Productivity Link

November 2015

Contents

Productivity in Electronics Sector

1. An Overview of Electronics Sector in Singapore

In the 1960s, Singapore began its venture into electronics as the sole TV assembly plant in Southeast Asia. From video game consoles to vehicle navigation systems, it typically included a part manufactured or designed in Singapore. This industrial strength makes it a vital part of the global electronics market.

The market is shifting to Asia and Singapore must be prepared to attract and secure as much of the business as possible. It is a prime location for companies wishing to manage and create new markets and products because of Singapore's strong business fundamentals and capabilities in the electronics industry.

The electronics industry displays a solid foundation in today's market and has innovative plans to move forward in the global economy. Singapore's electronics industry statistics include:
•Economic growth: 25% total manufacturing value-add contributed.
•S$16 billion fixed asset investments 2012: 38.8% total investments.
•Industry employment: 19% total manufacturing jobs, or 80,000 employees.

The electronics industry brings employment growth in finished electronics products, including logistics service providers and precision component manufacturers.

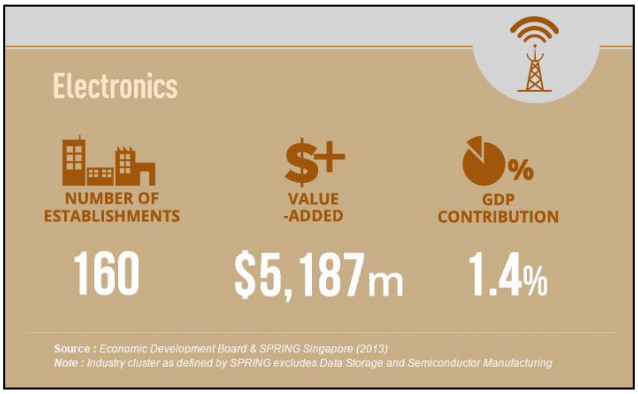

Figure 1: Electronics Statistics
Source: http://www.spring.gov.sg/Developing-Industries/ELC/Pages/electronics.aspx

2. Productivity Challenges in the Electronics Sector

Singapore has an impressive background in electronic productivity. In 2012, electronics contributed 5.2 percent to the country's GDP (Gross Domestic Product). It is the base upon which Singapore's thriving manufacturing sector is built. To improve productivity in the electronics sector, what challenges must be met or surpassed?

2.1 What are the barriers/challenges facing the sector's productivity?

Productivity in Singapore's electronics sector demonstrates the ability to meet and adapt to the rapid changes and demands in today's electronics arena. The successful industry leader in electronics will display:

- High quality of engineering talent.
- Ongoing workforce training.
- Ability to anticipate change and grow using innovative ideas and actions.

We list the key productivity challenges facing the electronics sector below.

2.2 Short Product Life Cycles

Companies in the electronics sector must be prepared to introduce new products while expanding on current market items. Consumers are eager to purchase and enjoy a constant supply of new technology that fits their lifestyle. Companies must run lean in preparation for switching operations quickly in response to ever-changing consumer demand. Closed-loop communication concepts between sales, manufacturing, and engineering will help product launches reach goals for volume, release, and quality.

2.3 Managing a Global Supply Chain

International sales involve understanding the complex operations of several countries and continents. Compliance, traceability, and standards of each area affect the speed and safety of products enroute to their destination. Control and understanding of the supply chain as well as preparation for potential problems leads to success.

2.4 Sustainable Engineering Strategies

Environmental conservation practices are used to measure a company's commitment to the public. The evaluation extends to other companies in the supply chain. Social responsibility includes manufacturing products that are safe to consumers, animals, and the environment during their lifecycle. Sustainable productivity also includes the products afterlife, including waste disposal, recycling capabilities, and the ease for disassembly.

2.5 Tighter Margins

Singapore businesses must provide quality products to be competitive with other companies around the world. Constant reevaluation and change of processes, personnel, and manufacturing will direct growth despite the lean margin between expenses and profit.

3. What are the enablers available to boost productivity in the sector?

What enablers are in place to help Singapore reach its vision of being a Home in Asia for global industrial leaders? Government policy and trade leaders support the transformation to a world class electronics hub. Innovative manufacturing, business, and technology solutions will increase growth and promote advancement in manufacturing such as hard disc media and wafers. Technological revolutions like 3D printing, intelligent robotics, and open source electronics are going to cause an upheaval in established multi-tiered and global supply chains.

Entry barriers will decrease 90 percent and unit cost savings will average 23 percent. Singapore must develop a plan to manage digitalization and be competitive with other countries.

3.1 3D printing reverses standardisation

The technology revolution is being led by 3D printing. Sometimes called additive manufacturing, it uses technology common to inkjet and laser printing. Solid objects are built a layer at a time by depositing layers of material on top of each other. Improved processing over the past 20 years has made 3D printers inexpensive enough for individual consumers to purchase.

3D printing permits companies to build parts to scale for various items such as machinery and vehicles. The cost of designing and creating a mold before a part can be produced is no longer an issue for many items. The adaptability of the electronics industry has responded to customer and consumer needs by making a cost-effective way to produce replacements.

3D printed in electronics application could stack ICs in ways that were previously impossible. Eliminate wire harnesses by combining them with 3D traces. Product designs are no longer limited to planar PCBs and designing electronics to fit parts, rather than designing the part around the electronics become possible.

