFACTORIES

We start by observing the flexifactory empirically, with examples drawn from Honda's operations in Japan, North America and Europe.

1. 1. Japan

Honda runs two main automobile factories in Japan, at Sayama, north of Tokyo, and Suzuka, west of Nagoya. Sayama is Honda's original automobile plant, and by the early 1990s it manufactured the larger models, like Accord, Prelude and Legend. Suzuka makes the smaller models, like Civic, Concerto, Integra, Today and City. Both factories are now high-output plants. Sayama's two assembly lines can make up to 540 000 vehicles per year, Suzuka's three can make up to 735 000.

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Some 4-wheel vehicles are made at other factories. Since production started in 1990, the NSX luxury sports car has been made in a special plant at Honda's Tochigi proving grounds northeast of Tokyo. The Acty series of small vans, originally made at Suzuka, has since 1984 been built by 40 percent Honda-owned subsidiary and parts maker Yachiyo Industries, (located close to Suzuka), which also makes the Beat mini sports car introduced in 1991.

Other Honda factories manufacture components and motorcycles, including: the Wako engine plant located near Sayama; Hamamatsu, the company birthplace, where power products are made; Mohka, near Tochigi, and Kumamoto, now the main motorcycle plant, on the island of Kyushu.

Let us examine two extreme types of flexible product change at Honda factories: first, short term responses to shifting demand for different models in the range; second, long-term restructuring of the type of product made at a factory.

1. 1. 1. Mixed Models on the Line, Honda Style

Sayama and Suzuka production lines are each capable of making various models simultaneously. At Sayama, for instance, seven types of car body can be accommodated: the basic Accord, Prelude and Legend, plus the 2-door Legend and the Accord-derived Accord Inspire, Vigor and Ascot. Some models can be made on more than one of the assembly lines at each factory, facilitating balanced use of each line. Declining demand for one model can be counter-balanced with increased demand for others. Such variation in demand over time is the norm, and the life cycles of the different models are purposely staggered (Accord was replaced in 1989, Legend in 1990, and Prelude in 1991, and so on).

Mixed models on single lines is of course no longer a novelty in the world automobile industry. What is interesting about Honda, however, is the system for mixing models on the line differs from Toyota's better known variant. The Toyota production system is now synonymous with assembly of vehicles in lots of one, with different vehicles and their derivatives spaced so as to balance the workload for workers (not too many complex derivatives next to each other), to balance the delivery of parts, and to be able to respond to market shifts by rejigging the mix.

Honda, however, produces in batches, 60 at a time, of cars exactly the same (eg red Civics, left hand drive, destined for continental Europe). At Sayama, several batches of different-derivative Accords may be made, before the line is switched to make Preludes for several batches. Models may be switched three or four times in a day. This system much simplifies logistical planning in parts supply compared to production in lots of one, and offers the same market flexibility. But instead of mixing the cars to accommodate workers who stay at fixed stations or in fixed groups, the workforce is reorganized between batches, with groups of workers moving about the factory to balance workloads.

At the same time different vehicles are designed in the knowledge that they will be manufactured on lines where existing equipment has given characteristics. Thus a given bolt on a Prelude will be given precisely the same torque as its equivalent on an Accord, or Legend, so that lineside tools do not have to be adjusted between batches.
1. 1. 2. Factory Metamorphosis

Honda has entirely restructured the purpose and products of some factories as the company has evolved. A prime example is the Kumamoto factory on Kyushu. Kumamoto was originally set up in 1976 for CKD assembly of motorcycles whose parts were delivered from central Japan, and the finished products were exported. It then shifted to make the CKD kits themselves to feed Honda's growing network of CKD motorcycle plants in other parts of the world. Agricultural machinery was added to its "portfolio", as well as engines for small cars and vans, in 1987.

Perhaps the most spectacular instance of such a factory metamorphosis in Japan is the Suzuka factory. Opened as a motorcycle plant in 1960, by the mid 1980s Suzuka had become the highest-output motorcycle factory in the whole world. Automobiles were first made there in 1967, three years after Sayama. Gradually, automobile production grew in importance at Suzuka, reflecting Honda's evolution (automobile sales accounted for c.50 percent of revenues in 1980, c.80 percent in 1990). Now, Suzuka makes no motorcycles at all. In 1991 its last motorcycle production was transferred to Kumamoto, and the final Suzuka motorcycle workers were switched to automobile production.

