# Successes, False Starts, and Promises in Manufacturing Engineering: Contrasting Perspectives from Hong Kong and Ukraine

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**Abstract**
This paper presents contrasting perspectives from Ukraine and Hong Kong with regard to the choice of manufacturing technologies and paradigms. With this view, definitions of manufacturing engineering and its constituent themes are first presented. This is followed by an overview of the worldwide changes that have been occurring in terms of manufacturing technologies and paradigms. The perspectives from Ukraine and Hong Kong are then discussed in terms of successes, false starts, and promises. It is noted that the technological choices themselves and their success or otherwise are significantly influenced by the larger socio-political framework within which the manufacturing sector operates. It is suggested that each nation would benefit by engaging in similar analyses.

**Introduction**
Global experiences in the twentieth century point to three broad trends. Firstly, almost every large developed economy in the world has achieved material progress through three sequential but overlapping movements: consolidation and modernization of agriculture, growth of domestic manufacturing followed by its gradual integration into global manufacturing, and growth of the service sector. Smaller economies such as Singapore, Hong Kong, etc., and even Japan, have progressed mainly through impressive performances in the manufacturing and service sectors. Secondly, there has been relentless and ever-increasing penetration of technology into every sector. Thirdly, owing to the emergence of affluent societies, the markets are becoming more and more customer oriented.

Meanwhile, the maturation of manufacturing sectors has followed four sequential but overlapping phases of societal emphasis. The first phase is characterized by competition through productivity (P). In the second phase, the focus shifts to achieving higher quality (Q), i.e. achieving higher consumer satisfaction, while maintaining productivity. The focus in the third phase is on gaining further market share through superior innovation. Innovation here does not necessarily mean major breakthroughs through intensive research and development (R&D). Successful innovation may merely involve sustained incremental innovations to maintain consumer interest.

Three groups in every nation influence the pattern of technological penetration (technology transfer): the politicians and bureaucrats who determine the macro-economic priorities and establish the operational framework for economic activity; the entrepreneurs and the professionals employed by them who actually realize progress in manufacturing; and the academics who “dream” on behalf of the nation and inspire (or, otherwise) youth to herald a new and more glorious tomorrow. Each of these groups has its own sectarian interests. The first group, although professing to promote the material progress of the citizens, is mainly driven by its instinct to survive in the face of continually changing socio-political pressures. Whenever this group has dominated, the free will and self-assertion of the second and third groups has been stifled. In societies where the second group has dominated, a pragmatic view of technology transfer has been taken albeit with the objective of increasing company profits. The role of the third group has generally been limited to that of a catalyst.

This paper aims to present two highly contrasting societal perspectives concerning technological choices and associated paradigms: perspectives from Hong Kong and from Ukraine — with the understanding that, for the purposes of this paper, Ukraine should be taken as being representative of the former USSR. In order to appreciate the conditions that led to these choices, one needs to have at least a cursory historical understanding of the two societies. Hence readers are referred to the two Appendix I and Appendix II which reproduce relevant extracts from [1].

The perspectives concerning choices towards technology and the associated paradigms will be structured in terms of successes, false starts, and promises. "Successes" are defined as those which have been tried by the manufacturing community in the society and broadly accepted as having significantly contributed to short-to-medium term (a horizon of 10 to 20 years) economic growth. "False starts" are defined as those which were tried but have been broadly perceived as having had insignificant impact on short-to-medium-term economic growth. "Promises" are those which are being actively considered by the contemporary manufacturing community in the particular society.

**Definition and Structure of Manufacturing Engineering**

Manufacturing Engineering has been defined by the Society of Manufacturing Engineers (SME) as

"that specialty of professional engineering which requires such education and experience as is necessary to understand, apply and control engineering processes and methods of production of industrial commodities and products, thus requiring the ability to plan the practices of manufacture, to research and develop the tools, processes, machines and equipment and to integrate the facilities and systems by which products may be manufactured economically". The immense scope of manufacturing engineering is clear from the definition. Hence, with a view to restricting this paper to an acceptable size, discussion will be largely confined to the domain of machining of discrete products. Further structuring of the discussion will be achieved through classifying the technological and paradigm choices into three broad themes S, M, and E as defined in [2] (see box).

