Manufacturing excellence for 21st century production

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Abstract
A new concept, 'Manufacturing excellence', is presented to enhance the suitability of tangible goods production for pursuing human happiness and world peace, whilst eliminating the earth-destructive activity caused by conventional mass production, mass consumption and mass disposal which wastes enormous amounts of valuable natural resources. Several approaches to manufacturing excellence — CIM-led factory automation, human-centred flexible manufacture, production for customer satisfaction, green production for environmental elegance, high added-value production, etc. — are discussed. Finally, socially appropriate manufacturing is proposed as a production perspective for the 21st century.

1. INTRODUCTION
Manufacturing — to produce tangible goods or products — has been a basic historical activity for several thousand years and contains the following three important features [1]:
1. Basic means of human existence. Without manufacture or production of goods the human being is unable to live.
2. Creation of wealth of nations. Wealth of a country or a nation is created by manufacturing. A country where manufacturing has been exhausted becomes poor and weakened.
3. Steps toward human happiness and world peace. An affluent and prosperous country can provide welfare and happiness; such a country no longer needs war to invade other countries or nations; manufacture of weapons then ceases, thereby resulting in world peace.

The National Academy of Engineering & Sciences in Washington, DC, places 'Manufacturing' as one of the three important subjects necessary for America's economic growth and national security; the others are 'Science' and 'Technology'.

It is indeed such an important activity — but today's manufacturing is faced with a great dilemma in most economically advanced countries. In this article this dilemma is pointed out, and a concept of manufacturing excellence is proposed to cope with the situation. Several methods of putting this concept into reality are discussed, and the ultimate spirit of manufacturing excellence is mentioned as a production perspective as we move towards the 21st century.

2. TODAY'S MANUFACTURING DILEMMA
The dilemma which manufacturing in most advanced countries faces today is summarized in the following.
1. Maturity and saturation of industrial products. Most industrial products have been manufactured and supplied in excess to the markets; hence people no longer have a strong desire to possess them. For example, in Japan a household possesses more than two colour television sets, more than one set of electric vacuum cleaners, refrigerators, washing machines, air conditioners, etc.

2. Low utilization of production facilities. Production capacity is presently in excess, compared to the market demands; hence it is hard for most factories to maintain high rates of machine utilization. For example, "Japan's factories are plodding along at only 74% of capacity" [2].

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3. **Deindustrialization or industrial hollowness.** As labour wages become very high in developed countries compared to developing countries, domestic production of non-sophisticated products can no longer compete with production of these items in the developing countries.

For example, setting Japan’s manufacturing wage (US$306.41 in 1991) at 100, the United States value is 92.8 and Germany’s 113.1, whilst Korea scores 36.4, Thailand 7.4, China 1.5 and so on [3]. Accordingly, manufacturing industries in the advanced countries have shifted to foreign production by installing their factories outside their native land, even into other developed countries to diminish the trade surplus. This phenomenon is called ‘deindustrialization’ or ‘industrial hollowness’.

For example, Japan’s great trade surplus (US$114 billion in 1991, 136 billion in 1992, and 143 billion in 1993) has raised the value of Japanese currency (US$1 = 360 yen in 1949, 308 in 1971, 227 in 1980, 145 in 1990, and 80 in April 1995). This Endaka (up-valuing of the Japanese yen) has enhanced foreign direct investment, totalling US$201 billion up till 1990, which is third in the world after the United States and the United Kingdom. Again, the foreign production rate (= (foreign production)/(domestic production + foreign production) in monetary units) is 6.4% in Japan, in comparison with the US (28%) and Germany (15%). Japan’s overseas production in 1993 was 74% for colour television sets, 64% for microwave ovens, 50% for videotape recorders, etc.

4. **‘3K’ feeling of youngsters.** The young generation now hates to work in factories, which are said to be ‘3K’ in Japan: ‘Kitanai’ (dirty), ‘Kitsui’ (hard work) and ‘Kiken’ (dangerous). Few skilled workers or craftsmen remain in workshops, and useful skills and techniques are no longer passed on.

For example, advanced countries cannot compete with developing countries in production skills; the number of gold medals obtained in the ‘Skills Olympics’ in 1993 was 18 for Taiwan and 12 for Korea, compared with 3 for Germany, 2 for France and Japan, and 0 for the United States and the United Kingdom.