1. 2. North America

Honda's factory structure in North America includes the following factories: a motorcycle plant at Marysville Ohio (opened in 1979), a dual assembly line automobile plant adjacent at Marysville (1982), a power products (eg lawnmower) plant at Swepsonville North Carolina (1984), an engine and mechanical components plant at Anna Ohio (1985), a single assembly line automobile plant at Alliston Ontario (1986), and a single assembly line automobile plant at East Liberty Ohio (1989). In addition, several dozen Japanese and joint Japanese-North American parts maker plants were set up during the 1980s in the midwest region to supply Honda, mostly in Ohio. These factories exhibit several types of product flexibility which we shall look at in turn: rapid model changeover, mixed model production, a network approach to flexifactory management, changes to the type of products made, and rapidity of change in investment plans.

1. 2. 1. Rapid Model Changeover

Rapid model changeover is typified by the 1985 introduction of new Accords at Marysville. In 1985, production workers were trained to build the new model as the old one reached its final months: some 200 went to Sayama in Japan to learn. Even as the last of the old was being made, the first of the new models was in production further up the line: on the same day. There was no shut-down at all, and comparatively little production was lost. In 1991 the new Civic model was introduced with the same rapid changeover simultaneously in Japan and North America.

1. 2. 2. Mixed Model Production

As in Japan, the North American automobile assembly lines were built to make different products. But there is an interesting difference. Whereas in Japan Sayama makes the larger models and Suzuka the small, each of the three North American assembly plants has manufactured both Civics (small) and Accords (large), in various proportions. East Liberty is Honda's most flexible plant in the world in its ability to make different models.
A related aspect of Honda's product flexibility becomes apparent when production planners make abrupt changes to the batch planned to be made. Honda's manufacturing strategy involves planning production schedules well in advance and adhering to them as strictly as possible. Simultaneous production of the appropriate model and parts takes place in different areas of the factories, according to strict forward plans. Despite the strict planning, however, production schedules can be changed abruptly. There may be a problem in painting, so that a particular colour cannot be used. Or a maker of certain parts may experience delivery or quality difficulties. Rather than simply stopping for a short time while the problem is solved, Honda's production planners quite often rejig the planned schedules to keep the factories running.

Many parts makers have to be ready to respond rapidly. They may need to change delivery timing or sequences, or alter the balance of different parts sent (eg for Civic or Accord, for different colours). Holding low stocks, they are unable to use inventories to provide the necessary elasticity. Honda may only give two hours notice of a change in production plans. Ability to quickly switch from one model to another is vital.

1.2.3. Network Approach to Flexifactory Management

Honda only makes two basic models (Accord and Civic -- plus their body-style variants) on its four assembly lines. In fact, in 1991, Honda was making only Accords at Marysville, only 3-door Civics at Alliston, and only 4-door Civics at East Liberty. At first sight this does not look very flexible, considering that in the "Japanese model" dozens of different vehicles and variants are supposed to come down the same production line each day. We've already seen that Honda departs from the "Japanese model" in its production planning. Are the North American lines and their workers actually less flexible, inferior to those in Japan?

No. To focus on the one-model-per-factory pattern of 1991 would miss the point. The production lines remain very flexible. As we have said, ability to make small and large cars on the same production line is a dimension of flexibility not seen in Japan. In fact, all four production lines are managed together, as a network. The allocation of models to the different factories has therefore regularly changed over time: sometimes one model per factory, sometimes two, with models switching back and forth between Marysville, Alliston and East Liberty to balance capacity utilization with market demand.

<table>
<thead>
<tr>
<th>Year</th>
<th>Marysville</th>
<th>Alliston</th>
<th>East Liberty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>4-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>4-A, 3-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>4-A, 3-A, 4-C</td>
<td>4-A</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>4-A, 2-A, 4-C</td>
<td>3-C</td>
<td>4-C</td>
</tr>
<tr>
<td>1988</td>
<td>3-C</td>
<td></td>
<td>4-C</td>
</tr>
<tr>
<td>1989</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>4-A, 2-A, W-A, 4-C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>4-A, 2-A, W-A</td>
<td>4-C, 4-A</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>3-C, 2-C</td>
<td></td>
<td>4-C, 2-C</td>
</tr>
</tbody>
</table>

* A = Accord, C = Civic: 2,3,4 = number of doors, W = station wagon
* Year of entry is calendar year in which the models produced at the factory were altered. No entry for a year implies no change over previous year.
There is nonetheless a priority on keeping production as simple as possible by in practice dedicating each model to a single factory. Making only two models in North America fits the same logic, easing logistical planning within each factory, within the parts maker network, and in links to Japan. Moreover, it fits patterns of market demand in the United States and Canada, with Accord and Civic sold in large numbers.

Not only are the factories operated as a network within North America, but decisions on how best to utilize each North American factory are made in a global context. Thus in 1988 Honda became the first Japanese company to export its North American automobiles back to Japan. The model chosen was the 2-door coupé version of the Accord, which had just entered production, solely at Marysville, and principally for the American market. Honda has also used its North American facilities to supply other markets, including Korea and Taiwan (4-door Accords), and Israel (4-door Civics), which have been closed to direct exports from Japan for various political reasons. In 1991 Honda completed the global circle when it began exports from Ohio to Europe. The Accord station wagon came first, followed in 1992 by the Accord 2-door coupé. In 1990 Honda became the first producer in North America to make right-hand drive cars, even though only small numbers were needed for countries like Japan and the United Kingdom.