**The S-Theme (Systems theme**) is concerned with "the organization and manipulation of information concerning the interactions between diverse manufacturing resources (people, money, materials and machines) with a view to meeting specified manufacturing system objectives such as improved productivity, quality, and competitiveness."
**The M-theme (Mechanical theme)** is concerned with "the conceptualization, analysis, selection and application of the mechanical entities (products, production equipment, and tooling) and manufacturing processes ....".
**The E-theme (Electronics/Computers theme)** is concerned with the planning and utilization of electrical/electronic devices, computer hardware and software, and communication and control systems towards flexible control and automation of manufacturing facilities.

Many of the technological choices to be discussed relate to automation which may be broadly defined as the replacement of human effort by machines. Hard automation aims to replace or enhance human muscular effort. Soft automation aims to replace or enhance human mental effort through an exploitation of the power of modern computers. Soft automation may be applied at the unit process level or at the systemic and organizational levels. When applied at the latter levels, soft automation is often called "linking" automation.

**Changing Manufacturing Technologies**

Merchant had made some technological predictions related to the machining sector in the early eighties [3,4]. He noted that there would be a sharp rise in the accuracy achievable in machining and that it would reach 2.5 nm by the mid-seventies. He also anticipated high speed cutting and predicted that cutting speeds would reach 2000 m/min by the same period owing to developments in cutting tool materials and machine tool design. On the side of machine control, he observed that "starting with the introduction of power feed in 1820 and continuing through automatic tracing and numerical cntrol to adaptive control, increased automation has increased productivity tenfold [by 1969]". He then predicted that further improvements will occur through the growing use of computer related technologies which will in turn lead to variable-prgram automation and variable mission systems.

The concepts of variable mission machining systems anticipated by Merchant matured in the eighties into flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM).. "A flexible manufacturing system (FMS) may be defined as a system dealing with high level distributed data processing and automated material flow using computer controlled machines, assembly cells, industrial robots, inspection machines and so on, together with computer integrated materials handling and storage systems [5].” By 1989 there were 800 FMSs in the world of which 82% were for machining [6]. Extrapolating these data, Merchant estimated in 1993 that there would be about 2000 FMSs distributed equally between “high-efficiency” and “compact” systems by the year 2000 [7]. Merchant also opined that artificial intelligence (AI) techniques, such as expert systems, smart sensors, and neural networks would play an increasing role in the years to come [7].

In 1988, the Society of Manufacturing Engineers (SME) published the results from their landmark survey conducted to explore the role of the manufacturing engineer in the 21st century [8]. As a part of this survey, they assessed the then prevailing levels of the usage (in the USA) of various manufacturing technologies and their anticipated usages by the year 2000. The following is the list of technologies identified as having significant predicted usage (current usage → anticipated usage in 2000); expert systems, artificial intelligence and networking (11% → 47%); automated material handling (23% → 58%), sensor technology such as machine vision, adaptive control, and voice recognition (16% → 51%); laser applications, including welding/soldering, heat treatment and inspection (17% → 51%); advanced inspection technologies, including on-machine inspection and clean room technology (32% → 57%), flexible manufacturing systems (32% → 56%); simulation (17% → 40%); composite materials (16% → 36%); computer-aided design (CAD), computer-aided engineering (CAE), computer-aided process planning (CAPP), or computer-aided manufacture (CAM) (56% → 69%); manufacturing in Space (2% → 13%); and bio-technology (1% → 8%).

**Changing Manufacturing Paradigms and Managerial Approaches to Manufacturing**

By the late eighties it was clear that world markets had turned distinctly customer-oriented. This fact is underscored by the fact that ‘the New Manufacturing Enterprise Wheel” proposed by CASA/SME in 1993 puts “customer” at the very center of the wheel [9]. Contemporary manufacturers have to cope with ever increasing demands for higher product quality, higher product variety, smaller delivery lead times, smaller product life cycles (from the point of view of the manufacturer), and lower production costs. Owing to the rapid spread of manufacturing to less developed countries, international competition has become intense. Many companies are facing the challenge of streamlining (often, downsizing) their enterprises through automation, etc.,or evaporating. It has also become apparent that one needs to go beyond the paradigm of flexible manufacture.