5. **Earth destruction or geo-catastrophe.** Excess mass production in capitalistic societies consumes excessive natural resources — materials and energy. This contaminates the environment and may even lead to geo-catastrophe.

For example, the world’s energy consumption had increased more than sixfold by 1990, compared to 1950. The world’s energy resources will last only about 50 years for petroleum and natural gas, about 75 years for uranium. Coal will last more than 200 years.

Automobile production consumes a great amount of resources: 17% of the iron and steel produced, 36% of bearings, 27% of machine tools, more than 40% of dies, etc. [4]. Around 10% of the cars produced (more than 5 million cars in Japan) are dumped every year; the disposed materials amount to 15–25% in weight.

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**3. CONCEPT OF MANUFACTURING EXCELLENCE**

**3.1 Manufacturing excellence defined**

‘Manufacturing excellence’ is now proposed as a keyword expressing the enhancement of the suitability of goods production for pursuing human happiness, while being rid of excess production, deindustrialisation, ‘3K’ and earth-destructive operations [5]. This word has been employed since 1984 [6] in a few works without any clear definition or with a narrow sense; for example, ‘just-in-time’, ‘total quality’ and ‘total people involvement’ are indicated as ways to attain manufacturing excellence [7]. Alternatively, it means continuous small improvements of all activities of the manufacturing firm in an attempt to win the competitive edge [8].

**3.2 Manufacturing culture**

A similar term to ‘manufacturing excellence’ is ‘manufacturing culture’. Orientation of culture to production was pointed out earlier [9] than manufacturing excellence.

The word ‘culture’ appeared in 1480¹, meaning worship. Its fundamental meaning ‘cultivate’, which comes from the Latin word colere, appeared in 1620; incidentally, ‘agriculture’ appeared earlier in 1603. In some cases culture means produce or crops; however, nowadays it is an abstract noun meaning intellectual and artistic activities such as philosophy, history, literature, art, music, sculpture, drama, etc. [10].

Putting manufacturing as an adjective before culture gives us ‘manufacturing culture’. Terms similar to manufacturing culture are ‘industrial culture’ and ‘corporate/enterprise culture’. In addition, another expression, ‘manufacturing renaissance’ means the restructure of goods production by constructing ‘amenity’ factories for human well-being. A term ‘industrial renaissance’ also exists.

‘Culture’ usually holds a positive meaning or spirit, as above, but it is often used with a negative — sarcastic, ridiculous or shallow-minded — connotation; e.g. monoculture, mass culture, pop culture, throw-away culture, etc. From this standpoint ‘manufacturing culture’ might be misunderstood as throw-away culture through mass production and mass consumption, even mass disposal. This is a reason why ‘manufacturing excellence’ is used in this article to enhance the elegance of goods production, rather than ‘manufacturing culture’.

**3.3 Cultural/civilized production**

Incidentally, there exists a term ‘cultural production’, meaning immaterial production such as art, literature, etc. [11]. It should be noted that Aristotle (384–322 BC) established an academic subject of ‘producing things’ in the Greek age, but production (poiesis), based upon production technique (poietike technē), was of poetry, not tangible goods [12].

An expression ‘civilized production’ exists in

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¹ Chronological figures throughout this paper are mostly based upon The Shorter Oxford English Dictionary on Historical Principles, Oxford University Press, 1973.
China. Often 'culture' is regionally restricted, while 'civilization' (which appeared in 1704) means a mode of state of human activity applicable all over the world [13]. But occasionally civilization means materialistic civilized production; these two words are often employed synonymously. 'Civilized production' then means just clean operation in a workshop. Additionally, it often means manufacturing based upon modern science and technology.

3.4 Present meaning of manufacturing and production

The term 'manufacture' originally appeared in 1622, stemming from the Latin manu factum (made by hand) and meaning the production of tangible or material goods ('products'). 'Production', on the other hand, appeared in 1483, stemming from producere (lead forward), and means making something new — either tangible or intangible ('service'). However, the present meaning of 'manufacturing' has widened into 'the conversion of a design into a finished product', while 'production' has a narrower sense, namely the physical act of making the product [14]. In 1983, CIRP (International Conference on Production Engineering) defined 'manufacturing' as "a series of interrelated activities and operations involving the design, materials selection, planning, manufacturing production, quality assurance, management and marketing of the products of the manufacturing industries".