The complexities of managing a flexifactory network at the global level emerged in speculation when the East Liberty plant opened in 1989 over whether the Integra model would be added, rather than being produced solely in Japan. By 1992 it had still not been added, even though, because of the North American recession sales slowdown, the East Liberty plant had yet to reach full capacity production. Examining this case, we see several factors coming into play: On the one hand:
- there is a need to make use of North American capacity.
On the other hand:
- North American demand for the Integra still fell behind Accord and Civic
- complicated logistical planning would be needed to make Integra and many of its components in North America
- the car was already made in Japan
- the subsiding Japanese market of the early 1990s meant that Integra production lost in Japan might not be compensated with another model
- East Liberty's full planned workforce had not yet been hired.

1. 2. 4. Changing the Type of Products Made

Over the longer term the factories add new product types and drop others. Thus the Marysville motorcycle plant added "Fourtrax" outdoor leisure vehicles in 1989 as motorcycle demand waned. The Swepsongville power products plant makes some automobile parts too. But it is in parts making factories that the practice of changing the type of product made is most evident in North America. Thus Honda's Anna mechanical components plant made aluminium wheels starting in 1987, but stopped when Honda decided to purchase them from a parts maker only a few years later in 1991.

A network of flexifactories exists among the parts makers. Their flexibility came into play in the late 1980s as the inter-plant division of labour among them evolved alongside Honda's burgeoning output, up from 150 000 per year in 1984 to over 500 000 in 1990.

Several transplant parts makers were first set up as joint ventures to manufacture multiple products in the same factory (thus cutting overheads). Collaboration was encouraged by Honda
during the early years of production. But the inter-firm division of labour has deepened over time as output has increased. As a result, Honda's earliest parts maker transplants have undergone significant evolutions in products manufactured. The principle followed is that the factories and the employees are retained, but they alter their roles to make different automobile components.

1987: shift of brake line production out of Bellemar Parts (majority Honda-owned) multiple metal-products factory at Russells Point Ohio to new specialist Japanese-US joint venture Hisan (Findlay, Ohio, 40 miles/65 km away).

1989: shift of sourcing for Alliston seats from Bellemar Parts Marysville factory, which had built 3rd production line for this purpose, to new Bellemar factory in Canada: line at Marysville then switches to supply newly opened East Liberty assembly plant.

1989: shift of some stamping and welding production (together with capital equipment) out of KTH (St. Paris Ohio), four-way Japanese joint venture transplant established in 1985, to Jefferson Industries (Jefferson, Ohio, 45 miles/70 km away), a 3-way joint venture established by two of the KTH partners together with Honda (30 %) in 1989.

1989: Honda subsidiary Yutaka Giken, major maker of metal stampings in Japan, builds new stamping facility for torque converters and oil pans adjacent to Bellemar Parts Russells Point factory. Yutaka Giken takes 10 percent share of Bellemar Parts, Honda increases its share from 80 to 87 percent, other Japanese partners reduced from 10 to 1.5 percent each.

1989: Sankei Giken, one of the Bellemar Parts owners reduced from 10 to 1.5 percent, opens Blanchester FCM in southwest Ohio, to make power steering systems for Honda. Tokyo Seat, the other Bellemar partner reduced from 10 to 1.5 percent, has meanwhile built several of its own factories in North America, making seats and seat parts for Honda and for other assemblers.

Noteworthy are the financial structures of ownership which have evolved in parallel (including Honda's own prominent role). Also evident is the pace of structural change, occurring only 2-7 years after initial production had commenced.

1. 2. 5. Rapidity of Change to Production Investment Plans

Not only are the products changed, but the scale of production is changed rapidly too: upwards at least (we will discuss downwards changes later). Honda's rush of investment into North America is itself remarkable. Annual automobile production rose from zero before late 1982 to over half a million only eight years later.

