

CASE FOR REVISITING NATIONAL MANUFACTURING POLICY TO PROVIDE FOR TECHNOLOGY WATCH AND INTEGRATION AND COEXISTENCE OF MANUFACTURING AND SERVICE SECTOR

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Abstract: *National Policy on Manufacturing 2011, has the objective of enhancing the share of manufacturing in GDP to 25 per cent within a decade and creating 100 million jobs. Its share continues to decline even after the adoption of the policy and the blame is brought on inadequate physical infrastructure, complex regulatory environment and inadequate availability of skilled manpower etc. Reality of the situation as it obtains in India is that these constraints are unlikely to ease within foreseeable future. Policy framework should be recognizing this reality and should look for technological solutions to overcome the infrastructural constraints. Concentration on enhancing the targets of manufacturing have taken our focus away from enhancing the advanced service sector by availing of technologies which are available and adaptable to minimize the adverse impact of lack of infrastructure. This note proposes that the manufacturing policy be revisited providing for integration and co-existence of manufacturing and service sector by providing for institutional arrangements for an effective technology watch and creating conditions for adaptation of feasible technologies on the horizon in real time and doing away with the mindset of a predetermined share of manufacturing sector in the economy.*

Our Industrial civilization is at crossroads. Oil and other fossil fuel energies that make up the industrial way of life are sun setting, and the technologies made from and propelled by their energies are antiquated. Emergence of sophisticated ICT based technologies has revolutionized the way communication takes place in managing the new complex commercial activities.

Scenario of industrial and commercial activities is becoming increasingly dependent upon internet technology and renewable energies which are creating a new infrastructure for a Third Industrial Revolution (TIR) that would change the way power

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would be distributed via an 'Energy internet' just like the information is generated and shared on line¹.

Image of workhouses and mills, smoking chimneys and dirty factories is fast fading away. In today's landscape, manufacturers are investors, innovators, supply chain managers and service providers, as well as producers. Achieving a manufactured product involves R&D, design, marketing, distribution, service and support. Definitions of manufacturing should be covering the various activities, that need to be co-ordinate and performed in order to deliver a physical product, as well as encompassing increasingly global, interconnected, multi partner and multi business elements. Complementary services required to support the physical product throughout its life cycle, from systems configuration and purchasing operations, maintenance, replacement and disposal, are increasingly important.

Trend suggests that the manufacturing industry as a whole must place substantial economic value in complementary non-production functions, service in particular. Long run player would consider innovation approaches that might provide a more sustainable advantage, focusing investment on exploiting technologies, and developing new business models in areas that might best address the provision of services related to their products. Emerging economies like China and India are concentrating efforts on the adaptation of high technology industries including aerospace, electronics, communication equipment, and consumer's products. Indian and Chinese entrepreneurs have been acquiring strategically important firms from developed countries.

Manufacturing remains a highly heterogeneous sector, covering a variety of industries from textiles to metals, wood manufacturing to aerospace, and pharmaceuticals to electronics. It can be differentiated in many ways: high and low volume production or product diversification, long and short life-cycle products, or mass-market versus niche

¹ The third Industrial Revolution: by Jeremy Rifkin, worldfinancialreview.com.

products. It differs across industries, firms in the same industry even across business units and divisions in the same firms. Therefore, there is need for better ways of defining and thinking about manufacturing and government policies which are aimed at enhancing the performance and competitiveness of manufacturing and should take into account industry, firms and product specific characteristics.

With the increasing role of knowledge bases in the manufacture outputs, the continuing importance of the manufacturing per se cannot be overlooked in the interest of national security and also for sustainability reasons and for development of new technologies. Economies like India and China cannot survive as a service economy alone as much as manufacturing industry can remain competitive only with a strong services sector supporting it. In fact manufacturing and services sector have to co-exist or even integrate with one another².

National manufacturing Policy (NMP) of the 12th Five Year Plan and beyond accentuates the importance of manufacturing as key to India's global economic success. The policy lays a framework to increase the manufacturing sector's current contribution of 16 per cent to the national GDP to 25 per cent by 2025³. India's industrial output viewed from its contribution as a percentage of GDP steadily continues to deteriorate and doubts are cast about India's ability to pull out of prolonged slow down. Economists attribute the deterioration in output to infrastructure problems, government red tape and the slow pace of economic liberalization. The biggest worry has been perceived to be on account of the slowdown in the manufacturing activity, which accounts for about three quarters of industrial output. Government have tried to revive investments by providing fast track clearances to large projects. It is noted that these projects would take time to show impact⁴.