4. APPROACHES TO MANUFACTURING EXCELLENCE

4.1 Automated production: CIM systems

A way to get rid of '3K' is to establish 'amenity' factories through automation. This tendency is now directed toward CIM (computer-integrated manufacturing) systems. CIM is a computerized system which integrates the computer aided of the following three different functions with a common database [15], based upon the academic discipline of 'manufacturing systems engineering' [16]:

1. computer aid to the production function (automated flow of materials: procurement — production — quality control — process control — cost control — distribution/sales): Computer-aided manufacturing (CAM);
2. computer aid to the design function (automated flow of technological information: research and development — product design — process design — layout design): Computer-aided design (CAD);
3. computer aid to the management function (automated flow of managerial information: sales planning — production planning — operation scheduling): Computer-aided planning (CAP).

CIM was advocated in 1973 by J. Harrington [17]; its automated flow of information can be understood as a 'SIS' (strategic information system), a term coined by C. Wiseman [18] in 1985. The SIS is mainly concerned with efficient operations of service industries. It is important to note that CIM is not a mere information system as SIS is, but is deeply concerned with 'goods' production.

4.2 Flexible/human-centred production

Technology-centred full automation, mainly comprising highly advanced production technologies, is not only insufficiently flexible but is also characterized by a lack of innovative flexibility, greater vulnerability to failure and, above all, neglect of human skills, robbing workers of their pride and pleasure of work [19], in spite of an enormous amount of capital investment (e.g. 3600 billion yen in Japan (~ US$28 billion) in 1989).

Harrington stated that "CIM does not mean an automated factory; people are very much involved". Manufacturing a variety of products of super-high quality with the use of high technologies, but still drawing heavily on skills of workers, is what flexible manufacture [20] or a 'human-centred' (anthropocentric) system [21] is all about. It means, for example, no conveyors in automobile assembly factories (Volvo in Sweden, Honda in Japan), industrial community systems run by craftsmen in Italy, flexible manufacturing by workers' own networks in the United States, and other human-driven enterprises. This mode of production pays attention to a new metaphysical 'production philoso-technology' beyond the conventional subjective 'production skills/techniques' and objective 'production technology'.

4.3 Manufacturing for customer satisfaction

Mass production of a single product, as instanced by the Model T Ford, is over; today, manufacturing firms must supply what consumers need quickly by minimizing the production leadtime. Cellular manufacturing, making a variety of products in the just-in-time mode, has replaced traditional flow-line manufacturing. There is no limit to what products will be made in this way in the future [22].

This new type of manufacturing is now called quick response manufacturing [23].

For example, Dell Computer, who received a customized product on Wednesday at 10:49 a.m., completed that computer at 8:37 p.m. on that day; the customer received the product on Friday at 10:31 a.m. [24]. In this sense, manufacturing is not only a means to produce tangible goods, but it is 'service' [25].

4.4 Resource-saving and environment-preserving (green) production

4.4.1 Japan's industrial activity

Although having very limited natural resources, i.e. occupying only 0.3% of the world's land but, with a population of 123 million, containing 2.3% of the world's people, Japan has been an economic power producing 13.7% (US$2986 billion in 1990) of the whole world's GNP (gross national product) — the world's second largest economy after the United States (US$5522 billion or 25.3%).

However, in Japan, which has built up an affluent
society, as shown in Fig. 1 [26], 1334 million tonnes of domestic natural resources and 711 million tonnes of imported resources (16% of the world’s annual total of resources distributed [27]) were used in 1990 (the latest available data), 1246 million tonnes of buildings, structures and products were accumulated, 73 million tonnes of export products were manufactured and 84 million tonnes of food (1.9 kg/day per capita) were consumed.

On the other hand, 419 million tonnes of resources were used as energy to support these activities whilst producing industrial wastes (19 kinds) of 222 million tonnes and general wastes (also generated from industrial activities) of 51 million tonnes, consequently amounting in total to 273 million tonnes. The resources that were recycled amounted to 182 million tonnes, approximately 8% of the total resources used.