A large measure of flexibility was apparent during the production build-up itself. Only a few months before production on the second assembly line at Marysville was due to start in 1986, and after much of the new investment was in place, the original plans were revised. Output growth would be accelerated with full capacity boosted from 15 000 to 360 000 rather than 300 000 cars per year. The expansion plan under execution in 1985 had already been ambitious. Civics were to be added to the Accords, and capacity doubled with addition of a second U-shape line built parallel to the first. Another major capital investment -- installing virtually a whole new welding department -- was taking place simultaneously. And all this while not only maintaining full production on the first assembly line, but changing the Accord model over on it
Yet the revised new rate of output was achieved during 1987, the target at first set for the original goal.
The reasons behind the sudden change of plans are revealing in themselves. In mid 1985, Honda's sales in Japan unexpectedly jumped upwards. But there was no way to increase production in Japan to respond. The only automobile capacity expansion in the pipeline was at Marysville. In only a matter of weeks Honda had decided to bring Marysville up to the 300 000 level by the end of 1986, a full year and a half ahead of schedule, and to increase total capacity by a further 20 per cent. That way production in Japan could be held back for the Japanese market. So expansion plans in the United States had been rapidly modified to cope with a changed market circumstance in Japan: another instance of the flexifactory network operating at the global scale.

Successful though these capacity increases were, Honda engineers encountered problems because they had not taken into account the possible future expansion of the Marysville plant when they designed the first assembly line in the early 1980s. They did not repeat the mistake with the East Liberty plant, purposely planning for it to be expanded if necessary. (The recession in North America in fact postponed the 1991 target for attaining full capacity at the factory.)

1. 3. Europe

In Europe we are principally concerned with two Honda manufacturing sites, the automobile engine plant and adjacent automobile assembly plant at Swindon in southern England (opened in 1989 and 1992 respectively), and Honda's very first overseas factory, the Aalst, Belgium motorcycle plant, opened in 1963. Various aspects of flexifactory operations can be observed.

1. 3. 1. Rapid Production Capacity Increases

The engine plant has already exhibited the kind of rapid unplanned increases to output we saw in North America. Honda built its engine plant firstly to supply its British partner Rover's Longbridge Birmingham factory, where Rover started to make its own 200/400 models and Honda's Concerto. The original plan had been to build 70 000 1.6 litre engines per year for all 40 000 Concertos and for a proportion of Rover's 200s and 400s. However the success of the new Rover models exceeded expectations, and in early 1990 Rover asked Honda for a significant increase in engine supply. Honda agreed to raise production to a rate of 116 000 per year later that same year, and by early 1991 had already doubled output to 140 000 engines per year: 40 000 for the Honda Concertos, 100 000 for the Rovers.

1. 3. 2. From Motorcycles to Automobile Components

The Aalst factory faced a crisis in the mid 1980s as demand for small motorcycles in northern Europe fell away. Honda received Belgian state aid to encourage workers over 50 to take early retirement, and to invest in new machinery. By the early 1990s Aalst was poised to make a transition from producing motorcycles (for thirty years) to making automobile components alone. The first automobile product was plastic fascias (dashboards), starting in 1986 for Rovers and Hondas made at Longbridge. In 1992 Aalst added production of fascias for Honda's Swindon automobile factory and Rover's Cowley factory too: daily output is to more than double. Automobile bumpers were also made at the plant for several years in the late 1980s, though this stopped in 1990.
By the early 1990s Aalst was set to become involved in automobile engine parts production too. A new site near Aalst will house an aluminium foundry from 1994 to make engine parts (Aalst itself cannot be used for environmental reasons) that will be machined at Aalst and then sent to Swindon. Later on other parts too are, from oil pumps to anti-lock brake parts. Machining starts first, with the foundry work to follow.

<table>
<thead>
<tr>
<th>Year</th>
<th>Workforce</th>
<th>Motorcycle Output</th>
<th>Instrument Panel Output</th>
<th>Bumper Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>222</td>
<td>61 791</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>218</td>
<td>70 753</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>221</td>
<td>56 830</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>220</td>
<td>53 175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>231</td>
<td>55 796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>190</td>
<td>58 308</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>185</td>
<td>47 046</td>
<td>36 541</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>210</td>
<td>48 671</td>
<td>87 192</td>
<td>805</td>
</tr>
<tr>
<td>1988</td>
<td>220</td>
<td>42 053</td>
<td>104 987</td>
<td>21 795</td>
</tr>
<tr>
<td>1989</td>
<td>252</td>
<td>39 180</td>
<td>100 767</td>
<td>20 441</td>
</tr>
<tr>
<td>1990</td>
<td>314</td>
<td>61 044</td>
<td>165 644</td>
<td>9 996</td>
</tr>
</tbody>
</table>

Noteworthy is that in 1991, for instance, 36 temporary workers were employed at the factory, over 10 percent of its staff.

At Aalst Honda is retraining workers who used to assemble motorcycles: after all, they have years of experience working the "Honda Way" that would otherwise go to waste. Meanwhile motorcycle production is also being rearranged within Europe, with Aalst production being centralized to Honda's factories in Spain and Italy where demand remains higher.

