MICRO FACTORY RETAILING: A BUSINESS MODEL AND DEVELOPMENT TRAJECTORY FOR EMERGING ECONOMIES.

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ABSTRACT

This paper outlines the fundamental challenges facing policy-makers in developing economies, with specific reference the automotive industry in China, in defining and implementing policies based on the concept of sustainable development. The global vehicle manufacturers are attracted by market prospects in China as the country seeks greater integration into the world economy. It is argued that a twin-track strategy should be adopted to preserve the existing industry while nurturing the development of an alternative model, that of Micro Factory Retailing.

Keywords : Automotive industry, sustainable development, China, industrial policy

1. INTRODUCTION

This paper outlines the fundamental challenges facing policy-makers in developing economies, with specific reference the automotive industry in China, in defining and implementing policies based on the concept of sustainable development.

The automotive industry is a vast economic entity at the forefront of globalisation. Vehicle production and use generates wealth, supports employment, and provides unprecedented personal and goods transportation. Motorisation is accompanied by increased consumption of material resources (Wells, 1998), pollution, congestion, and traffic accidents. The automotive industry therefore embodies the dilemma of having to reconcile economic growth with social and environmental sustainability. This dilemma is even more pronounced in developing countries for which, as is argued in this paper, the structure of the existing mainstream industry, its products and the manufacturing processes used to create them are all inappropriate. The process of globalisation appears inexorable, and in the automotive industry there are few companies anywhere in the world that are not now integrated into multi-brand groups. If China, arguably the most important of all the developing countries, wants the benefits of motorisation and an automotive industry conventional analysis would show that there is no alternative to joining this globally integrated business structure.

In the World Trade Organisation (WTO) -ordered era, nation states have reduced ability to protect domestic markets and producers or to influence patterns of investment and trade. As is shown below, the existing domestic industry is often highly vulnerable to international competition so the first problem confronting policy-makers pursuing sustainable development is that of the potential decimation of the existing industry.

Equally, in order to support the industry and promote continued investment, nation states might take economic measures to stimulate the market even though the physical infrastructure and urban environment are unable to support more cars in use.

In the first section, the industry and market in China are compared with the global picture. In the subsequent section, there is a brief description of policy with respect to the automotive industry in China as it has developed over the years. In the third section an analysis is given of the policy options available to China over the next Five Year Plan period (2000-2005). Here it is argued that a twin-track strategy should be adopted to preserve as much as possible of the existing industry (despite all the attendant drawbacks associated with this industry) while nurturing the development of an alternative model, that of Micro Factory Retailing. The conclusions draw attention to ambiguities in the concept of sustainable development, and in particular to the question of prioritisation or sequencing with respect to the economic, social and environmental elements of sustainability. As such, the MFR concept is an attempt to bridge the gap between an idealised sustainable world, and the reality of the contemporary global automotive industry.

2. THE MOTOR INDUSTRY AND MARKET: CHINA IN A GLOBAL CONTEXT

2.1 The industry

The history of the automotive industry is one of increasing global consolidation and integration, through a process of mergers and acquisitions, propelled by the search for economies of scale (Feast, 2000). Over the last ten years the pace of change has accelerated, leading to the emergence of multi-brand, multi-location industrial groupings as shown in Table 1.

Automotive companies can no longer simply be associated with a single ‘country of origin’, the national boundaries that once defined production, markets, the ability to raise capital, etc. are of declining relevance. Few companies or countries have been able to stand outside the process of globalisation – most recent and dramatic has been the virtual demise of the Korean automotive industry as an independent force. The leading six groups shown in Table 1, if unconsolidated groups are included, together accounted for 78.1% of global production in 1999. Even this understates the dominance of large groups. Companies such as Proton (Malaysia) and Maruti (India) have technical and financial links with these large groups, as is the case with the automotive industry in China shown below.

Table 1 The major multi-brand groups in the automotive industry

Group (global production volumes, millions, 1999)	Constituent brands	Geographic spread
GM-Fiat Consolidated 8,786 Unconsolidated 3,807 Total 12,595	GM, GMC, Buick, Oldsmobile, Chevrolet, Cadillac, Saturn, Pontiac, Holden, Saab, Opel, Vauxhall, *Isuzu, Subaru, Suzuki, Fiat, Alfa Romeo, Lancia, Ferrari*	Wide geographic coverage, weakest in Asia.
Ford Consolidated 7,220 Unconsolidated 1,013 Total 8,233	Ford, Lincoln, Mercury, Volvo, Jaguar, Aston Martin, Land Rover, Th!nk, *Mazda*	Strong in Europe and North America, weaker in Asia
DCX Consolidated 4,310 Unconsolidated 2,720 Total 7,030	Mercedes, Chrysler, Dodge, Jeep, Smart, *Mitsubishi, Hyundai, Kia*	EU, US, Japan-Asia. Weak in former COMECON and South America.
Toyota Consolidated 5,182 Total 5,182	Toyota, Lexus, Daihatsu, Hino	Leader in Japan and Asia, strong in North America.
Renault-Nissan Consolidated 2,286 Unconsolidated 2,415 Total 4,701	Renault, Samsung, RVI, Dacia, *Nissan, Infiniti*	Chronically unprofitable Nissan and regionally focussed Renault.
Volkswagen Audi Group Consolidated 4,594 Total 4,594	VW, Audi, Skoda, Seat, Rolls Royce, Bentley, Bugatti, Lamborghini, Scania	Leader in Europe, well-represented in South America, but weak in North America and Asia.