The Japanese have for years been successfully addressing the issue of quality. Having enthusiastically accepted the teachings of Deming, they realize that increased inspection is not the answer. Instead, they emphasize process control with the objective of preventing rather than detecting and correcting defects. They discard the concept of aiming for quality yield within 6-*sigma* limits of product specifications in favor of the zero-defects goal. They believe that quality cannot be achieved through technology alone. The roles of the workers and corporate culture are equally important. Much emphasis is therefore placed on corporate loyalty to the workers in return to their loyalty to the company, worker motivation and training. Worker motivation is often sustained by forming Quality Circles which undertake continuous improvement (*Kaizan*) activities. This worker-oriented culture is in direct contrast to “Fordism” [10] and “Taylorism”, etc. of the USA where workers merely execute plans prepared by professionals and managers. The Western approach to production therefore relies on “pushing” plans generated with the help of MRP I & II software (Materials Requirement Planning I & II) on to the shop floor. The Japanese answer to the same problem is “pull” manufacture through Kanban and Just-in-Time (JIT) manufacture. A metaphor often used in JIT views the shop floor as a tank with rocks submerged in water. The submerged rocks represent unidentified problems where as the water level represents a manufacturing objective such as the desired level of in-process inventory. The management periodically lowers the water level, i.e. it challenges the workers to meet a tighter production objective. This exposes some of the problems (rocks). The workers are then expected to ‘pulverize’ these rocks while the professionals merely act as technical consultants. Continuous improvement is thus achieved. Many of these concepts have now been adapted by Western industries where the preoccupation with quality improvement and assurance has been equally intense. A consequence of this preoccupation has been the widespread implementation of ISO 9000-9003, Malcolm Baldrige Award, and

European Quality Award [11-13]. Likewise, TQM (Total Quality Management) [13], where quality is viewed as the concern of every unit in an organization has become widely accepted. It is also interesting to note that the CASA/SME wheel of 1993 places "people", "teamwork", and "organization" in the layer just next to the centrally placed "customer" [9].

The paradigm of FMS focuses on the achievement of higher product variety. A larger product variety invariably means smaller batch sizes. This constitutes a radical move away from the classical paradigm of mass manufacture which, since Henry Ford's time, has been a significant contributor to the growth in the living standards of people all over the world. However, as more and more societies became affluent due to the success of mass manufacture, the very same consumers are increasingly able to exert their choices. An FMS endeavors to meet the challenge of increased product variety through the use of flexibly automated processing equipment (usually, CNC) and material handling equipment (flexible conveyors, robots, AGVs, etc.), networking the computers controlling these equipment, and computer-based supervisory control. Browne *et al* identified eight kinds of flexibility: machine flexibility, process flexibility, product flexibility, routing flexibility, volume flexibility, expansion flexibility, operation flexibility, and production flexibility [14]. Chen and Adam have suggested a method for measuring each of these flexibilities [15]. Through their case studies, Chen and adam concluded that productivity and lead times were substantially improved when FMS was adopted while the results in terms of quality and work in progressive were inconclusive.

FMS is a technology intensive solution focusing on the unmanned factory [16]. This approach is likely to fail where capital is scarce and, as a historical necessity, manufacturing has to meet the additional social objective of employment provision. Thus, since the late eighties, there has been a progressive shift towards softer paradigms that place equal emphasis on machines and human workers while taking full advantage of computer-based technologies. Agile manufacture [17] is one such paradigm where the total system view is taken so as enable the enterprise to *quickly* adapt to change. One-of-a-Kind-Production (OKP) [18] addresses manufacturing with a batch size of one.