2. LOGIC OF THE FLEXIFACTORY

In this second part of the paper we draw upon Honda examples to examine first the logic, then the limitations, of the flexifactory. The starting point is to compare it to what went before, which we will call for convenience the fixed-factory. Now, these names imply that the two factory types are opposite poles to one another. This dualist approach is a fashionable mode of analysis (fixed v flexible, mass v lean, Fordism v flexible, mass v flexible specialization, etc.), which emphasizes novelty and difference, invariably in order to stress the superiority of the new.

However, this form of analysis is insufficient, since in placing the accent firmly on the flexibility aspect of the flexifactory it fails to take a balanced view. So we will turn later on to some of the "fixities" of the flexifactory itself -- ie its internal limitations. (The implication is of course that the fixed-factory possessed its own kinds of flexibilities.) We shall nevertheless retain the appellations because they capture the currently vital differences between the two factory types.
2.1 The Fixed-Factory

What are the characteristics of the fixed-factory? This is essentially the type of factory associated with the idealized (American) model of mass production:
- the factory is built and machinery installed for production of a single model ("dedicated machinery");
- changing models is the infrequent (8-10 years) occasion for major investment and a long production shutdown since it requires virtual gutting of large parts of the factory ("retooling");
- the tasks employees undertake are strictly controlled and limited by prior agreement ("job control focus"). Redeployment can require arduous negotiation between management and worker representatives;
- markets are geographically limited, with companies mostly aiming to supply single countries or contiguous groups of countries from each factory. Factories are not equipped to make products that meet specifications in other markets (legal requirements, left-hand/right-hand drive);
- market fluctuations lead to some factories working overtime because demand for "their" product is high, while other factories belonging to the same company operate below capacity.

The fixed-factory therefore rests upon this now well-rehearsed base of fixed machines and fixed labour. The result is a company the time-space market flexibility of which is markedly limited. Granted, this characterization has more accurately depicted some high-output automobile factories than others (BMW's Bavarian factory network is an early flexibility innovator outside Japan). And we will readily admit that the fixed factory retained its own forms of flexibility - in particular the ability to discharge employees during recessions or market slowdowns - that would appear to be denied to the flexifactory (see below).

These caveats aside, the model of the fixed factory does help us to understand the flexifactory. This is because our interest lies less in arguing over the historical novelty of factories that possess characteristics of flexibility (various types are already known: eg craft workshops, high technology factories such as satellite construction, "flexible specialization" workshops), and more in pointing to the emergence of a highly developed flexible factory form in precisely the key industrial sector heretofore characterized by fixed-factories: and this not at its margins but in Honda, a leading and very successful firm at the heart of the sector.

2.2 Characteristics of the Flexifactory

These are the basic characteristics of the flexifactory in its Honda version:
- the factory is capable of making more than one model simultaneously (eg several small models at Suzuki, several large models at Sayama, large and small models at Marysville, East Liberty or Alliston)
- introduction of new models is relatively frequent (4 years) and is very rapid, with minimal retooling not necessarily occasioning large-scale new investments (eg 1985 Accord at Marysville).
- over a longer period, the very kind of product manufactured can change (eg Suzuki, Aalst)
- employees are expected to be flexible so that the labour force is fluid with the goal of accommodating shifts in model mix (eg Suzuki), willing to retrain to make different products (eg Aalst)
- Market flexibility is achieved in part by rejigging the balance of the models that are made simultaneously (this happens constantly), and in part by ability to increase outputs rapidly (eg Swindon engine plant 1990-1991, Marysville expansion 1985-1986).

- Geographical flexibility is achieved by planning to make cars at each factory for markets in various parts of the world (eg Suzuka and Sayama products all over world, Marysville Accords to Japan and Europe, East Liberty Civics to Israel).

- Flexifactories are operated as a network to balance their capacities (eg shifting production around the North American network).

Even within one company the nature of the flexifactory's flexibility can vary, depending upon the demands made upon it in its primary market. Thus in Japan the two assembly plants make a mix of large cars and small cars respectively, while in North America the three assembly plants have each made both a large car (Accord) and a small car (Civic).

2.3. A Hierarchy of Flexibility

The flexifactory forms the bridge in a hierarchy of flexibility between, below it, flexible employees and flexible machinery, and above it, a network of flexifactories and a company taken as a whole.

2.3.1. Premised upon "Micro" Flexibility

The flexifactory can play a key role in turning the flexibility of people and machines that many companies are now emphasizing into an overall flexible corporate strategy. It allows these "micro" forms of flexibility to be utilized to the full. The flexifactory is thus premised upon:

- Flexible machines, able to manufacture a new model or to simultaneously manufacture different models with small or no changes. This is not to say that no new investment accompanies model introduction: rather that this can be kept to a minimum if desired. A variation on this theme should be mentioned: design-for-flexible-manufacture (eg bolts with the same torque across different models, Accord station wagon).