² The ten myths of manufacturing, Advance Institute of Management Research (AIM) - The U.K.'s Research Institute on Management, www.aimresearch.org

³ Enhancing manufacturing competitiveness: New age solution driving change, frost and Sullivan, www.frost.com

⁴ India factory output contracts, inflation ears-WSJ.com dt. February 12, 2014, Anant Vijay Kala and

Measuring the comparative performance of economies in terms of their sector shares (firms, factories and services) is rooted in the concept developed by economists in 1940's, when it was surmised that service sector should be peaking at about 45 per cent of GDP because of the limit of the tradability of service sector at reasonable costs. However, with the onset of jets and IC based technologies; the limits set by the economists for the growth of service sector were to become untrue so much so that even in the face of declining share of manufacturing, the gross output of this sector continued to rise. However, there continues to be a general perception of decline on a factory closing than an engineering firm opening. A continuing and excessive focus on factories may take energy away from aggressively developing more advanced services⁵.

In spite of the stability in its share in GDP, the manufacturing sector in India has undergone significant structural changes both in pre and post reforms period. Traditional industries have progressively declined and modern industries have gained in importance and the shift towards modern industries has, of course been faster in more recent period. Share of organised sector has become predominant in manufacturing and output structure had become in favour of intermediate products and capital goods. In the post reform period there have been sharp changes in technological composition of manufacturing output in the organized sector⁶. Manufacturing in India thus has been increasingly adapting technologies and is beset with newly ordered value chains and therefore is requiring the support from service sector increasingly. The sector has improved in its productivity. Economy in India is coping with the coexistence of manufacturing and service sector and both supporting each other. When NMP in India sets a target of 25 per cent contribution in the manufacturing within a decade from 2011, it overlooks the fact that economy would not be governed by business as usual parameters in the years to come and would have the advantage of a set of technologies

Mukesh Jagota. Online.wsj.com/news/articles

⁵ Manufacturing decline is a misconception; Tia Nowack; interviewing Joy Atikian; The author of industrial shift: the structure of the new world economy; February 10, 2014, www.manufacturing.net.

⁶ Structural changes in Indian Economy, Emerging Patterns and Implication, ISID Working Paper 2012/2, T.S. Papola.

which would shake the usually established ratio between the manufacturing and service sector. Technologies on the horizon have the potential of overcoming the infrastructure constraints which are coming in the way of growth presently particularly in India as the capacity of India in setting up conventional infrastructures is beset with knotty problems not to be resolved with ease. A long term NMP must therefore identify such technologies on the horizon which are already being adopted and adapted by the developed economies and also other emerging economies and redefine the targets of the ratios between manufacturing sector and service sector which can co-exist and national efforts are concentrated both towards developing advanced service sector capable of advancing the technologies on the horizon towards the manufactured activities of high value to maintain the competitive edge for the national economy. Manufacturing sector in India has already demonstrated its capacity to take advantage of the technology adaptation and be part of international value chains in product development. With focus on planning for an appropriate mix of advanced services and manufacturing there is nothing to prevent India from becoming the World's dominant service sector.

NMP needs to differentiate between sustaining technology development which is toward incremental improvements to an already established technology which an ongoing enterprise would be including in its day to day operations to remain competitive and disruptive technology, which lacks refinement as on date but has the capability of creating altogether new opportunities in the market and sometimes creating redundancies of existing paradigm of products and businesses. In the latter category of technologies, which are rightly termed as disruptive technologies that unexpectedly displace established technologies⁷; policy initiatives need to be spelt by government so that facilitations are created in the economy for availing the benefits that these technologies are capable of and create conditions for smooth transitions in the market. Not every emerging technology will alter the business or social landscape but some truly do have the potential to disrupt the status quo, alter the way people live

⁷ Disruptive Technology. Techtarget.com/definition/disruptive-technology.

and work, and rearrange value pools. It is, therefore, critical that policy should aim at identifying technologies that would matter to the economy and spell out programmes to prepare the communities accordingly.