(Source: CAIR, derived from Storey, 2000. Brands include commercial vehicles. Unconsolidated companies shown in italics. Note: global production in 1999 was 54.1 million vehicles)

There are significant barriers to entry and exit for this industry (see Nieuwenhuis and Wells, 1997). Quite apart from the huge capital cost involved in establishing production facilities on a scale that could be competitive with existing market offerings, new entrants need a distribution system and a brand to which consumers could relate. The most recent attempt to enter volume car production, by Samsung of Korea, failed abysmally even though start-up costs were reduced by the use of Nissan designs and tooling.

Production in China is uncompetitive in global terms by almost whatever measure used. In some respects this is unsurprising. Historically, closed and small markets have shown a distinct pattern of import-substitution development with most of the following elements:

- High import tariffs on new car and commercial vehicle imports. The import share of the local market is therefore very low;
- Local market demand served by very small car assembly plants;
- Each plant producing a range of models;
- Models produced often of a previous generation to those found in contemporary industrial markets;

- Models produced largely as assembled kits (so-called CKD - Completely Knocked Down; or SKD - Semi-Knocked Down). The plant therefore may lack some of the facilities associated with a high volume car assembly plant e.g. press shop, engine or gearbox facility;
- No exports are produced;
- Multi-national vehicle producers form partnerships with local investors, often as a government requirement;
- Independent local vehicle manufacturers may continue to exist, but these are very low volume and confined to specialised product types.

The result is relatively low volume production of dated models for which consumers are charged high prices. In China, an average small car costs Rimimbi 100,000 compared with Rimimbi 120 for a bicycle (Liu Jie, 2000). In very small markets, such as Ireland and New Zealand, the removal of import barriers has resulted in the closure of small-scale production facilities. The concern for countries with a larger but still protected industry – notably India and China – is that a similar fate awaits once import barriers are removed.

Table 2 Production of passenger cars in China and selected other countries

Country	1995	1996	1997	1998	1999	2000 (F)
USA	11,646	11,520	11,780	11,649	12,459	12,171
Japan	7,611	7,864	8,492	8,056	8,100	8,025
Germany	3,853	4,048	4,209	4,869	4,860	4,778
Canada	2,184	2,127	2,555	2,521	2,991	2,705
S. Korea	2,044	2,308	2,363	1,625	2,362	2,511
France	2,040	2,120	2,259	2,603	2,784	2,870
Spain	1,959	1,942	2,010	2,216	2,189	1,981
UK	1,532	1,686	1,698	1,748	1,776	1,888
Brazil	1,303	1,467	1,680	1,244	1,103	1,192
Belgium	1,168	1,144	1,005	951	918	903
China	**376**	**494**	**529**	**507**	**539**	**606**
World	42,166	42,776	46,778	45,938	48,338	48,430

(Source: Automotive World Quarterly, 1/2000 p254. Note: USA and Canada include light trucks)

Total vehicle production in China has grown from 469,000 in 1990, to a peak of 1,592,000 in 1998 – though output fell by 14.3% to 1,365,000 in 1999 (EIU, 1999). In 1990, passenger cars accounted for only 9.0% of output. Although the share of passenger cars has grown, reaching 30.4% of total output by 1999, production remains dominated by commercial vehicles. China is the fourth largest producer of commercial vehicles in the world (Ward's, 1999 p14) and is expected, assuming economic growth continues, to become the second largest truck market in the world by 2005. Still as Table 2 shows, in an industry where scale is important, China accounts for just over 1% of global car production. Table 3 shows the main vehicle producers in China, where it is evident that overall production volumes are not high.