The problem of coping with ever decreasing product life cycles forced enterprises to abandon the traditional separation between design and manufacturing. When the time allowed between product conception and release is down to a few months, it becomes necessary to collapse the conception, initial design, prototyping, design for manufacture, and product testing stages by overlapping these functions. This strategy, often called simultaneous or concurrent engineering [19], requires a number of new managerial approaches as well as technological tools. It demands a non-bureaucratic and non-hierarchical project team based approach. The teams need to be empowered to make decisions. This might require a thorough reengineering of the organization. According to Hammer and Champy [20], reengineering is "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed." One major technical problem is a standardized form for comprehensive product definition which is capable of supporting the specialist requirements during various overlapping phases of product development [21]. STEP, the Standard for the Exchange of Product Model Data, is a major step in this direction. Secondly, product interpretation tools and manufacturing interfaces [22] are needed to support activities such as product classification and coding (Group Technology — GT) [23], computer-aided process planning (CAPP) [24],computer-aided tool design, etc. This in turn has generated a need for automated geometric feature recognition (GFR) [25,26], etc. Another major technological development inspired by the desire to radically compress product development lead times is Rapid Prototyping Technology (RPT) which includes recent technologies stereo-lithography, selective laser sintering, etc. [27]. Many believe that, after CAM, RPT represents the real technological development with all round impact.

In the early nineties, it became apparent that the above technological developments had made manufacturing too complex to be modeled and controlled by traditional means. There is a growing feeling that the tradition of modeling and controlling manufacturing systems as hierarchical systems is no more adequate. As a consequence, many new viewpoints such as bionic [28], fractal [29] and holonic [30] manufacturing systems are currently being discussed. Amongst these, the most promising seems to be holonic manufacturing. For instance, van Brussel had presented demnostrated at the August 1994 meeting of CIRP's scientific committee for assembly that assembly systems can achieve a more robust performance when they are configured as holonic systems. He noted that a holon is a functional unit (hardware or software) which possesses two distinguishing properties: autonomy (ability to perform its function independently in an uncertain and dynamic world) and cooperation (the requirement to cooperate with other holons whenever an opportunity arises within its functional domain).

More recently, owing to growing worldwide concern for the protection of the earth and sustaining its resources, increased attention is being paid to the disposal of hazardous wastes, design for disassembly, design for avoiding environmental damage, etc. Green Manufacture, and Sustainable Manufacture will become major movements in the future [31]. ISO 14000 has already laid down a framework for enterprises to successfully address environmental issues.

Finally, owing to the emergence of more open markets, the various design and manufacture functions are getting dispersed across different global sites. This has led to a move towards Global Manufacturing (GM) as the new paradigm [32]. This has brought issues concerning international business, inter-cultural relations, conflict resolution, product data exchange through international networks (ISDN, Internet, etc.), etc. within the ambit of manufacturing engineering.

**Contrasting Perspectives from Hong Kong and Ukraine**

Tables 1 and 2 summarize the perspectives from Hong Kong and Ukraine respectively (admittedly, in the subjective view of the authors). Some important insights obtainable by examining the two tables in the light of the information provided in Appendices 1 and 2 are presented below.

1) Both regions have found success in the use of technologies such as CAD, CAM, NC, CNC, CMM, conveyors, EDM, shop-floor networking, and throw-away inserts. This is notwithstanding the fact that Hong Kong is largely geared to consumer products industry whereas the industry in the former USSR was more precision engineering oriented as a result of the dominance of defense production. While machining is a minor sector in Hong Kong in comparison to electronic and plastics production sectors, Hong Kong has a thriving die and mold making industry which is crucial to its other product sectors. Dies and molds are usually of fairly high precision and have complex surfaces thus requiring the use of computer-aided technologies.

