Patri K. Venuvinod, 2007, Published in KAB Consultants Magazine, Hyderabad

The Emerging Weightless World

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The other day, while surfing the Net, I bumped into the homepage[1] of one Danny Tyson Quah, Professor of Economics at the London School of Economics and Political Science, and Head of the Department of Economics. The page contained information and links to his teaching, research, and other general work. Looking at the page I came to three conclusions. Firstly, Quah is a highly scholarly and rigorous economist interested in understanding the world as it is today. Secondly, he has a deep understanding of what is happening in China and India, the two most populous but rapidly developing nations. Thirdly, and more personally, his expositions have clarified many of the notions I have been struggling with over the last three decades.

Among Quah's papers and blogs the ones that seized my immediate interest were his analyses of the emerging *weightless world*[2]. Now *weight* is something that has been on my mind throughout my life, notwithstanding the fact that I have never been obese.

As a child I had grown up in Shakarnagar, the home of Nizam Sugar Factory. My father, who was a sugar technologist there, would regularly escort me on informal visits to the factory. Being basically a chemist he would patiently explain me the myriad chemical intricacies underlying the conversion of sugarcane juice into white, crystalline sugar. But I couldn't be bothered with any of that. I was more fascinated by the mammoth mechanisms made up of flywheels and gears that were visibly and noisily squeezing the juice out of truckloads of sugarcane at one time. At the far end, I was fascinated by the whirring noise made by the centrifuges separating refined sugar from the juice. For me technology to be meaningful had to be weighty, large, visible and noisy—something you can feel with your senses.

It was perhaps because of this fascination with the weighty that I chose to study mechanical engineering when I joined Osmania Engineering College in 1959. I could have chosen to become an electronic engineer, a profession that was just coming to public attention. But what good could come out of the practically weightless electrons, apart from enabling us to listen to the radio!

The fascination with the weighty was also in keeping with the times in India. Under Prime Minister Nehru's leadership, new, massive factories were coming up all around—BHEL, HAL, HMT, and so forth. All this reassured me that I was on the right track. Many of these ventures were in collaboration with USSR and other East European Countries. These countries were indeed good at building weighty machines.

Then in 1978 I moved to Hong Kong. Hong Kong at that time was thriving as a center for manufacturing watches, electrical appliances, and some types of machinery. My knowledge of mechanical engineering served me well and I climbed up the academic ladder fairly fast. Then, one day, I happened to go to an international machine tool exhibition in Tokyo. There were huge stalls from different countries, with thousands of visitors strutting all around. The Japanese and Swiss stalls were particularly busy. I also

visited the Russian stall which sported about a dozen large machines. But, to my surprise, there was hardly a person around. I was told that it was because the machines were not slim and streamlined and user-friendly. They were noisy and did not fully exploit modern digital electronics. That was my first wakeup call: a machine is much more than an assemblage of metal and plastic pieces.

Meanwhile manufacturing continued to boom in Hong Kong. A new department of manufacturing engineering was to be launched at the City University of Hong Kong. I was selected as the founding Head. I plunged headlong into building the new department and quickly developed new manufacturing programs. We also built some world-class laboratories. I put a taboo on installing any purely mechanical equipment in our laboratories—it was to be instrumented to the fullest possible extent and interfaced to a computer. The argument was that the educational benefit derivable from a machine arises essentially from the data collected[3].

I was happy with what we had achieved in a short time. But the euphoria didn't last long.

As it happened, China had opened its doors a few years ago. After some initial hesitation, Hong Kong tycoons moved into mainland China in a big way. The result: factory after factory moved from Hong Kong to the mainland while manufacturing within Hong Kong's borders nosedived. What was Hong Kong to do with the new manufacturing graduates my department was churning out? Very soon it became clear to me that my department had to diversify. But diversify into what? After much deliberation, we moved strongly into two new areas: Mechatronics and Engineering Management.

Here my interest is in the first. We argued that as manufacturing got hollowed out in Hong Kong, Hong Kong will have to move up to the design level[4]. And most things to be designed those days were already incorporating electronic devices and embedded computers. We were excited by this new integrative discipline as we embarked upon launching the first ever undergraduate mechatronic degree program ever in Asia.

(Much later I happened to pass on our mechatronic engineering curriculum to Mahatma Gandhi Institute of Technology in Hyderabad which, I have been told, led to their launching the first ever mechatronics course in India.)

Initially our curriculum development efforts sought to draw inspiration from the prevailing definition of mechatronics: "a synergistic combination of precision mechanical engineering, electronic [read computer] control and systems thinking in the design of products and manufacturing processes[5]." So all we had to do was to throw in appropriate amounts of mechanical (M), electrical/electronic (E), and computer (C) engineering to the extent we thought the students could cope with. However, we soon realized that "throw in" approach might satisfy the expectation of 'combination' but not of 'synergy'. We needed a more meaningful principle to guide us. After much introspection we homed in on the principle shown in Fig. 1. Why? This brings me back to what Quah now calls the "weightless" world.

