

Developing a National Automation Masterplan for the Construction Industry

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Abstract

This paper outlines the national automation strategies for a small internationalised economy like Singapore's. It then proceed to give a brief profile of the Singapore construction industry and the issues and challenges it faces in terms of quality demands, labour shortages and safety and productivity concerns. The concerns are all the more vivid with the new decade, the emergence of Singapore as a developed economy and a Total Business Centre to support headquarter service activities of multi-national corporations (MNCs). The paper then summarises the 3-pronged strategy to promote construction automation under the proposed *Masterplan*, and outlines a comprehensive programme to be carried out by CIDB, with the help of industry associations, to introduce and accelerate construction automation in Singapore. They involve carrying out construction automation development projects, manpower training and development and a complete incentive programme to support these activities.

1 WHY AUTOMATE *A National Perspective*

Automation technology has rapidly established itself as a key competitive edge in the high value-added markets. Both developed countries and the Newly Industrialised Economies (NIEs) have recognised the inevitability of automation in maintaining their competitiveness. A recent survey indicated that Taiwan and South Korea have invested heavily in factory automation, which currently stands at a level 25% higher than that in Singapore.¹

There are several compelling reasons for Singapore to want to implement automation. Firstly, Singapore's labour force is projected to grow at an average rate of 1.2% between 1990 and 2000 and a mere 0.1% between 2001 and 2003, while the long term national goal is to achieve an economic growth rate of 4 to 6%. This shortfall has to be

¹ These findings are supported by a report published by the Korean Productivity Centre in 1986 which revealed that almost all South Korean SMEs employ some form of automation in their manufacturing processes. It was also found that 98% of South Korean SMEs are interested in automation implementation, significantly higher than the corresponding figure of 69% for all Singapore companies captured in a survey by Singapore Industrial Automation Association (SIAA).

compensated by increased productivity, which to a large extent, can be realised through the widespread implementation of automation.

Secondly, Singapore's economic growth is strongly influenced by the presence of foreign investments. To continue to attract offshore investments in manufacturing facilities, Singapore has to keep abreast of manufacturing trends and technologies. It has therefore position itself as a manufacturing location ideal for automated operations by building up the relevant manpower, infrastructural and technical expertise and support. This will, on one hand, encourage existing manufacturing companies to upgrade their operations to remain competitive and on the other, attract new capital, skill and knowledge intensive industries into Singapore.

In the absence of a national automation plan, efforts to promote factory automation in the past have not been very focused. The level of automation in our Small and Medium Enterprises (SMEs) is low. Automation, if at all implemented, is confined to stand-alone automatic machines and material handling equipment. Most SMEs view automation as a high cost investment and are often not fully aware of the benefits that it can bring about. Considerable effort is therefore required to educate our SMEs on automation before they fully accept and implement it. The level of automation in Multi-National Corporations (MNCs) is higher. Nevertheless, they are still piecemeal in nature and efforts must be directed at encouraging these companies to integrate their 'islands of automation'. The last decade has seen a gradual increase in the level of automation in Singapore. Total number of industrial robots reached 309 in 1987 and robot density was 7.8 in 1986 (see figure 1 & 2). Electronic and computer industries were the main users with about 47% of the total robots deployed.

A National Automation Master Plan Committee (NAMPC) was set up in July 1987 to draw up a plan on how to systematically promote and develop factory automation in Singapore. The Committee identified the problems inhibiting automation implementation in Singapore and recommended 5 key strategies to overcome these barriers and to achieve the national automation goals. They are:

- (a) *Manpower Development*
To develop a ready pool of qualified and knowledgeable automation manpower to be in a position to exploit the latest automation technologies.
- (b) *Technology Development*
To establish a pool of automation experts to provide technical assistance to companies in implementing automation and to build up our capabilities in automation technology.
- (c) *Infrastructure Development*
To facilitate the growth and accelerate automation in our

industries, we need to have the appropriate physical, financial and information infrastructure in place.