Table 3 The main vehicle producers in China, 1998

Company	Market segments	Production 000s (% total)	Comments
First Automotive Group	All classes of commercial vehicle, cars	288.0 (18)	Licenced production of Audi 80, (now A6) and VW Jetta. 40% VW Audi Group.
Shanghi Automotive	Cars	230.0 (14)	Licenced production of VW Passat and GM Buick. 15% VW Audi Group
Dongfeng	All classes of commercial vehicle, cars	190.0 (12)	Licenced production of Citroen 505 , Volcane. 25% Citroen (PSA).
Tianjin Automotive	Light commercial vehicles, cars	160.0 (10)	Produces Daihatsu Charade under licence; New agreement with Toyota to produce Yaris. No foreign ownership.
Beijing Automotive	Light & heavy commercial vehicles, cars	81.0 (5)	Produces Jeep Cherokee under licence; 42% DCX
Chan'an Automotive	Cars, minivehicles	70.0 (4)	Equity links to Suzuki

(Source: EIU, 1999 p19; CAIR)

The three largest companies accounted for 44% of vehicles produced in 1998, but there remains a very long 'tail' of smaller producers, especially in the commercial vehicle sector. It is clear from Table 3 that almost all the vehicle producers in China already involve joint-venture operations. This trend continues, with Hyundai announcing an agreement with Jiangsu Yueda Group (already producing the Kia Pride under licence) to invest US$300 million in new capacity to produce a small car (Just-Auto, 2000). What Table 2 does not show is that there are a very large number of much smaller vehicle manufacturers in China – well over 120 (Xing, 1997) producing very low volumes. This means that average per-plant output is in the region of 10,000 units per annum in China. In the contemporary global industry, per-model production volumes of core platforms can exceed 2 million units per annum while at plant level the optimum high volume configuration is one or two models with output in the region of 350-400,000 per annum. The highest efficiency plants world-wide produce over 100 cars per worker per annum, while the lowest throughput times are in the range 12-14 hours per car. Chinese production cannot match this performance, despite making much simpler, more standardised and lower quality products. Equally, there can be huge operational difficulties for automotive companies in China. In the latter 1990s Peugeot pulled out of their joint venture plant when the company was unable to reconcile local political demands with profitable operation (see Harwit, 1997), although their place has now been taken by Honda.

Access to the most recent product and process technologies will not in itself transform the competitiveness of the automotive industry in China. The industry at a global level is itself undergoing a process of profound change but that process is constrained by social, cultural

and institutional forces in the industrialised countries. The developing economies may therefore offer both a market opportunity for vehicle manufacturers, and a chance to escape some of these constraints. This appears to be the case in, for example, the experiments in production organisation currently underway in Brazil by VW, GM and Ford (see for example, Pires, 1998; Calman, 2000). It is also significant that Fiat chose Brazil as the central production facility for their Palio model – a car designed specifically for emerging markets. Evidently, issues such as labour organisation, working hours and pay, working practices and social costs are all part of the competitive equation.

Equally, the industry at a global level has been subject to profound sustainability and business critiques (Schuller, 2000; Freund and Martin, 1993; Keoleian, G. et al 1997; Maxton and Wormald, 1994; Hawken et al, 1999). One of the reasons for the consolidation of vehicle manufacturers is to mitigate the costs and risks associated with the development of a plethora of new technologies that in some respects may offer improved environmental performance (Wells and Nieuwenhuis, 2000a). Associated with these developments are regulatory regimes and voluntarist agreements in the industrialised countries that shape the basic requirements of market entry. Producers in emerging economies will need to keep apace with these technologies, or risk market exclusion. Moreover, emerging economies will not want to be seen as the repositories of outdated technologies, especially as the urban areas of emerging economies have some of the worst environmental problems in the world.

2.2 The market

Despite the consolidation noted above, platform strategies, modular supply, lean distribution and a host of other strategies, car production is a barely profitable business. The automotive industry continues to seek expanding markets, with the 'under-industrialised' emerging economies as the focus of attention. China, as with other 'developing' economies, is attractive to global corporations because of the market potential of over 1.3 billion consumers (Xing, 1997; Schlevogt, 2000). As one industry executive has put it, 'There are people here with money, and they will buy Buicks' (Zahner, 1999). It is widely believed that markets in the industrialised world are essentially saturated, able to generate only replacement demand. Volume growth is therefore to be generated by the geographic expansion of markets: regions such as South America, Eastern Europe and Asia are thought to offer long term growth prospects. In terms of the measures normally used in the automotive industry, China is evidently under-motorised compared with the industrialised countries. China had 157 people per car in 1998, compared with 1.3 in the US, 1.8 in Japan (SMMT, 1999). The countries that have more people per car than China are few, and include some of the poorest in the world such as Burma, Bangladesh and Vietnam.