Mckinsey Global Institute identified 12 technologies that could drive truly massive economic transformations and disruptions in the coming years. Some of these technologies have already been gestating for years and thus will be familiar e.g. mobile internet, internet of things, cloud technology, advanced robotics, next-generation genomics, energy storage, 3D printing, advanced materials, renewable energy, advanced oil explorations, autonomous and near autonomous vehicles⁸. NMP does recognize that manufacturing and technology development are closely interlinked as technologies become useful when they are converted into products through manufacturing and the feedback from manufacturing fosters continuing technology development, and it prescribes access for Indian companies to foreign technologies as well as development of advanced indigenous technologies⁹. NMP would have done better by laying more thrust towards the need for making an assessment of technologies in the horizon which have the potential of adaptation in India taking into consideration its weakness of developing robust conventional infrastructure and incentivizing the measures for the application of such technologies. For example, deploying of internet of things can be thought of improving infrastructure management which would require strong education and training programmes and the related programmes could very well be imparted through an expanded mobile internet which has the potential for better delivery. NMP, in view of the obvious impact of technology onslaught, should also be visualizing new metrics that capture more than GDP effects with a view to demonstrating balancing the need to encourage growth with responsibility to lookout for the public welfare as new technologies are sure to reshape economics and lives. Merely firming up specific ratios for manufacturing in the economy

⁸ Disruptive technologies: Advance that will transforms life, business, and global economy, Mckinsey global institute, May 2013.

⁹ Press note no. 2 (2011 series) dt. 4th Nov, 2011 of Department of Industrial Policy & Promotion (Manufacturing Policy Division) of Govt. of India on National Manufacturing Policy.

cannot be the primary objective of NMP. Many of the technologies on the horizon are readily available and may require little or no capital investment. For example, 3D printing could help democratize the design, production and distribution of products and services. Capacities for adapting 3D printing and required IT capabilities are within the reach of small entrepreneurs spread across the territories including in developing economies like India. Widespread dissemination of such inexpensive technologies has the potential of overcoming infrastructure constraints and creating employment in inaccessible and remote areas as well. 3D printing, also called additive manufacturing, moves away from the Henry Ford era mass production line, and will give meaning to customizable, one off production. 3D printers use a variety of very different types of additive manufacturing technologies, but they will share one core thing in common; they create a three dimensional object by building it layer by layer; until the entire object is complete. In 3D printing, a computer aided (CAD) file is created with the use of 3D modeling programmes and the file is sent to the 3D printer. Along the way, software slices the design into thousands of horizontal layers. These layers will be printed one atop the other until the object is done. So in days ahead, current manufacturing processes would be out dated as these involve cutting and drilling and result in wastage of materials. Already fast 3D printers are available in the market for a few thousand dollars, and are saving the companies many times that amount in the prototyping process. Nike, for example, creates prototypes of multi-coloured range of shoes. Not only huge costs have been saved in this process but also on the spot changes in the design are affected instantaneously. Companies have been using these printers for short run or custom manufacturing, where printed objects are not prototypes; but actual end user product. Besides, the commercial 3D printers, personal and Do It Yourself (DIY) 3D printers are available in the price range of \$ 300 - \$ 2000. Thus more and more 3D printers for personal use have been available in US and other advanced countries. Free software programmes like Google-Sketch is available which are easy to learn to get on with the use of the 3D printer. If one does not possess a 3D printer, 3D printing service bureaus have come up in the markets in advanced and many developing countries

which can inexpensively print and deliver an object from a digital file up loaded from a website. 3D model files are also available free on the internet to suit one's fancy and thus some print jewellery of their choice and some print even replacement parts of their machineries. The technology has given a free play to art & craft as well and also in the design of toys. At the present stage of the technology many printing methods have become available enabling the use of materials like clay, cement, silicon, resins, plastics, polymers and even food items like chocolates and cheese. Techniques have become available where layers of adhesive-coated paper, plastic, or metal laminates are successively glued together and can be cut to a shape by laser cutter. Thus this technology is a game changer and would impinge on every aspect of industry and personal lives. Bio printers have also come up based on 3D printing and are capable of printing human tissues for both pharmaceutical testing and eventually entire organs and bones.