- Flexible people, a fluid labour force within the factory, and this at various levels beyond changing tasks on a two-hourly basis (rotation internal to production teams/groups): regular reconfiguration of some groups within the workforce as models change during the day (eg the Japanese factories) (an alternative to line-balancing production in lots of one), and retraining for different tasks and different types of products (eg Suzuka, Aalst).
2.3.2. Global Network of Flexifactories

Looking "up" the hierarchy from the flexifactory, we can see that the goal is not a single flexifactory or a set of isolated flexifactories, but to manage a network of them (e.g., Honda's North American factories, and its parts makers). The same basic principle applies to global-scale management, although the task of managing a global-scale network of flexifactories presents new challenges (political considerations in terms of imports, exports and local production, suitability of different models for different regions).

Management of a network of flexifactories is designed to support the strategic flexibility of the company as a whole in responding rapidly to markets that are uneven not only (1) over time (e.g., growth v recession) but also (2) regarding segments (e.g., large v small models, basic v luxury models) and (3) geographically (differential market growth rates for the company in various world regions). The desired goal is time-space corporate flexibility at the global scale. Each flexifactory is "opened" to a wide range of markets for its products. At first the flexifactory seems like an extra demand that will bring added complications. But to control a network becomes a competitive advantage not just in terms of ability to react to market change but also in cost terms, as we shall now see.

2.4. Flexible Mass Production

The common setting up of the dualism "flexible v mass production" as a conceptual prism to aid understanding of contemporary change (or most recently lean v mass production) is not very helpful in the Honda case. Factories like Honda's, producing tens of thousands of identical products each year, are clearly undertaking mass production. The trap fallen into by the simple dualist models is the implicit assumption that "mass production is defined by mass production as we know it (especially its American form)" whereas in fact the latter was only one possible version (the same analytical mistake underlies the argument that idealized Japanese production techniques are not Taylorist).

Reality is matched better in the Honda case by the term "flexible mass production". (The Honda case may show this more clearly than some other Japanese companies given Honda's manufacturing system and the fact that Honda tends not to offer myriad "customer order" variants of each model, but the point may also have wider validity.)

This leads us to the question of economies of scale. In parallel to the mass v flexibility dualism in the literature runs that of economies of scale v economies of scope. Yet despite the theoretical linkage of flexibility to the latter, in practice the flexifactory can also offer better realization (i.e., in reality, not theoretical) of economies of scale than does the very factory form whose *raison d'être* these were: the fixed-factory.

First, flexifactory fixed costs are kept down because it is cheaper - in production engineering terms - to change models, whether short term balancing of simultaneously-made models, or model replacements. Second, economies of scale are in fact better realized with this kind of "niche" production than under mass production, precisely because - in part as a result of the first point - the flexifactory is much more likely than the fixed-factory to be run at close to full capacity *in practice*. 
For either type of factory to realize its theoretical economies of scale it must be maintained at full capacity. The fixed factory's capacity utilization in practice depends on sales of a single model. The flexifactory, with its varied products, is more likely to achieve full capacity 

*whatever the market conditions* (although its advantage over the fixed factory will decrease to the extent markets are stable).

### 2.5. The Flexifactory and the Corporate Balancing Act

An issue that follows directly from the preceding discussion relates to the way overall corporate strategy often rests upon a balance: of success in some segments, regions and periods, against failure in others. Market balancing acts, risk spreading, carefully spreading the timing of new investments and new model introductions, these are vital planks of most corporate strategy. Traditionally, however, most of the equalization process takes place at the financial level: it is assumed that profits will be higher in some segments, regions and periods to make up for less remunerative activities in others. The point is that (with fixed-factories) product plans have to be laid well in advance, based upon expectations and predictions about the evolution of patterns of demand that stretch well into an unknown future. If a company operates a production structure composed of fixed-factories, it is more or less stuck with the them and their output often for several years (there is of course some leeway in overtime work, and for some product types outsourcing work, though the latter is difficult in automobile assembly).

The expectations and predictions about demand are more likely to prove accurate in cases of (1) stable economic growth and/or (2) monopolistic control ("market leadership"). But where these are absent, as in the global automobile industry in the late twentieth century (North America being the clearest case), they are more likely to turn out to have been in error: leading to sometimes gross imbalances in supply and demand between segments, among regions, and over time.

In this context there are clear advantages to operating a network of flexifactories. It provides a fresh tool to facilitate the corporate balancing act, the key being that the balance between supply and demand in different segments, regions and periods no longer depends more or less exclusively on the (exogenously given) evolution of demand. In other words, flexifactories provide a useful tool for improving the elasticity of supply.