Inevitably, however, the collective automotive industry over-invests in the eagerness of each company not to be excluded from the growth prospects. The explanations for lower than expected growth rates in new car sales in emerging economies are partly economic. Wealth has not been generated and / or distributed at the level expected while the product offered to consumers has tended to be of high cost and low quality. However, it is insufficiently appreciated just how 'constructed' the market for cars really is. The established markets take the elements of this construction or 'technology regime' that support the purchase and use of cars for granted. Such elements include: the physical

infrastructure (roads, car parks, shops, etc. suited to car use); the business support network (car dealerships, repairs, fuel, roadside rescue, parts); an enforceable regulatory regime (driver and vehicle testing, traffic control, insurance, policing); and cultural attitudes (driver/ pedestrian behaviour, propensity to save/borrow, use of credit to purchase goods). In terms of economic structures, the automotive industry has strong mutual dependency links and convergent interests with several sectors including steel, aluminium, advertising and electronics. Emerging markets are often different from the industrialised countries in terms of the totality of these support structures, and these differences may matter. Thus it is not surprising that with a period of rapid motorisation China has become a nation of learner drivers at a time when the road network in urban areas is over-whelmed. The result is an appalling accident rate and chronic road congestion. It is illustrative that in 1999 at least 80,000 people died as a result of traffic accidents in China, with parents driving their children to school because it is no longer safe for them to walk (Xin, 2000).

The market in China is quite different to that prevailing in the established industrial countries. Private purchases of new cars are comparatively rare: new cars are bought by state administrations, state enterprises, taxi companies, and the emerging private enterprises. There is virtually no market for used cars with vehicles retained by the first owner for the entire useful working life, only a rudimentary service network, and a lack of credit facilities. Cars account for a relatively small proportion of the total market, about 30% in 1998.

After some years of growth, the market in China fell in 1999, by about 12% to 1,340,000 (all classes of vehicle) and is expected to decline again (EIU, 1999). Industry analysts are wary of forecasting further growth in sales, pointing to recent economic and political turbulence – a mid-range estimate being a market of 2 million units by 2005. Yet such are the uncertainties that some believe the market could be 50 million units by 2010 (Just-Auto, 2000). A market of 50 million units would double current global vehicle sales, and would require China to buy vehicles at the rate seen in the United States. There are some legitimate imports into China (a few thousand per year), and an unknown quantity of illegal imports. In Beijing there is a surprising array of brands and models available, including relatively exotic cars such as the Alfa Romeo GTV.

3. AUTOMOTIVE INDUSTRY POLICY IN CHINA: A BRIEF HISTORY

Overall, the main policies of importance to the automotive industry in China have been those concerned with economic issues. Rules over foreign trade and investment have shaped the character of economic development in the Chinese automotive industry, and will continue to do so (Prime and Park, 1997). However, in the future the more ‘domestic’ economic issues such as under-employment, the indebtedness of the financial sector and most of the state-owned enterprises, wages levels and inflation will be of greater importance in determining China’s place in the global automotive production system. China appears set on a path of economic liberalism within the ‘one country, two systems’ framework. This involves retaining (and reforming) the State Owned Enterprises, along with the one-party system, while allowing the expansion of foreign trade and ownership of capital. Over the period beginning in about 1979, China has adopted a series of measures both with respect to trade and internal policies on the route towards global economic

integration that has culminated in accession to the World Trade Organisation. While this strategy has not been entirely consistent or coherent, the overall thrust of policy-making has been the understanding that the modernisation of China could not be achieved in isolation. Rather, access to external capital and technological resources is now seen as the mechanism to bring material prosperity to China (Chartier, 1998; Prime and Park, 1997). Policy-makers in China seem aware of the potential problems, both environmental and socio-political, that rapid economic development can bring (Wu and Flynn, 1995). However, these policy-makers remain locked into a centralist form of green modernisation and environmental moralism (Yanarella and Bartilow, 2000), as is shown in the discussion on automotive industry policy.

China was relatively late to engage in vehicle production, such that in the in terms of passenger cars the first domestic product did not appear until 1963. The development of the industry can usefully be divided into the following phases:

- First phase 1949-1980. In this period the automotive industry was small scale, with output reaching 200,000 units per annum by 1980 – by which time the share of passenger cars was just 2.4% (SIC, 2000 p16) – using very dated product designs.

- Second phase 1981-1993. In this phase China sought to lay the foundations for a 'modern' automotive industry. 1980 marked the introduction of the VW Passat (Santana) model at Shanghi, while in 1987 three enterprises were selected as passenger car production centres (First Automotive Works; Second Automotive Works; Shanghi Automotive Industry Corporation). By 1992 total output reached just over 1 million units.

- Third phase 1993-2000. This phase has seen the reinforcement of the central role of the automotive industry in the economy, in particular through the 14th National Party's Congress in 1992 that set the sector strategy. By 1999 output was about 1.8 million of which 30.9% were passenger cars. By this phase contemporary or near-contemporary products were being introduced (e.g. the Audi A6, Honda Accord, GM Buick).