Table 1: Hong Kong

| | Systems Theme | Mechanical and Electronics/Computers Themes |
|---|---|---|
| Successes | Continuous improvement, Quality circles, ISO 9000-9003, Statistical process control, Statistical quality control, Taguchi experiments, TQM, Zero defects.<br>Expert systems.<br>JIT, Kanban, MRP, Simulation, | Computer networking.<br>CAD, CAM, NC¸ CNC, Comp-aided tool design.<br>Conveyors.<br>Coordinate measuring machines.<br>EDM, Wire-cut EDM.<br>ISDN, Shop-floor networking, Shop-floor data acquisition.<br>Throw-away inserts (carbide, coated and ceramic) with and without chip-formers.<br>Lasers (non-machining).<br>Stereolithography. |
| False Starts | FMS. | |
| Promises | CIM,<br>Global manufacture.<br>ISO 14000.<br>Reengineering. | AI.<br>CAE, CAPP.<br>Composite materials.<br>Concurrent engineering.<br>Expert systems.<br>Flexible conveying systems.<br>Internet.<br>Machine vision.<br>On-machine inspection.<br>RPT, Selective laser sintering. |
| Not considered | | High-speed cutting.<br>Manufacturing in space.<br>Universal robots. |

Table 2: Ukraine (while it was a part of the former USSR)

| | Systems Theme | Mechanical and Electronics/Computers Themes |
|---|---|---|
| **Successes** | Computer-aided production planning.<br>Group Technology.<br>Statistical process control.<br>Simulation (elementary),. | AI (primitive).<br>Automated materials handling.<br>Automated storage and retrieval.<br>CAD, CAE, CAPP, CAM, NC, CNC.<br>Coordinate measuring machines.<br>Composite materials.<br>Conveyors.<br>EDM, Wire-cut EDM.<br>High Speed Cutting.<br>Lasers (mainly non-machining).<br>Machine vision.<br>Rotary M/c system for mass production,<br>Shop-floor Networking.<br>Throw-away inserts: with and without chip-formers, carbide, and coated. |
| **False Starts** | FMS.<br>Centrally planned manufacture.<br>Non-competitive (monopolistic) manf.<br>Vertical integration., | Adaptive control for constant force.<br>Machining with additional energy (vibrations, heating, lasers, etc.).<br>Universal robots.<br>Self-sharpening tools. |
| **Promises** | CIM.<br>Concurrent engineering.<br>Expert systems.<br>Flexible conveyors.<br>Global manufacture.<br>ISO 9000.<br>Stereolithography, Selective laser sintering. | Automated work cells.<br>Ceramic cutting inserts.<br>Chip control.<br>Clean room technology.<br>Manufacturing in space.<br>Multi-sensor monitoring systems.<br>Self-learning machine tools.<br>Smart sensors.<br>On-machine inspection.<br>On-line optimization of cutting conditions, |
| **Not considered** | Reengineering.<br>STEP, etc..<br>Quality Circles, TQM, Zero defects.<br>JIT, Kanban, MRP.<br>. | |

2) Most manufacturing enterprises in the former USSR were run by ministries whose priority was defense production which by its very nature was 'hi-tec' in nature. Further, these industries were supported by mammoth research and development organizations. Thus, a greater variety of M/E technologies were adopted by Ukraine in comparison to Hong Kong. Thus, whereas Ukraine had applied primitive AI, automated material handling, automated storage and retrieval, composite materials, high speed cutting, machine vision, and rotary machines for mass production, Hong Kong had found little utility in them. An associated observation of interest is that, even by the nineties, both Ukraine and Hong Kong had not reached the accuracy and cutting speed levels corresponding to those predicted by Merchant as likely to be common by the mid-seventies [4].
3) R&D was a priority in the former USSR by virtue of the military imperative. Hence, there were mammoth R&D organizations engaged in initiating and exploring new design and manufacturing technologies. For instance, EDM was first developed by Lazarenko in the former USSR. R&D however is, by nature, a risky business. Hence, it is not surprising that Ukraine had a fairly long list for false starts in M/E technologies (see Table 2). Three further factors however contributed to this