(d) *Automation Culture Development*

The long term goal is to develop an automation culture through education and promotion to ready the industry to accept and implement automation.

(e) *Co-ordination*

To constantly review and formulate policies, provide guidance and impetus to the industry to co-ordinate and sustain the automation drive.

2 THE CONSTRUCTION INDUSTRY TO SINGAPORE

Construction is a US\$2.5 billion dollar industry in Singapore and is expected to grow to US\$3 billion from 1991 onwards (see figure 3). It contributes 10% to Singapore's GNP and employ about 11% of the workforce. There are 2,900 contractors and construction material suppliers registered with the Construction Industry Development Board, a government body set up in 1984 to oversee the orderly long term growth of the industry. From the period 1984 to 1989, the Singapore construction industry underwent a shake out when construction demand in 1988 dropped to a third of the US\$5 billion in 1983. The displacement in terms of capital and personnel was enormous, and many outstanding professionals left the industry to join the academia and other economic sectors like investment banking.

The industry as a whole was resilient in weathering the restructuring process that followed, and has emerged stronger and trimmer and better capitalised. With the registration of contractors by CIDB imposing requirements on financial and personnel resources and company track records, many construction companies became better capitalised and better staffed. In 1989, some 50 Singapore companies have a paid-up capital of US\$2.5 million compared to a handful in 1983. Construction exports rose 7 times from US\$60 million in 1984 to US\$400 million in 1989 amidst a slump in the international construction market. These developments point to the growing maturity of the Singapore construction industry which has established for itself a competitive niche in the regional construction markets.

3 EXPECTATIONS OF THE COMING DECADE

The 1990s promise to be an exciting time for the Asia Pacific. Intra Asia Pacific trade and tourism can be expected to achieve multi-fold increases. The investment boom resulting from Japan, Taiwan and South Korea relocating their manufacturing facilities and the economic and infrastructural expansion of countries like Thailand, Malaysia and Indonesia is expected to continue.

Singapore is expected to develop strongly into a global business centre. It will no longer be just a manufacturing base for multinational corporations(MNCs), a role increasingly being taken over by the fast growing economies in the neighbouring countries. Instead, it aims to be a total business centre where MNCs will locate their regional headquarters and other value-added facilities and direct their regional manufacturing operations.

What does this portend for the construction industry? It means that there will be greater demand for living, working, transport and leisure facilities of a standard comparable to other international cities. It means high quality, high technology construction, with greater use of information technology and construction automation.

4 ISSUES AND CHALLENGES FACING THE CONSTRUCTION INDUSTRY

The following document the major issues confronting the industry which automation will help to address.

4.1 Labour Shortage

The cyclical nature of the industry makes it difficult to retain a sufficient pool of skilled workers to support construction as compared to the service and manufacturing sectors. This and the continued reliance on foreign workers for lesser skilled jobs pose a severe challenge to the long term growth of the industry.

4.2 Worker Safety and Health

In addition to labour shortages, the case for automation is also generated by the need for better safety standards and the humanitarian concern for the health and welfare of workers. Activities such as concrete trowelling and finishing are "back-breaking" tasks detrimental to workers' health in the long run. Others like foundation work and working at heights can expose workers to serious accidents. While statistics may capture the frequency and severity of construction accidents, the costs in terms of human misery cannot be quantified.

4.3 Productivity

In any work or process including construction, there will be activities that are tedious and repetitive. Productivity would improve tremendously if ways can be found to mechanise and automate these activities onsite or if applicable, bring them into the factories. Automation, when carefully integrated with other activities, will enable a more streamlined design and construction process resulting in higher productivity and speedier completion. It is important also to design for standardisation and modular coordination.

4.4 Quality

As the standard of living rises and Singapore develops the status of an international city, there is greater demand placed on the construction industry to deliver quality buildings and infrastructure. Construction automation is seen as one promising tool towards achieving better quality in construction, through better consistency and closer tolerances in compliance with specifications. Construction robots can be used for tasks traditionally undertaken by the skilled labour force.