In the 9th Five Year Plan the automotive industry was talked of terms of being a 'pillar' industry, meaning it had a central place in the economic development of the country. The intention of the 'pillar' concept was to ensure that investment was not scattered across industries, and that the target industries would then stimulate other sectors. In 1986 the automotive industry accounted for 2.5% of all manufacturing in China (as measured by output value), by 1997 it has grown to 4.2% (SIC, 2000 p20). At the same time, the Chinese government has a clear view of sustainability where economic development is of primary importance. In broad terms, sustainable development in China has the following elements (SIC, 2000):

- An emphasis on economic development to alleviate poverty and provide the material basis for environmental protection
- Control of population growth rates along with the provision of employment
- The sustainable use of resources, starting with eco-efficiency
- An emphasis on the needs of future generations

- The integration of sustainable development policy in China with that promoted world-wide.
- To put in place the monitoring and management systems, education links, etc. to support the strategy of sustainable development.

It is interesting to note that Chinese planners have excluded tractors from their definition of the automotive industry. This is a critical omission because these two-stroke diesels (with very poor emissions performance) perform multifarious tasks in the countryside and urban fringes – including transportation of goods and people. Furthermore these vehicles, by far the most popular in China, have been developed by many manufacturing operations and without any centralised government planning and support – in distinct contrast to the 'high profile' car sector.

However, environmental issues have not been ignored. In 1992, following the Rio Earth Summit, the Chinese government introduced 'Ten counter-measures of environment and development in China' and, under Local Agenda 21, has sought strategies for sustainable development (SIC, 2000). Sustainable development was recognised as a guiding principle in the 9th Five Year Plan. Principles specific to the automotive industry include:

- The improvement of productivity in the industry, the scale of output, and it's overall competitiveness
- The generation of employment, including in supplier companies, while also providing Chinese consumers with vehicles
- The control of environmental and health costs of vehicle manufacturing and use

Underneath these principles are a series of policy measures designed to meet some or all of the objectives. The key measures are:

- The enactment of government industrial policies for the automotive sector as a designated 'pillar' industry
- The use of import quotas and tariffs (to be phased out under the WTO accession agreement)
- The imposition of an automobile consumption tax (from 1993) and automobile acquisition fee (from 1994) in order to control demand
- The imposition of taxes on fuel in order to generate the funds required for road building and maintenance
- The introduction of an automobile discard law (in 1986) to remove older vehicles from the parc
- The requirement for vehicles to conform to various emission standards, issued in 1993
- The removal of lead in petrol (commenced in 1998 in the major cities)
- The requirement for vehicles to be examined on an annual basis to ensure safe and efficient operation

Air quality problems have long been a concern in major urban areas in China, and continue to be a priority – indeed the tractors mentioned above are forbidden to enter urban areas for precisely this reason. The administrative authorities of major urban areas have considerable power, and have sought to impose measures to improve air quality – including the tractor

bans. One interesting policy has been the treatment of old vehicles. Despite the shortage of vehicles in China, in 1986 rules were introduced to ensure older and high-milage vehicles were scrapped: the detailed rules depend upon the class of vehicle concerned. For passenger cars, scrapping is mandatory after 10 years; after 500,000 km; if damaged beyond repair; if spare parts are no longer available to support the car; or if fuel consumption is 15% or more higher than the tested standard for that model. The policy is implemented through the police, though no data are available as to its effectiveness. The introduction of this measure reflects the poor quality of the vehicles (even when new) and the weakness of the maintenance infrastructure in China, but has the environmental benefit that the parc is relatively young compared with most emerging economies.

4. POLICY OPTIONS FOR CHINA WITH RESPECT TO THE AUTOMOTIVE INDUSTRY OVER THE PERIOD 2000-2005

The attempt to introduce sustainability into the 2000-2005 plan period represents an enormous challenge for China. Almost all the key industrial sectors are replete with environmental problems, not least the automotive sector.

In an era when direct state control in China will inevitably decline, the scope for policy options is reduced. At the same time, the inter-connectedness of issues in sustainable development means many agencies both within and without the state will need to be co-ordinated. China will further face the economic stresses of WTO accession (Chartier, 1998). Here two possible strategies are identified. The first is that of global integration. If successful, China would be left with a viable automotive industry, albeit one owned and controlled by global companies, and a positive automotive trade balance. The alternative strategy is that of regulatory niche management to construct the market in such a way as to support the development of micro-factory retailing. In practical terms the two strategies are not mutually exclusive. Rather, the period of the 2000-2005 plan can be used to establish the existing industry on a competitive level, while putting in place the measures needed to develop the longer-term strategy of sustainability. In this sense the two strategies are not mutually exclusive in the short to medium term.