scenario. Firstly, R&D in the former USSR was manly driven by the priorities set by the central planners who were oblivious to the litmus test of consumer need and consumer choice. Secondly, USSR enterprises were basically monopolies without domestic competitors. Neither did they have to survive against international competition in view the national choice to insulate the domestic market from the Western world. Finally, there was limited grass roots freedom for professionals within the hierarchically and bureaucratically run enterprises to engage in critical analyses of the decisions of the powers to be. Thus, it is not surprising that R&D projects were mainly approved on narrow technological grounds rather than through a comprehensive justification involving technological, system-level, economic and consumer-oriented criteria. For instance, at one time, there was much national hype about achieving high machining accuracy through adaptive control aimed at maintaining a constant cutting force. The system was applied (by force) in many factories. However, this technique works only when the stiffness of the machining system does not vary as the cutting forces traverses the work surface. Small wonder then that the system turned out to be a false start notwithstanding the fact that the inventor was actually awarded the Lenin prize. It appears that manufacturing was defined in the USSR as the "conversion of raw materials into products that meet a set of design specifications". In contrast, Hong Kong views this to be a trivial definition of manufacturing. For Hong Kong, "manufacturing is the art and science of *competitively* converting raw materials into attractive products for the *customer*". Any one can make products. Only a few win in a scenario charged with competition. Consequently, technological choices in Hong Kong are largely driven by comprehensive criteria. As a result, the list of false starts in Hong Kong is practically empty in terms of M/E technologies.

4) Further significant differences between Ukraine and Hong Kong are apparent when the choices with regard to the S-theme are examined. Note that the Productivity→Quality transition has been consummated in Hong Kong through extensive and successful adoption of quality movements such as statistical quality control; continuous improvement and quality circles; statistical process control, Taguchi experiments, and Zero defects; ISO 9000I-9003; and TQM (in that historical order). At the same time competitive productivity was maintained through initiatives such as MRP, Kanban, JIT, and production simulation. In contrast, similar productivity and quality based movements were conspicuously absent in Ukraine. The term *quality* was in vogue but it was interpreted only at the product level and that too as mere conformance to specifications.
5) FMS has been a false start in both Ukraine and Hong Kong. In Ukraine in particular, there was much organizational push towards FMS. The Government decided to install several showpieces (as it is presently happening in China) in the hope of spurring the national manufacturing infrastructure towards the adoption of high technology. However, almost all these FMS ventures failed. This was because the level of electronics and computer infrastructure/education and the prevalent organizational structures in manufacturing enterprises were inadequate in servicing the technologically complex FMSs. The flirtation with FMS in Hong Kong was lukewarm in comparison. A couple of enterprises attempted it but the movement did not catch on. This does not necessarily mean that FMS will not come back in the future when the conditions are ripe. In the mean time, increasing attention is being paid to the softer approach of moving progressively towards CIM. Hence, linking automation is attracting particular attention. Shop-floor networking and data acquisition is getting popular. Use of ISDN and other networking technologies is intensifying. There is considerable academic interest in global manufacture, virtual manufacturing, etc.
6) Another significant feature of the former USSR was the separation of design from manufacture. This was because the design process was more closely linked with the remote R&D organizations than with the shop floors. As a result, worldwide developments in concurrent engineering did not get implemented in the USSR although some R&D organizations had attempted to promote it. Concurring engineering is concerned with more than the technological tools (such as design for manufacture, design for assembly, etc.) needed to support it. It also implies organizational changes directed towards the creation of fully empowered product based project teams. Such empowerment was contrary to the societal preference towards central planning. In contrast, Hong Kong had never relied on a centrally planned economy. With the taxation ceiling around 16%, Hong Kong Government had neither the intention nor the clout to influence societal technological choices. The choices were driven by the entrepreneurs themselves and were dictated by their instinct for survival against international competition. Government budget was rarely diverted towards establishing new manufacturing technologies within manufacturing enterprises. The capital for new technologies mainly came from the

savings the entrepreneurs had made from their previous investments. This engendered a more pragmatic and less ideologically driven approach towards investment in new technologies.