Viewing the import and export of materials and products to and from Japan, the export is only 73 million tonnes whilst the import is 711 million tonnes, showing an extreme imbalance. In the case of Britain, an island country like Japan, both import and export amount to approximately 150 million tonnes and are well balanced; incidentally, the United States, which is a big country with a huge amount of resources, imported 295 million tonnes and exported 410 million tonnes in 1986 [28 (quoting an OECD report)].

The resource balance in Japan is abnormal and all Japanese islands are becoming garbage-dumping grounds. Excessive accumulation of materials over time is indicated by the shaded region in Fig. 2. Though Japan is a leading export country in financial balance (export: $306.6 billion with a surplus of $103.3 billion (but only 3% of GDP) in 1991), it is an extremely conspicuous import country in material-resource balance.

4.4.2 Net national welfare

Environmental pollution, resulting from the above garbage dumping and urbanization, reduces the value of the nominal GNP. The 'green GNP' or 'net national welfare' (NNW) [29], which is a measure of preserving the environment in good order and enhancing the quality of human life, has recently been declining; that is, in Japan NNW as a percentage of GNP was 94% in 1975, 86% in 1980, 80% in 1985 and 75% in 1990.

4.4.3 Recycle-oriented manufacturing systems

Recognizing the above facts relating to consuming a huge amount of natural resources for industrial and manufacturing activities, design and production in the coming age should be directed to the preservation of a better environment at all stages of the material flow of procurement — production — distribution — consumption — recycling — disposal, in the early stage of design [30], thereby resulting in permanently sustainable development by taking resource saving into account. This is green design/green production.

The material flows in the current society and in the recycle-oriented society are represented in Fig. 3. In the current society, the flow starts with extraction of natural resources from the earth, and is followed by production and consumption; then all the waste is dumped into the environment. On the other hand, in the recycle-oriented society the flow contains a bypath called recycling, in order to reduce the environmental burden to a reasonable level.

The following activities are vital in the recycle-oriented manufacturing system.

1. Considering the recycle of the used materials from the design stage. Product design is undertaken not...
only from the viewpoint of function and quality, but by taking efficient recycling and minimum harmful waste discharge into consideration.

2. Enhancing re-production and re-use of the parts. After consumption of the products, parts or materials capable of re-production and re-use are collected.

3. Analysing the cost-effectiveness of the recycling activity. Recycling should be sustained economically. A cost-effectiveness analysis is useful for this purpose; that is, the expense required for recycling should be shared by society or covered by reasonable product pricing.

For example, a model was constructed for a firm using a recycle-oriented manufacturing system, which purchases needed parts from the raw-material suppliers, and assembles a product item with the purchased parts together with the recyclable parts processed inside the firm’s plant. The firm sells reproducible parts to the outside raw-material suppliers. The other wastes are dumped. This firm sets the following two goals:

(i) Maximize the recycling rate for each part beyond a specified aspiration level.
(ii) Maximize the total profit.

Fig. 4 shows a solution which takes account of re-use and re-production of the parts after the product’s use. As seen in this figure, the total profit and recycling rates have a trade-off relationship [31].

4.4.4 Product life cycle assessment

Quantitative analysis and evaluation of the total environmental burden through a product’s life — extraction of natural resources and material balance, energy consumption through production and use of the product, emission of air-contaminating materials and gases, effects on animals and plants, etc. — is known as life-cycle analysis or assessment (LCA). This aims to lessen, even to minimize this environmental burden, and is based upon the total cost-minimum principle.
4.5 High added-value production

4.5.1 Japan’s industrial power

Along with the progress of economic growth, the industrial structure changes from primary industry (agriculture, forestry, fishery and mining) to secondary industry (manufacturing, construction and public utilities) and to tertiary industry (transport, communications, wholesales, retailing, foods and beverage, finance, insurance, real estate, services, medical services, education and others) — a law propounded by W. Petty and C. Clark. When the labour population engaged in tertiary industry exceeds 50%, the country is recognized as an economically advanced country which has entered into a post-industrialized society or an information-oriented society.

In Japan, having peaked at 36.8% in 1973, the secondary industry’s labour population has been on the decline, while that of the tertiary industry exceeded 50% in 1977 and has since been growing.