Fig. 1

There are fundamental differences between the M, E, and C elements of a mechatronic device. The M-elements are made up of chunks of matter with high inertia. The high inertia prevents them from moving fast. In contrast, the E-elements depend only on the controlled flow of electrons, the lightest of the basic constituents of matter. Being

light, they can move at incredibly high speeds, sometimes nearing the speed of light. In even sharper contrast, the C-elements essentially achieve the controlled flow of bits (Boolean zeros and ones), entities having no weight at all!

What does all this mean to the designer of contemporary products? It simply means that whatever that can be done electronically should *not* be done mechanically, and whatever that can be done through computers should *not* be done through hardwired electronics. This is the significance of the horizontal arrow over MEC in Fig. 1.

Moving along the arrow dramatically enhances product functionality and convenience to the user. For instance, the products become smaller and cheaper. Hence they become more portable. The devices become smart (intelligent and self-learning[6]) and remotely controllable (even via the Internet). Also many diverse functions can be packed into the same device. To be convinced of this all one needs to do is to think of how cell phones have been morphing over the last decade.

When M and E have been all but obliterated, we get the pure world of IT (remember however that a PC is still a mechatronic device: it has the audibly whirring disc drive and lots of electronic hardware). What matters however is that IT has transformed the entire economic landscape of the world. Here are some facts quoted by Quah in support of this claim:

- Since 1990, US firms have been spending more on computers and communications gear than on all other capital equipment combined[7].
- In 1991, Nintendo generated the highest profits per employee, US$1.5m per worker—overtaking, by a considerable margin, car manufacturers Toyota. This success came on the strength of a single IT product[7].
- In the period 2000-2003, email-based transactions helped some 50,000 companies round the world achieve 10 times higher sales growth, 2 times higher profitability, 2 to 3 times higher labor productivity and significantly higher employment growth than companies not using email for commercial purposes[2].

Fig. 2 shows how the new weightless economy is substantially different from the old 'weighty' economy. In both cases skills, education, knowledge, and consumers are important. However machinery and patents which played dominant roles in the old economy are no more dominant. In short, the new weightless world is a dematerialized world. Product realization in the new economy just requires knowledge and an intimate understanding of consumers. This means that barriers to entrepreneurship—an issue I addressed in some detail in my article in KAB Consultants' Career Guide, July 2007—are dramatically lower in the new weightless economies.

Now let us compare the origins of the rapid growth witnessed in China and India in recent times. Today China is recognized as the workshop of the world. Go to any departmental store in US and pick up an article at random. It is likely to have been imported from China. China has thus excelled in the old economy dominated by manufacturing. However, unless it dramatically enhances its innovative capacity and start patenting in a big way, it will hit a wall sometime in the future.

Recent growth in India however is totally different. Quah has put it as follows[8]. "*By coincidence or otherwise, all the successes on which India has taken global lead concern digital technologies: computer software, business processing, pharmaceuticals, Bollywood movies. These successes are all about creating, storing, and manipulating strings of 1s and 0s—whether kept in order in a database, wrapped together to make*

computer code, encoded in chemical formulas, or sequenced so they make an image on-screen that edifies and entertains. All these successful industries have been facilitated by dramatically falling prices on relevant tools, driven by creativity and brainpower, and enabled by job reorganization. Large projects in these industries can be dissembled, have their component parts worked on independently and asynchronously in spatially-remote locations, and transported back over."

Clearly it is easier to succeed at entrepreneurship in the new India than in the new China. That is good news particularly for young professionals from Hyderabad, Bengaluru and Mumbai.

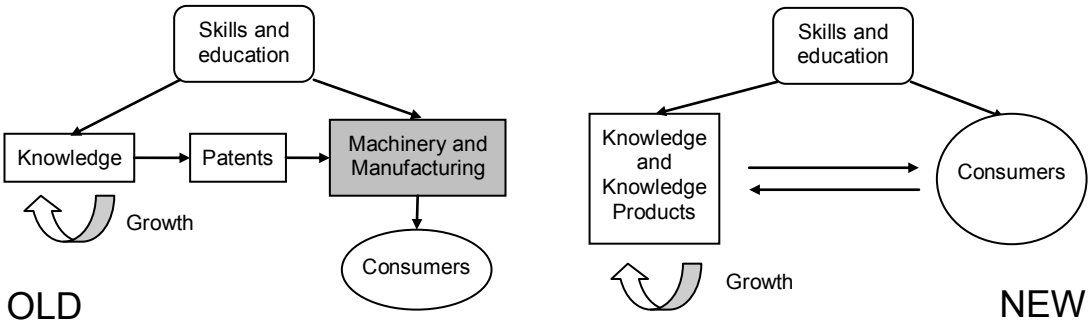

Fig. 2 1 Technology and growth: old and new[2].

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