7) The importance of the socio-political ethos in a country in influencing societal choices with regard to manufacturing technologies and paradigms is apparent from Tables 1 and 2. In the former USSR, the national choice was for a centrally planned economy. However, owing to the immense size of the country, the central planners were remote from the grass roots personnel operating manufacturing enterprises. This resulted in a bureaucratically driven decision making process. In particular, the central Government established several (30 to 50) ministries each of which focused on a specific industrial sector, e.g. machinery, power, mining, aviation, military production, machine tools and tooling. Each of these ministries established mammoth enterprises where each enterprise was isolated from enterprises belonging to other ministries. Hence each enterprise tended to be *vertically integrated*, i.e. it tended to produce many components itself irrespective of whether they could be more profitably acquired from a 'rival' enterprise. At the same time, each of these enterprises was constrained to accord a high priority accorded to defense related production so that the production of consumer products became marginalized into a 'side business'. Consumer focus was thus particularly absent. The situation in Hong Kong, where most Hong Kong enterprises have been engaged in 'original equipment manufacture (OEM)', has been in total contrast to the above scenario. The conceptual designs for products came from clients from affluent societies. Hong Kong merely manufactured them competitively through a horizontally integrated network consisting of a large number of small manufacturing enterprises where each enterprise was driven by its own instinct for survival and growth, were *horizontally integrated* through ever more sophisticated communication technologies and transport infrastructure. Much of Hong Kong's success lies in the agility resulting from its horizontal integration. With growing expansion of its activities into China at the cost of a shrinking domestic manufacturing base, this instinct for horizontal integration is likely to bring greater rewards in the global manufacturing era which is imminent.

**Conclusion**

Significant differences exist in the choices exhibited by Hong Kong and Ukraine with regard to manufacturing technologies and paradigms. The choices themselves, the manner in which the choices are implemented, and, therefore, their success or otherwise, are strongly influenced by the socio-political ethos prevailing in the regions. Developing nations will do well to utilize the insights thus obtained in judiciously making their own technological choices.

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**Appendix 1: Hong Kong**

"At the beginning of the present century, HK [Hong Kong] was a sleepy village inhabited by fishing communities and, interestingly, pirates. Even by the 1950s, Hong Kong's manufacturing industry was largely confined to textiles and low end products such as silk flowers. Starting from such a modest base, Hong Kong's manufacturing industry grew rapidly to encompass high quality textiles and garments, electrical appliances, electronic products, computer peripherals, watches, light engineering goods and a limited range of production machinery. Thus, by 1988, HK's manufacturing industry was employing around 900,000 workers who were contributing to nearly a quarter of Hong Kong's GDP. Today, with its recent spectacular growth in its service industry, HK ranks among the top 10 countries in the world in terms of per capita income (over US$ [2,200]). Two factors contributed to this phenomenal growth. Firstly, the Government has been unwaveringly sticking to a *laissez faire* policy unmatched in any other part of the world and, therefore, confining itself to the maintenance of law and order, and the development of the general infrastructure and education. Taxes have been low with a ceiling of around 15%. Defense needs are conspicuous by their absence. This has meant that a greater proportion of the Government's budget could be channeled into the development of infrastructure ..." " Secondly, the people of HK, who are largely made up of emigrants from mainland China, have been exhibiting a remarkably high degree of entrepreneurship. As a consequence, by 1988, there were over 80,000 manufacturing enterprises spread across the territory. The uniqueness of HK lies in its ability to horizontally integrate such a large number of small sized enterprises, each specializing in a narrow range of manufacturing activities (there are companies engaged just in mold polishing) into an agile, commercially-driven, and export-oriented industrial system."

"HK's industrial development, till the seventies, was mainly dominated by constant improvements in labor productivity through better training and use of progressively advanced forms of process technology, if not automation. However, by the eighties, HK realized that its competitive advantage of low cost labor was being rapidly eroded. Hence, in 1988, the Government .... exhorted the industry to "move up-market" through the production of high-value-added goods. HK's manufacturing industry responded to these exhortations in three ways. Firstly, taking advantage of the opening up of China and the low labor costs prevailing there, it invested heavily in Southern China and moved a substantial part of its low-end manufacturing there. [According to recent estimates, over three quarters of domestic manufacturing has moved out so that employment in domestic manufacturing has fallen to 360, 000 whereas the number of employees in HK enterprises in southern China has grown to 4 million.]. Secondly, it rapidly upgraded the manufacturing technologies employed within HK. Thirdly, it extensively adopted a variety of quality initiatives such as ISO 9000, TQM, etc. Thus, the P→Q [Productivity→Quality] transition seems to be nearly completed in HK now. However, it must be acknowledge that HK has not yet adopted innovation as a competitive weapon. This is partly because of the opportunities available for horizontal expansion into China, the fragmentation of HK's industry into a large number of small-sized units, and the general view of manufacturing as just another business to make money." "Further, HK has always been closely connected with the world manufacturing community and able to attract substantial overseas investment."