5 CONSTRUCTION AUTOMATION *A Quantum Leap for the Construction Industry*

As the Singapore construction industry gears itself for the 1990s and its attendant demands on quality and productivity improvements, new ideas must be developed and implemented to stimulate the pulse of the industry. The shortage of skilled labour and the reluctance of the younger generation to take up construction vocations mean that we have to look at other measures to raise productivity. These issues underline the urgency for introduction of automation in the construction industry.

To tackle this challenge in an orderly manner, a National Construction Automation Taskforce was formed to spearhead the development of a comprehensive set of strategies and programmes for the construction industry, in short a Construction Automation Masterplan. The taskforce chaired by CIDB, is represented by CEOs of 5 top Singapore contractors and prefabrication product manufacturers and 3 top Japanese contractors, academics, an automation consultant and a leasing company etc. It has the following terms of reference:

- (a) Identify the areas where automation can be applied to the construction industry in Singapore;
- (b) Develop a programme for promotion of construction automation; and
- (c) Propose channels for acquisition and use of automated equipment.

6 CONSTRUCTION AUTOMATION MASTERPLAN

The Taskforce developed a masterplan to introduce and promote automation in the construction industry in Singapore. The Masterplan centres on a 3-pronged strategy:

6.1 Technology Development

CIDB and the Singapore Contractors Association Limited(SCAL) will launch a series of development projects to develop and introduce automation solutions to common design and construction processes. These projects will be pursued jointly with Singapore and international

automation consultants and research institutions. They include identification of prospective automation targets, project feasibility studies and development projects to apply and adapt available technology or to develop and introduce automation solutions.

6.2 Manpower Development

The construction industry has benefitted from earlier government efforts in building up automation consultancy and expertise in the research institutions and industry. Factory automation has been successfully introduced and the country is exposed to the benefits and visual familiarity with automated processes of production. Nevertheless, a comprehensive programme to introduce and promote construction automation must include training a pool of automation technicians and operatives and developing professionals with an eye for picking out possible automation solutions to common design and construction processes.

6.3 Incentive Support Programme

The infusion of a new technology is often seen as a troublesome intrusion on existing established practices rather than a means to overcome shortcomings. In addition, such forms of investments, be it on research, technology acquisition or manpower training and development, involve up-front cost. Many still view these costs as unnecessary expenses instead of investments in future competitiveness. Other factors that influence the investment decision, even if it is viewed as such, are risk and uncertainty of returns and the discontinuous nature of construction work which make it difficult to justify major long term investments. These circumstances present formidable hurdles to automation. It is within the powers of government to lower these initial barriers by providing fiscal and financial incentives to accelerate the pace of automation.

7 A COMPREHENSIVE PROGRAMME TO DEVELOP AND INTRODUCE AUTOMATION IN CONSTRUCTION

In order to actively promote and accelerate the pace of construction automation, the taskforce went one step further and recommended a comprehensive automation programme to be implemented by CIDB.

7.1 Automation Development Programme

On technology development, CIDB and SCAL has already embarked on several automation projects. They are:

(a) *Mini-piling Robot*

CIDB helped finance the development of a mini-piling robot. Called Robopile 2000, the robot is a versatile remote-controlled mini hydraulic piling machine that can negotiate through the space of a standard door frame and drive micropiles for strengthening and underpinning works (see slide). The Robopile 2000 was developed over one year at a cost of US\$45,000. 3 Units have already been sold to Germany and Sweden and the company expects to receive a further 10 to 15 orders to purchase the robot.

(b) *Cost Modelling Expert System*

A third project pursued by CIDB and the National University of Singapore is to automate the design process through the use of an expert system on construction cost modelling.

Other projects being considered include a self-climbing painting robot, a concrete finishing robot, and a generic project management software for retrofitting projects.

7.2 Construction Automation Incentives Programme

To enable the 3-pronged strategy to proceed smoothly, CIDB is considering the taskforce's proposal to set aside a US\$25 million fund over 5 years to help accelerate the pace of construction automation. This involves a set of incentive plans to fund feasibility studies, acquisition and leasing of available technology to automate and mechanise, manpower training and development and automation development projects.