### 2.6. Employee, Community, and Locational Stability of Flexifactories

We have looked first down and then up the hierarchy of flexibility, from "micro" flexibility to overall corporate flexibility. In doing so we have commented too on the partly parallel geographical hierarchy of spatial scale that links flexifactories located in different regions to the global market. We can now come down the geographical hierarchy again to investigate the relationship of the flexifactory with its immediate locality, especially with its employees and their communities. Like most workplaces, the flexifactory is a key node linking local, everyday life, to the global economy.

When a production structure is based on a network of flexifactories, corporate flexibility at the global scale is attained, paradoxically, via the establishment of locationally stable production sites. Three factors converge to produce this result: (1) geographical immobility of the workforce taken as a whole, (2) long-term employment, and (3) the specificities of internal corporate culture. We take the first factor for granted here and discuss the other two.
2. 6. 1. **Long-term Employment**

In practice long-term employment means two analytically separate things. First is a "job for life": the mutual expectation of employment in a single company for a whole working career. Second is a "no layoff" policy in times of production slowdown due to recession. These both depend upon corporate competitiveness and the particular strategies used to achieve this. And a strategy of flexifactories plays a central role in permitting both: long-term market decline in demand for a product can be compensated by a shift into a new product area (eg Aalst, Suzuka); short-term problems can be minimized by shifting under-capacity around to find an optimum balance among factories (eg the network in North America). Indeed the flexifactory is intimately related to policies of long-term employment: inversely, it is policies of long-term employment that "purchase" the willingness of employees to accept "micro" flexibility (willingness to be reallocated to new production tasks), the foundation of the flexifactory itself.

2. 6. 2. **Corporate Culture**

Long term employment is in turn closely tied to internal corporate culture. Company-specific training and career development foster a specific "Company Way". The "Honda Way" refers more to how activities are undertaken, problems resolved, co-workers interacted with, than to specific technical abilities. Its existence is fundamental to proper coordination under decentralized management systems: ie employees can be relied upon to behave in certain specific ways without being given specific guidelines. The result is that a basic element of management control is locked into the brain of the individual worker. Compared to a traditional organizational structure with hierarchical cascade of commands from on-high, the result is that in the flexifactory the workers cannot easily be replaced: certainly not en masse. Naturally this has manifold implications for labour relations (although these do not concern us directly).

2. 6. 3. **Locational Stability**

Adding together the three factors -- geographical immobility of the workforce as a whole, long-term employment, and the specificities of internal corporate culture -- the flexifactory is closely tied to its locality. Physical relocation of the factory is difficult to envisage. This is worth noting because physical relocation has been an important tool of corporate strategy in over recent decades (the United States provides multiple examples): whether to find new, larger premises because of physical constraints (from central city to suburb or rural area), to improve management's hand in bargaining with employees (from core industrial region to poor region), or to reduce labour costs steeply (from industrialized to third world country). But the flexifactory is less locationally mobile than is the fixed-factory, because the cost of relocation (either moving all its employees, or politically because the long-term employment understanding is breached, or starting to train employees from scratch (hiring is as difficult as firing) is higher. The flexifactory is immobile because of its attachment to its employees. Rather than the workers going to where the work is, the work must be brought to the workers.

(Some critics might argue that flexifactories are in fact based upon a very rapid work pace that only young employees can keep up with. This would imply a tendency for factories to relocate in search of a new crop of young workers to harvest as their current workforce aged. Here it is
being argued, by contrast, that the long-term employment/micro-flexibility/corporate culture nexus implies an opposite tendency.)

The flexifactory thus alters the principles that lie behind factory location decisions. In the fixed factory, machines are viewed as more valuable than the majority of the employees, and barring "sit-ins" it is not costly to move them. Moreover, the skilled workers and engineers and managers in whom knowledge was locked are always more geographically mobile. By contrast, in the flexifactory, the production employees are more valued (factory shells and land can be ignored as minor issues (though not for the case of Japan, where the land on which factories are located is a more important factor altogether)).

Finally, a separate factor encourages locational stability of flexifactories. This is their insertion in parts supply chains that also gain advantage from spatial proximity (ie just-in-time links, inter-factory visits by engineers, other advantages of close interactions between factories in the supply chain). Thus establishment of a network of parts makers in Ohio constrains the ability of any factory within it to relocate beyond a certain distance. Among the factors contributing to this are potential longer distances for just-in-time deliveries, new costs because linked factories must move too, and the reciprocal duty owed by Honda and parts makers, all of which have taken considerable risks in their North American investments.

3. LIMITS OF THE FLEXIFACTORY

Thus far we have emphasized the advantages of the flexifactory over the fixed-factory. This is the logical result of seeing the two types as polar opposites: which is a first step in the analysis. But it is important to progress beyond this dualist analysis to gain a balanced view. The fixed-factory possesses its own flexibilities (eg to discharge workers, because there is less understanding of long-term employment). Likewise, the flexifactory has its limits: it does not represent some ultimate and unrestricted flexibility. Understanding these limits is vital to working out how the flexifactory has to be managed.