Wider issues associated with car use are not addressed in this paper, although it is recognised that issues such as transport and urban planning are a vital component of sustainable development and mobility. A key issue for China is to ensure that the use of bicycles is not sacrificed to the needs of motor vehicles in urban areas.

4.1 Global integration

There appears to be scant prospects of the automotive industry in China pursuing an independent development path. Indeed, the issue of greatest concern is that production facilities in China will be exposed as uncompetitive as trade barriers are removed. The global integration strategy is therefore to accept the inevitable, but attempt to ensure China emerges as a regional hub within the global production networks of the major vehicle manufacturers.

This means producing to global standards in terms of quality, environmental performance, and productivity. Low labour cost is in itself not a resilient source of competitive advantage in the capital-intensive automotive industry, although in a cost-conscious industry it does still matter. The critical production issues are those of labour organisation and working practices, and the extent to which the Chinese are prepared to acquiesce to the demands of the vehicle manufacturers. Reliance must be placed on external capital and technology, a position that places the vehicle manufacturers in a powerful position. If Chinese policy-makers are unable to construct an operating environment suited to the vehicle manufacturers, either now or in the future, investment will not be forthcoming – and China cannot afford to import vehicles to meet all market requirements.

In order to promote the regional hub concept China will have to continue with the existing industrial policy, concentrating resources on a small number of vehicle manufacturers. Inevitably, the vast majority of the smaller vehicle manufacturers will be unable to compete in the domestic market. Supply to the domestic market will remain the critical issue: only very rarely (as in the VW Setubal plant in Portugal for example) is the majority of production exported beyond national boundaries so it is unlikely that a new plant could be established in China as an export-only platform. Interestingly, GM has just started exporting the Zafira model from a plant in Thailand back to European markets.

There is scant scope for significant export markets for the automotive industry in China, either within the immediate region or at a global scale, within the time period of the 2000-2005 plan. Potential target regional markets are already developing their own industries (and equally intending to increase exports, as with the Thailand case above), while global over-capacity ensures endemic over-supply. Quite apart from the low productivity of car assembly plants in China, the materials and component supply base lacks many key product technologies and production processes. It is indicative that sheet steel for car bodies has to be imported from Japan for the Xiali plant in Tianjin for example, even though China has a huge steel industry. As contemporary thinking on production organisation in the automotive industry presupposes proximate suppliers delivering complex modules in sequence to the assembly process, it is evident that the development of the supply base is as much a priority as that of vehicle assembly itself. Local content requirements (on value added per vehicle, ex-works) have hitherto been modest, only 40% is expected in China compared with 80% in the case of the European Union (until 2000 when import limits were dropped).

There is also the logical move of following global emissions standards for petrol and diesel engines. At present there is no single set of uniform emissions tests and standards that applies world-wide. Rather, there are broadly similar, but in detail different, standards in force in Japan, North America and Europe. China should seek to follow these standards on emissions and fuel quality.

China also needs to put into place the mechanisms and measures needed to monitor progress in terms of sustainable development. Measurement of air quality, for example, needs more comprehensive treatment. Equally, while some of the vehicle manufacturers in China have ISO14001, they are exceptional. Further to this point, China needs Life Cycle Analysis information for cars manufactured and used in China in order to guide future policy – though clearly this is a major task.

4.2 The micro-factory retailing concept

As noted above, the global automotive industry is itself undergoing huge changes in organisation, in the product, and in functional activities such as manufacturing and retailing. The danger for China is that the country will be burdened with an industrial 'model' that is obsolete and over which there is little local control. This is the chief problem with the 'regional hub' strategy. Given the power and scope of the vehicle manufacturers it is difficult to conceive of any alternative. However, the concept of micro-factory retailing (MFR) is an attempt to provide an alternative model, applicable to the established industrialised countries as well as the developing world (Wells and Nieuwenhuis, 1999), that deals with the industry and market in a cohesive manner.