**Appendix 2: Ukraine and the former USSR**

Until December 1991, when the former USSR broke up into a number of smaller republics, Ukraine was an integral part of largely centrally administered USSR. Hence, an understanding of USSR in effect provides an understanding of Ukraine.

"Manufacturing in the former USSR had a long history. Imperial Russia had been on the fringes of the industrial revolution sweeping Europe in the 19th century. However, after the USSR was formed following the October 1917 revolution, the country started facing many difficult problems owing to its feeling of "capitalistic encirclement" and the resulting political and economic isolation from the rest of the world. Consequently, to stimulate technological development from within, the central Government established several (30 to 50) ministries each of which focused on a specific industrial sector, e.g. machinery, power, mining, aviation, military production, machine tools and tooling. These efforts were coordinated centrally through national five year plans. Thus, by 1986, the USSR had achieved a per capita GNP of US$ 6490 which was only 30% lower than that of EEC. More importantly, it became the leader of the second world and was engaged in a neck-and-neck race with the USA in space research and nuclear arms." "Nearly three quarters of the working population was employed by the manufacturing sector to sustain these industrial efforts ."

"The P→Q→R [Productivity→Quality→ Innovation] transition seems never to have been properly consummated in the former USSR owing to the national policy of giving priority to the "production of means of production" rather than producing for public consumption or export. This policy resulted in each industrial ministry tending to be fully self sufficient with little interaction with other sectors. For instance, almost every major ministry tried to produce its own machine tools, molds, dies, stamps, etc. in spite of the fact that there existed a ministry specializing in machine tools. As a result, there was a concentration of industry in vertically integrated and bureaucratically run industrial organizations of large size. However, due to a lack of consumer consciousness, the quality of goods produced remained poor. The term *quality* was in vogue but it was interpreted only at the product level and that too as mere conformance to specifications. The roles of corporate organization, culture, and management in assuring quality were totally missed. Movements such as ISO 9000 and Malcolm Baldrige Awards were conspicuously absent. As for innovation, there indeed were some highly impressive pockets. But these existed mainly in the context of perceived defense needs. Consequently, these innovations only addressed technical issues with little regard to the $-sign, a consumer oriented definition of quality, and competition in the world market.... Further, it seems to have missed out on the consumer electronics revolution and the transformation of manufacturing that has been occurring through extensive use of computers.”

Prof. B.G. Krishna Reddy,
Head, Production Engineering,
Department of Mechanical Engineering,
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Warangal 506004,
Andhra Pradesh,
India.

Dear Prof. Krishna Reddy,

25 October 1996

**17th AIMTDRC**

Thank you for your letter of 11 September 1996 inviting me to present an Expert Lecture at the captioned conference. I am now writing to confirm that I would be able to personally present the attached review paper which is entitled "Successes, False Starts, and Promises in Manufacturing Engineering: Contrasting Perspectives from Hong Kong and Ukraine". The paper is co-authored by me and my colleague, Prof. V.A. Ostafiev, who is an eminent academician from Ukraine. I believe that many of the insights derived from the comparative analysis of Hong Kong and Ukraine will be of significant interest to Indian audience. I hope you will find the paper satisfactory for inclusion in your esteemed conference.

In fact, I had sent you an EMail message over a week ago indicating that I should soon be sending you a review paper. Have you received it? I had also enquired in that message whether I need to pay the registration fee. Please write to me with the clarification asap.

Before closing, may I say that I am particularly excited with the opportunity to touch base with AIMTDRC again after so many years — that too at RECW in the presence of my dear former colleagues. I wish you and your organizing team a successful conference.

Yours sincerely,

(Prof. Patri K. Venuvinod)
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