8 CONCLUSION

Labour shortage, ageing population, safety and quality demands are the same forces that drive every developed economy towards the automation age. It is no different for Singapore, as the country emerged gradually to become a developed economy. Because Singapore's economy is small and vulnerable to minor disruptions in the world and regional economy, it helps to have the government act as a stability mechanism to usher in long term development planning for the respective economic sectors. In the case of construction, the government jointly with the industry have attempted to promote and accelerate the infiltration of automation technology which it sees as inevitable in the coming decade to meet the demands for quality of life and respond to other pressing issues of labour shortages, etc.

Figure 1

**ROBOT INSTALLATIONS AND DENSITIES FOR
SELECTED COUNTRIES**

COUNTRY	NO OF ROBOTS 1986	ROBOT DENSITY 1985	ROBOT DENSITY 1986 - (EST'D)
JAPAN	118000	42	53
SWEDEN	2383	15	17
W GERMANY	12400	8	11
USA	25000	7	9
BELGUIM	1050	8	8
UK	3683	6	7
SINGAPORE	227	5.3	7.8

Singapore (1987): Robot Installations - 309
Robot Density - 9.7

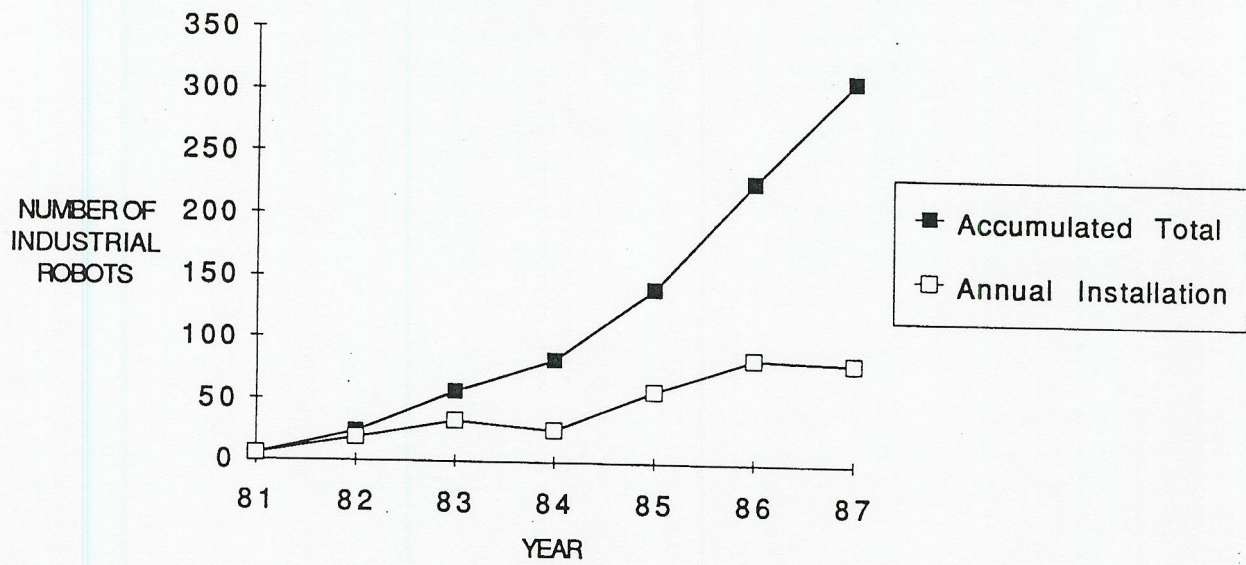
* Robot Density - No of Robots per 10,000
manufacturing workers

Source: The Industrial Robot October 1986 and September 1987
(International Figures)

EDB Survey (Singapore Figures)

Figure 2

INDUSTRIAL ROBOTS GROWTH RATE IN SINGAPORE (AS AT DEC 87)



SOURCE: EDB

Figure 3

CONSTRUCTION DEMAND