As indicated in Table 1, in 1990 the Japanese manufacturing industry yielded an output of 39.7% with a labour force of 23.4% (USA: 18.0%; Britain: 20.3%; Germany: 31.5%). Although manufacturing efficiency is certainly high in this respect, a more important scale, added value or GDP (gross domestic product), which represents the newly created value of the total output less the total input, was only 27.5% (USA: 22.1%; Britain: 22.6%; Germany: 37.2%); in this sense, Japan’s manufacturing cannot be said to be extremely efficient [32].

The ‘efficiency index’, defined as the GDP share divided by the labour-force share (of an industrial sector), shows 1.18 (USA: 1.23; Britain: 1.12; Germany: 1.18) in Japan’s manufacturing sector, holding a higher level among all industries. However, the manufacturing of the United States, which has been stagnating in recent years, shows an efficiency index of 1.23; hence the Japanese manufacturing industry is not particularly superior. Moreover, as represented in Fig. 5, Japan’s manufacturing efficiency index was high until 1970; however, this important measure has declined since 1975 in spite of the development of factory automation and CIM.

It is particularly important to note that the ratio of the value added over the output — the ‘yield ratio’ — is 35.5% in Japan’s manufacturing industry, the lowest level among all industrial sectors.

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**Table 1. Japan’s industrial power and efficiency (1990)**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Labour force</th>
<th>Output</th>
<th>Gross domestic product</th>
<th>Yield ratio</th>
<th>Efficiency index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million(^1)</td>
<td>% (a)</td>
<td>Trillion yen(^2)/person</td>
<td>% (b)</td>
<td>(b/a)</td>
</tr>
<tr>
<td>Primary</td>
<td>6.16</td>
<td>9.4</td>
<td>20.31</td>
<td>3.30</td>
<td>2.3</td>
</tr>
<tr>
<td>Agriculture, forestry &amp; fishing</td>
<td>6.06</td>
<td>9.2</td>
<td>18.03</td>
<td>2.98</td>
<td>2.1</td>
</tr>
<tr>
<td>Mining</td>
<td>0.010</td>
<td>0.2</td>
<td>2.29</td>
<td>22.63</td>
<td>0.3</td>
</tr>
<tr>
<td>Secondary</td>
<td>21.73</td>
<td>33.1</td>
<td>456.33</td>
<td>21.00</td>
<td>52.1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>15.35</td>
<td>23.4</td>
<td>348.07</td>
<td>22.68</td>
<td>39.7</td>
</tr>
<tr>
<td>Construction</td>
<td>6.02</td>
<td>9.2</td>
<td>86.19</td>
<td>14.83</td>
<td>10.2</td>
</tr>
<tr>
<td>Electric, gas, &amp; water</td>
<td>0.37</td>
<td>0.6</td>
<td>19.07</td>
<td>51.81</td>
<td>2.2</td>
</tr>
<tr>
<td>Subtotal (Goods production)</td>
<td>27.89</td>
<td>42.9</td>
<td>476.64</td>
<td>17.09</td>
<td>54.4</td>
</tr>
<tr>
<td>Tertiary (Service production)</td>
<td>37.83</td>
<td>57.6</td>
<td>399.98</td>
<td>10.57</td>
<td>45.6</td>
</tr>
<tr>
<td>Commerce</td>
<td>11.70</td>
<td>17.8</td>
<td>84.91</td>
<td>7.26</td>
<td>9.7</td>
</tr>
<tr>
<td>Others</td>
<td>20.70</td>
<td>31.5</td>
<td>255.33</td>
<td>12.34</td>
<td>29.1</td>
</tr>
<tr>
<td>Non-profit</td>
<td>5.43</td>
<td>8.3</td>
<td>59.74</td>
<td>11.01</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>65.72</td>
<td>100</td>
<td>876.62(^4)</td>
<td>13.34(^4)</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^{1}\) US$6054 billion  
\(^{2}\) US$92.1 thousand  
\(^{3}\) US$3096.8 billion  
\(^{4}\) US$47.1 thousand  

4.5.2 Japan's industrial productivity

Manufacturers' policy of high-volume sales at small profits to expand the market share, and their low pricing to overseas markets, often criticized as 'dumping', partly accounts for the low efficiency of Japanese manufacturing.

Therefore, in spite of the fact that the physical productivity of the Japanese manufacturing industry is superior to those of American and European countries (setting Japan's at 100, the US scores 86 and Germany 60), Japan's added-value productivity — GDP per capita in 1990, added value created by manufacturing per employee (per hour) in 1989 — is not so high; it is in fact rather low among advanced countries, as represented by Fig. 6 [33]. Incidentally, Japan's yearly working hours are high: 2076, compared to the US (1961) and Germany (1573).