Architecture and construction are changing as well. 3D printed models of complex architectural drawings are created quickly and inexpensively. Massive 3D printers are printing concrete structures, with the goal of someday creating entire building with a 3D printer¹⁰.

Government as advanced as U.S. have decided to give significant support to this technology. In the State of the Union address in 2013, President Barrack Obama announced that 3D printing had potential "to revolutionize the way we make almost everything", as he launched the National Additive Manufacturing Innovation Institute with funding of USD 30 million. The UK government is promoting 3D printing with a GBP 14.7 million package for projects by innovative enterprises utilising this technology. Singapore has announced that it will invest USD 500 million over next five years in the development of 3D printing¹¹. European Commission proposes to revive its declining manufacturing sector by asking member countries to invest heavily in new technologies

¹⁰ What is 3D printing? An overview www.3Dprinter.net/reference/what-is-3d-printing

¹¹ 3D printing technologies and beyond, Nov. 2013-netopia www.netopia-eu/wp

such as 3D and industrial biotechnology¹². Japanese government is facilitating 3D printers entering schools where students would receive hands on experience in learning about 3D data and 3D printing technology. Japan hopes, that this initiative will keep them competitive with countries like US where plans to introduce 3D printing in schools have been underway since 2010. The Japanese economic ministry sees 3D printing technology as playing a central role in the future of cutting edge manufacturing worldwide, and the decision to fund 3D printing in educational settings is in line with this vision. MITI has included 4.5 billion yen (US \$ 44 million) in the year 2014 budget to support R&D to manufacture metal products using 3D printing technology. Japan is conscious of its lagging behind US and Europe in this technology and hopes that the funding schools would foster students' design and manufacturing skills to help Japan stay on top of technology trends in and development in 3D printing¹³. Though China is famed for cheap mass produced goods, she is looking to 3D printing technology to help its manufacturing produce high end goods. Consequently investment focus on 3D printing has been geared more towards technology transfer leading to increased demand and local supply of rapid prototyping capability than low end 3D printers. Rather than produce small items with 3D printers, the country's manufactures have been looking to 3D printing development to reduce development times and production wastes, particularly in the design, development and manufacture of aircraft. This focus on large scale 3D printing technology contrasts with current developments in the west where 3D printing has primarily been driven by (1) products personalization, (2) increased geometric flexibility and functionality and (3) low volume/high value manufacturing. Revenues from China's 3D printing industry reached US \$ 163 million in 2012 and the forecast is that it may grow to US \$ 1.6 billion by 2016, which would make China the largest user of 3D printing technology in the world. Beijing has been investing in 3D printing research since 1992 and it held its first 3D printing international conference in 2013. China's Dalian University of Technology has developed the world's

¹² EU sees industrial revival through 3D printing and biotech. In.reutero.com /assets/prints? aid 26-2-2014.

¹³ Japanese government to fund 3D printing in education, Feb,3 2014 www.3ders.org/articles.

largest 3D printer and has network of ten 3D printing innovation centres funded with over US \$ 32.6 million of government investment. Advance Chinese Universities and vocational schools offer courses in 3D printing. A large number of rapid prototyping service providers and 3D printed objects have come up. There are companies selling 3D printed products produced in China using 3D printing (e.g. 3D printed smart phone cases) on global market. There is a growing body of design in China proficient in designing components and other items suitable for 3D printing¹⁴. World's largest 3D printer produced by China and referred to above has a maximum processing size of 1.8 m. unlike most other 3D printers, it use 'contour scanning' technology that shortness processing time by 35 per cent and reduce manufacturing cost by 40 per cent. The processing time of traditional 3D printer is proportional time to the volume of a part, while in this Chinese version processing time is proportional to the unit of surface area of a part; speeding print efficiency to 5-15 times that of traditional 3D printers. The material for this printer is common coated sand. This achievement of China would be surpassed when it unveils its next largest 3D printer, capable of printing metal objects up to 6m in diameter which would be able to print out the frame of virtually any automobile¹⁵. When this note is being finalised, news has appeared that a Chinese company has built a group of ten completely 3D printed houses in just under 9 days. The houses, each covering an area of 200 sq. meters are made of concrete. An enormous 3D printer 500 ft long, 33 ft wide and 20 ft high was used to print each of the structural components of the house which will cost \$ 4800 each. The 'special ink' that has been used was made from industrial construction waste, and thus the project has been environment friendly¹⁶.