3. 1. Coping with Downward Shifts in Output

Perhaps the most immediate question that springs to mind is how to deal with the implications of declining output for employment needs. Is the "promise" of long-term employment merely the same de facto result that was obtained by eg US companies like GM in the 1940s-1970s, or IBM or Volkswagen in the 1960s-1990s: ie premised upon growth? Or is it more than this, a new fixed cost as the price for micro-flexibility, the boundary between fixed and variable costs having shifted permanently towards the former?

The immediate response to make is that the flexifactory is precisely a tool to prevent the question of redundancies from arising in practice and threatening the principle of long-term employment: instead of taking output decline for granted, the object is to replace declining models or products with others, thus maintaining capacity and therefore employment (eg Aalst case). Thus decline in certain markets (segments, regions) can be dealt with by redirecting production to other segments and regions.

Moreover, sudden declines in demand can be met by a combination of (1) allowing finished product inventory to build up (which Honda temporarily did in North America in 1991, attracting great attention), (2) institution of "non-production days" in which employees come to work for further training, (3) not renewing contracts for a cushion of temporary workers hired
expressly to prepare for such situations (as at Aalst). Sometimes timing may be fortunate: thus Honda had not hired the full contingent of East Liberty workers when the North American recession started, and so could avoid taking on this new fixed cost. Such measures naturally have their limits, but they do allow leeway if demand suddenly falls.

The major problem remains how to cope with simultaneous decline of demand in several markets at once so that there simply is no room to reorganize production within the flexifactory network. Here, long-term employment does appear to pose a problem, unless this fixed cost can be carried until new products come on line in new segments. Hence (in theory at least), the fixed-factory is less able than the flexifactory to cope with shifting demand patterns within an overall trajectory of growth, but is better able to cope with an overall decline in demand.

3. 2. Requirements of Locational Stability

The locational stability of flexifactories discussed above is not without potential costs that must be accounted for. It places a premium on labour relations because the option of - the threat of - physically relocating production and making present employees redundant is less viable. (Honda nevertheless encourages the same sense of strong competition between its factories for new investments - with implicit threats about future growth - that other companies use as a lever of control.) A related consequence of locational stability is heightened managerial concern over the local political-economic context in general (relations with local and regional government, local society in general).

3. 3. Limits on Changing Products

Despite the advances made by the flexifactory over the fixed-factory, ability to change the product being manufactured is not boundless. There is a hierarchy of ease-of-product-change:
- changing the mix of existing models
- replacing an old model with a new one with little or no shut-down
- shifting over time from one product type to a different one.

There are limits on the type of new product that can be added without new investments in production equipment. The dimensions of the Honda Accord station wagon (Aerodeck in Europe), introduced at Marysville in 1990, had to be designed to fit existing production equipment (hence the third compartment is not very large and the rear window slopes forward). Conversely, in Japan, products like the Acty van, the Beat sports car and the NSX sports car are not made at Sayama or Suzuka. And plans to make a North American Multi Purpose Vehicle, or "people carrier", in the mid 1990s, will likely require a separate production area in Ohio to accommodate its larger dimensions (though Honda will not build a separate factory in a new region - a common pattern for fixed-factories).

CONCLUSION

Evidence from Honda's worldwide manufacturing operations reveals a systematic strategy to utilize factories in a flexible way, changing products rapidly and at relatively low cost: whether through mixed model production, rapid product changeover, or changing the type of product made. Understanding the logic of flexifactories starts by comparing them to fixed-factories. The flexifactory has numerous advantages, among them coping with demand shifts (between segments, among regions, over time) and realizing economies of scale in practice. Inserted in a
hierarchy of flexibility, the flexifactory is based upon the "micro" flexibility of people and machines, and in turn leads up to a flexible company as a whole. Flexifactories are best run in network form, with allocation of products to factories coordinated across different factories, across the globe. The flexifactory is intimately related to long-run employment policies and to an emphasis on internal corporate culture. The result is that the factories are locationally stable.

There are nonetheless limits. These include the issue of how to decrease employment levels, the implications of locational stability for labour relations and local relationships, and the boundaries that determine just what products can really be made on the same equipment by the same people. Regarding the last of these, the important point is that by comparison with the fixed-factory (the comparison that matters in terms of corporate competition), the boundaries of product change flexibility are pushed much further out.

Thus the flexifactory plays an integral role in Honda's global operations, linked intimately to each of Honda's other cutting-edge corporate practices. It forms the link between micro flexibility at the work-place and overall corporate strategy. It is the lynchpin connecting the (otherwise contradictory) long-term employment of people imbued with a "Company Way" with constant global demand shifts. And it contributes towards locational -- and therefore community -- stability in an unstable global economic environment.