The MFR concept starts with the identification of the key characteristics in the current industrial model. The basic features of contemporary vehicle manufacturing are the following:

- Large capital cost manufacturing plants
- Manufacturing processes that impose large environmental burdens
- All-steel cars of a general purpose design
- Intensive consumption of virgin raw materials
- Dense networks of suppliers
- Geographically extensive markets
- Long logistics lines for finished products
- Large networks of franchised dealerships for car retailing and aftermarket activities

Despite many measures, traditional manufacturing and distribution faces problems within the established industrialised countries. The high capital costs with very 'lumpy' investment in plant and models inherent in Budd technology are also high risk for low reward (Wells and Nieuwenhuis, 2000b). There is endemic over-supply of new cars, leading to discounting on new car prices and the rapid erosion of residual values in older vehicles such that the product becomes economically obsolete. At the same time, the introduction of a new model can often lead to long delivery times for customer-ordered cars. The inflexibility of manufacturing is exposed as an inability to adjust output to demand and difficulties in switching from one model to another – responding to increasingly violent market fluctuations is difficult with existing technology despite the huge advances made in manufacturing processes. The reliance on continued sales of new car as the main source of revenue growth is increasingly untenable in developed markets, while costs rise as shorter model cycles lead to lower per model lifetime volumes. These problems are exacerbated in China. Traditional manufacturing only results in cheap vehicles for consumers under optimum (high volume) conditions. Those conditions do not pertain in China, so the result in vehicles with a high per-unit cost. Moreover, the established structure in the automotive industry includes a network of dealerships in order to sell, service and maintain cars in use. In total, this too demands a large investment in buildings and equipment, although in most cases the vehicle manufacturers do not bear this cost directly. Still, ex-works distribution and retailing account for 23-35% of the market price of a new car.

Table 4 The investment costs of MFR compared with traditional manufacture and distribution

Item	MFR	Traditional
Volume per plant	5,000	250,000
No. of plants	50	1
Workers per plant	100	3,000
Total staff in production	5,000	3,000
Investment per plant	£50 m	£1.5 bn
Total investment in production	£2.5 bn	£1.5 bn
Model R&D cost	£100 m	£500 m
Model specific dies, etc.	£250 m	£500 m
Total investment in model	£350 m	£1.0 bn
No. of dealerships	0	500
Staff in distribution	0	5,000
Investment per dealer	£0	£3 m
Total investment in distribution	£0	£1.5 bn
Total investment	£2.85 bn	£4.0 bn

(Source: Wells and Nieuwenhuis, 1999) Note: Assumes 500 new car sales per dealer, investment cost of £3 million per dealer and 50 staff per dealer for traditional retail. Assumes £5 million per micro factory in model specific dies, etc.)

Ironically, product-cost pressures have been a key factor in the retention of the all-steel body that is central to Buddist manufacturing. On a per-unit, manufacturing-cost basis the all-steel car is cheap compared with any alternative – but only as long as high production volumes are maintained. The automotive industry has striven to attain these volumes. Consumers and the environment ultimately pay the cost of the greater mass of all-steel cars that, as Hawken et al (1999) have demonstrated, are extremely eco-inefficient. Interestingly, the search for economies of scale within Budd technologies inevitably results in general-purpose designs of mass appeal. These designs embody huge redundancies, aspects of performance that are rarely, if ever, used. An average car is idle 95% of the time. It has a useful range of over 400km while the average trip length is considerably less than 40km; it may have a top speed of 220kph when the legal limit is 140kph; it can seat five adults, but often carries only one. In short, the lack of specialisation in product can also be regarded as a contributor to eco-inefficiency and hence a barrier to sustainability.

With micro-factory retailing the terms of competition are changed. Table 4 presents a hypothetical comparison between traditional manufacturing and micro-factory retailing. Rather than seeking to match the high-volume, low unit cost approach of traditional

manufacturing and distribution, micro-factory retailing (MFR) refutes that logic by placing small factories within the markets they serve - and so eliminates the distinction between production and retailing. Rather than having one large plant producing, say 250,000 cars per annum the MFR approach would involve 50 plants, each assembling 5,000 cars per annum (i.e. 250,000 in total). Neither is there a necessity to produce 250,000 essentially identical models, the high flexibility inherent in MFR would allow many product designs, and hence foster design solutions appropriate to the location and having greater use-specific environmental efficiency. There would be no separate distribution channels or sales outlets: the factory is also the sales, maintenance, service and repair location. Powertrain components and other generic items could be centrally produced in conveniently located highly automated facilities for distribution to the decentralised assembly plants, thus benefiting from economies of scale. Ironically this would conform to the early Ford dictum of 'manufacturing near the source of supply and assembling near the point of distribution.'

In principle at least, MFR resonates with many sustainability concerns. The low capital intensity is relevant to countries such as China where investment funds are lacking. The incremental nature of the investments contributes to risk reduction. The structure of an MFR-economy is decentralised, local, labour intensive, and hence distributes wealth generation and acts as a mechanism to prevent the drift of the rural under-employed to the cities. The existing low-volume producers in China, branded 'inefficient' by Buddist standards, could become MFR operations. In addition, this decentralised structure also means that the affects of changes in market demand, new investments, etc. become dissipated across geographic space creating a more robust economy without 'hot spots' of growth or decline. The manufacturing processes of MFR (there are several candidate technologies) are in general of lower environmental impact than contemporary car plants, for example MFR can dispense with the traditional automotive paint shop. With the MFR concept the cars can use materials other than steel, materials that offer greater durability and lower weight – with all the attendant environmental benefits.