3D printing is recently becoming a buzz world for software companies in India and strategies are being worked out to tap this technology in the expectation that the technology would prompt manufacturing companies to spend more on information

¹⁴ 3D printing in China, a reality check www.3dprinter.net 24-02-2014

¹⁵ China set to showcase world's largest and fastest 3D printer, voice of Russia, 3D print.com.

¹⁶ Times of India, New Delhi p.13

technology¹⁷. 3D printing is at a nascent stage in India. There are less than 10 organisations offering commercial 3D printing services in India due to expenses involved. These printers are being imported. High end technologies are not freely available in India. Methods like organic printing are unheard of¹⁸.

India has been behind in the race to take on this technology compared to China who started taking interest in developing technology on their own since 1992 and have reached a stage when they have proven capacity to make world's largest 3D printers and have been using industrial 3D printers, which it has been using successfully to manufacture titanium alloy landing gear for jets, bearing frame of aircrafts as well as parts used in satellites, rockets and power plants. China's military is using 3D printing to visualize landscapes. A 3D printed model allows tacticians to better visualize landscapes for military planning, topographic analysis, emergency services and civil engineering¹⁹. Thus India would have a herculean task to catch up, if it can with policy instruments designed to provide for leap frogging as is being done in Japan.

Global forecasts foresee tremendous opportunities arising from demand spurt for this technology in India when it endeavours to catch up and 3D market demand is projected to rise more than 20 per cent per year to \$ 5 billion globally²⁰.

Policy framework of manufacturing, it appears has to lay emphasis on technology watch with a view to immediately integrating the emerging technologies with the industry and manufacturing so that India does not develop lags vis a vis other economies as it seems to have developed in relation to 3D technology. NMP needs to recognize that manufacturing sector and service sector have to co-exist and integrate technology in the environment of fast changing technology scenario. Laying exclusive emphasis on share of manufacturing in the economic growth would be limiting attention to the emerging technologies which in any case would be boosting the share of service sector in the

¹⁷ Business line, Mumbai, March 3, 2014 businessline.com

¹⁸ 3D printing is just beginning in India, 3dprinterinsider.com

¹⁹ China's Military using 3D printing to visualise landscapes; [3d printerinsider.com](http://3dprinterinsider.com)

²⁰ 3D printing market & 3D printer industry growth 2020 forecasts.

economy. NMP would thus do well to commend the embracing of disruptive technologies on the horizon so that sectors such as robotics, internet of things, internet of power network etc. remain under focus and encourage indentifying skills required to be developed for adapting such technologies in industry and economy in general so that India keeps pace with the rest of the advanced economies and other competitive emerging economies without too much worrying for specifying definitive ratios between manufacturing and service sector.

In fact technology watch has to be on continuous basis and that too with a vigilant eye. While India is yet to take on 3D printing, 4D printing has already dawned on the horizon enabling the product to continue to evolve after manufacture to adapt to the changing environment e.g. water pipes expanding or contracting to change capacity or change flow rate²¹. Those who are out of step with the emerging technology are bound to slide further. Technology watch as integral component of NMP would lead to a vision requiring an understanding of technological forces that precipitate the profound transformations in society.

It is emphasized that NMP 2011 is revisited to commend institutional arrangements for technology watch on the horizon on a real time mode with a view to assessing them for their suitability of adaptation in India with inputs as required from government and inducing the entrepreneurs to foray into opportunities being foreseen in the environs of emerging technologies. The focus of NMP would naturally be towards developing advanced manufacturing which would be backed by advanced technologies being supported by advanced service sector and thus establish that manufacturing sector and servicing sector have to integrate and co-exist without firming up ratios for either of the sectors in the overall mix of GDP.

²¹ If u think 3D printing is disruptive, wait for 4D blogs. Wsj.com/tech/2013/07/30.