It should be noted that the productivity of Japan's manufacturing industry was 52% of that of the United States in 1975, and the gap has been closing every year: 60% in 1980, 70% in 1985, 80% in 1990.

4.5.3 Japan's capital utilization

In Japan, added-value productivity is not high, as mentioned above; hence the efficiency of capital utilization is also low. An important financial factor — ROI (rate of return on invested capital) or more specifically ROE (return on equity) — was only 4.8% in Japan in 1993. This is almost the lowest in the world, compared to 18.4% in the United States, 19.1% in Britain and 10.0% in Germany [34].

As another example, sales in 1993, in millions of US dollars, were 68 582 for Hitachi (Japan, No. 6 in the world), 61 385 for Matsushita Electric Industrial (Japan, No. 8) and 60 823 for General Electric (USA, No. 9); but the respective profits earned were 605 (No. 69), 227 (No. 164) and 4315 (No. 3) [35]. Rate of return on sales is, then, 0.9, 0.4 and 7.1 and return on equity is 2.1, 0.7 and 16.7, respectively. Profits earned per employee are: $1830, $8893 and $19437, respectively; Hitachi earned merely 9.4% and Matsushita 4.6% as much as General Electric.

4.5.4 Towards high added-value production

Recognizing such inefficiency of the manufacturing industry, Japan should retreat from a situation of high-volume production and dumping-like sales activities, accompanying little profits obtained. By developing highly original, quality products with high added values, manufacturers will be able to assure themselves appropriate profits through better coordinated production. Cost reduction through cost control activity is especially important in decreasing the total cost of producing an item of product.

5. CONCLUDING REMARKS FOR ULTIMATE MANUFACTURING EXCELLENCE

The advanced countries are now largely responsible for the environmental issues of sustaining our Earth. It is time for such countries, and individual manufacturing firms, to stop excessive production of industrial products accompanying exhaustion of natural resources and global destruction, and to establish a way of obtaining reasonable profits as well as seeking long-term moderate growth, thereby contributing to the public welfare. Otherwise, all mankind will no longer be able to live — "End of production" (J. Baudrillard, 1982).

This is the discipline of 'socially appropriate manufacturing/production' [36]. The essential spirit to support this discipline may be the 'satisfaction-consciousness' based upon Taoism and Buddhism that emerged in the Orient. This vital spirit says that "the man who realizes that he is satisfied is (spiritually) wealthy" (Chapter 33 from the book of Laozi written in ancient China).

Production based upon the spirit of satisfaction-consciousness is 'satisfaction-conscious production'. The traditional excessive 'mass' production should be replaced with this satisfaction-conscious production mode as early as possible. Under this production mode, 'socially useful production' [21] is also undertaken; only durable products are produced, in a quantity as small as society requires.
On the other hand, consumers must also follow ‘satisfaction-conscious’ consumption, namely, to refrain from mass or excessive consumption, and society must proceed toward the goal of ‘minimum disposal’.

The above concept of manufacturing and production is considered to be what we may call the ‘ultimate’ manufacturing excellence (production aesthetics), which should be the vision of the future management strategy of every manufacturing firm.

Socially appropriate manufacturing over the world, or satisfaction-conscious production by each individual manufacturing firm, is not easy; it will be attained by recognition of ‘manufacturing ethics’. There exist the spirit of capitalism based upon the ethics of Protestantism in the West, and the spirit of Buddhism/Confucianism in the East. It is said that the latter idea has contributed to the economic and industrial development of Asian countries in recent years. However, the rate of adopting ethical codes is high in the West; it is rather low in Japan. For example, the rate of adopting the ethical codes by industrial firms is: USA, 85%; Germany, 51%; EC, 41%; whilst Japan remains at 30% [37].

In conclusion, it is now strongly expected that global design, planning, implementation and control/management for socially appropriate manufacturing activities all over the world, including highly advanced countries, developing countries and underdeveloped countries, will be performed nationally and internationally in the coming age — towards the 21st century — pursuing manufacturing excellence in order to forestall the complete exhaustion of natural resources and the global collapse and ruin of our Earth.

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