In the longer term, the MFR model is not premised on the continued consumption of raw materials in order to produce ever-greater volumes of new cars. Rather, it is a model conceived as the embodiment of concepts such as product stewardship where revenues are earned over the entire product life-cycle. Over a period of time the emphasis of work in the factory could shift from new car production to repair, maintenance, retro-fits, and recycling. This ability to escape dependence upon continued sales of new car as a source of income is a further contributor to the economic resilience of MFR operations, a factor of some importance in view of the large fluctuations in economic performance (and hence new car sales) that many countries endure.

With respect to ownership, the MFR model could be adapted to a variety of different business structures. At one extreme, it could be developed by an existing vehicle manufacturer, perhaps as a means of launching a new 'eco' brand, with full ownership retained (Wells and Nieuwenhuis, 2000b). Alternatively, the vehicle 'manufacturer' could in practice franchise the concept to third parties in a manner similar to that used for dealerships. However, the MFR concept dramatically lowers the barriers to entry into the automotive industry and to that extent is appropriate to small and medium-sized enterprises, local co-operatives, or family businesses. One interesting possibility is that a

large user group (say the Beijing taxi company) would provide an ideal market for the MFR concept, and could therefore undertake the investment themselves.

China could explore the use of regulatory measures to provide a 'hospitable' climate for the emergence of a network of vibrant, indigenous, small-scale manufacturers of cars. An interesting example is that of the 'kei' class of micro-cars in Japan. In brief, for taxation purposes cars in Japan fall into one of three classes. The kei class is unique in the world, defining the cars by the external dimensions, weight and engine size. The government supports the kei class market with fiscal and other incentives because of the contribution made to improvements in fuel efficiency, reduced parking space needs, and a (marginal) reduction in traffic congestion. An interesting feature of the kei class market in Japan is that only certain local vehicle manufacturers are present, there are no imports. Overall, the kei class accounted for over 25% of sales in Japan in 1999 (JAN, 2000). So, on the basis of environmental and other needs, Japan has effectively protected an important segment of the industry.

By defining environmental or sustainable market niches, it is possible to create conditions that are unsuitable for the typical products of contemporary high volume manufacturing and also lay the foundations for a quite different automotive industry. This notion of regulatory niche management as an industrial policy has not been sufficiently explored in the literature. China could legitimately define classes of vehicle on the basis of carbon dioxide emissions, weight, zero emissions capability, renewable resource content, etc. and construct traffic policies, fiscal regimes and other measures around the definitions adopted in order to create the market required.

5 CONCLUSIONS

The attempt to create policies for a sustainable automotive industry in China raises several key issues:

- The problem of sequencing or prioritisation of policies for sustainable development. There is an inherent contradiction between the desire to achieve a transition to sustainability when the transition process itself may be unsustainable! Some have argued that environmental degradation will increase with economic growth until a certain threshold of income is reached, at which point sufficient wealth is being generated to allow the investments needed for environmental improvement (Cole, 1999; see also for example Baldwin, 1994).

- The paucity of policy measures available. Over the last twenty years the degree of direct and central control exerted by the political structures has been eroded in China while the requirements of the WTO, World Bank, etc. are increasingly the norms that define the scope for policy action. This makes even more vital the exploration of local measures, as advocated by Yanarella and Bartilow (2000).

- The scope for 'environmental' measures to be used as industrial policy. China has legitimate concerns over various environmental issues, notably urban air quality, which

could be used to put in place an environmental regime that provides a domestic haven from the storms of global competition.

- The difficulty of defining an end-point. Does sustainability imply no change? Is it a steady-state economy/society (Hediger, 1997) and if so, when do we know that the process of transition is over? . More pragmatically, how does a country like China determine that it is going in the right direction?

- Can emerging economies 'leapfrog' into advanced and environmentally better technologies, so avoiding the problems encountered in the established industrial economies? The example often cited is mobile telecommunications, but as the case of the automotive industry in China shows, the issues are more complex than simply deciding which technology to use.

- Rather than presenting sustainable development as a 'take it or leave it' option in which the ideal is too remote from pragmatic reality to be achievable, policy-makers need to explore ways to ensure a transition to sustainability, even if in part this means retaining existing (unsustainable) practices.

ACKNOWLEDGEMENTS

This paper derives from work undertaken in 2000 for the Chinese government by Dr P Wells and Dr P Nieuwenhuis on secondment to the United Nations Industrial Development Organisation (UNIDO). The opinions expressed here are those of the author alone.

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