Figure 2: Voxel8's 3D printer - disrupting the design and manufacture of electronic devices by providing new functional materials with a novel 3D printing platform
Source: http://www.voxel8.co/

3.2 Wire-to-Board Connections - Minimising Costs

Using established technologies such as springs systems, IDC (insulation displacement connectors), or crimping, provide innovative solutions for inexpensive connection of any type of single or standard wire cable to the PCB. High costs are typical when handling large quantities of wire-to-board connections in mass markets. The right connection technology is being used to easily and economically establish connection between the cable and circuit board.

This is an example of thinking outside of the box to reduce costs, increase productivity, and attract customers. Instead of two individual elements requiring additional work and an average expense of 15 cents, creative engineering can make it possible to connect millions of units at a lower cost. The process saves money because it requires fewer steps. That keeps businesses competitive with other international markets.

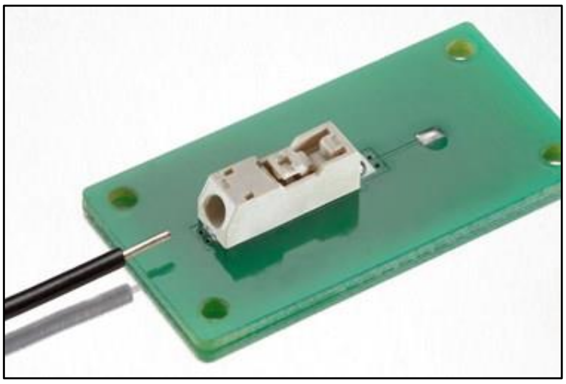

Figure 3: Spring Systems and Plug-in Contact
Source: http://www.newelectronics.co.uk/electronics-technology/minimising-costs-for-wire-to-board-connections/88435/s

3.3 The Internet of Things and Human-Robotics Collaboration

The Internet of Things (IoT) is the heart and soul of machine-to-machine communication. It involves vast networks of data-gathering sensors. Mobile, instant connections built on cloud computing makes IoT more than a machine. It is an environment that permits “smart” data transfer over a network without the necessity of human-to-computer or human-to-human interaction. Animals, objects, and/or people have unique identifiers that send gathered data.

Information gains value when it is analysed in real time. That activity relies on cloud-based applications that interpret and transmit data. The intelligent interchange advises of a situation and how to deal with it. An example is YuMi, a human-friendly dual arm robot from ABB Robotics commercially launched April 13, 2015. YuMi has the ability to feel and see, in addition to innovative force-sensing technology that provides safety to human co-workers. YuMi will change the way we think about assembly automation.

Figure 4: Robot YuMi from ABB Robotics – Transforming Assembly Automation
Source: http://new.abb.com/products/robotics/yumi

Humans and robots working side by side in harmony is no longer the vision of the future. It is here and now, prepared to change the way humans regard industrial and manufacturing processes. YuMi demonstrates the number of possibilities for IoT and electronics.

3.4 Nanotechnology

Nanotechnology provides faster, smaller, and more portable systems that can manage and store larger and larger amounts of information. It is already in use in many computing, communications, and other electronics applications, including:

Nanoscale transistors that are faster, more powerful, and increasingly energy-efficient. Soon the computer's entire memory may be stored on a single tiny chip.

Magnetic random access memory (MRAM) enabled by nanometer-scale magnetic tunnel junctions that can quickly and effectively save even encrypted data during a system shutdown or crash.

Displays for many new TVs, laptop computers, cell phones, digital cameras, and other devices incorporate nanostructured polymer films known as organic light-emitting diodes, or OLEDs. OLED screens offer brighter images in a flat format, as well as wider viewing angles, lighter weight, better picture density, lower power consumption, and longer lifetimes.

Other computing and electronic products include Flash memory chips for iPod nanos, conductive inks for printed electronics for RFID/smart cards/smart packaging; more life-like video games; and flexible displays for e-book readers.

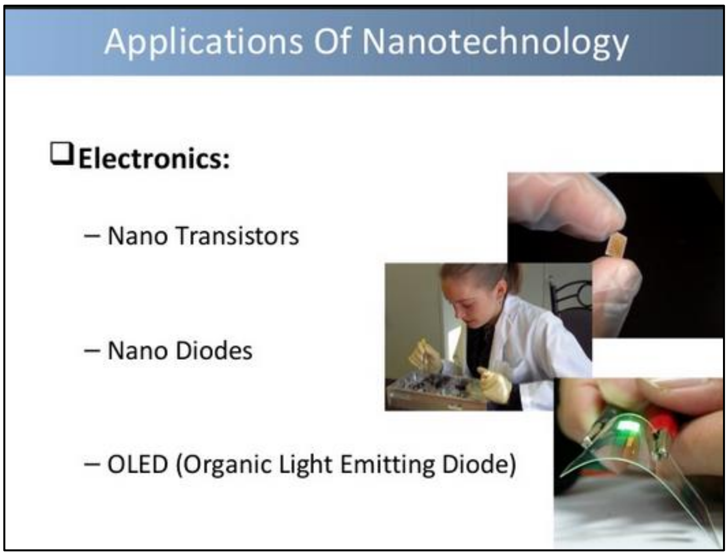

Figure 5: Applications of Nanotechnology in Electronics
Source: www.slideshare.net

4. Possible Immediate Actions

The Ministry for Trade and Industry (MTI) will continue to partner the electronics industry as it increases competitiveness. The industry is regarded as a key pillar of Singapore's economy based on its 2013 statistics:

- Bringing in 5% of Singapore's Gross Domestic Product (GDP).
- Holding 2nd highest labour productivity among manufacturing industries.
- Largest contributor to business expenditure for Research & Development.

Support will be given to companies that raise energy efficiency, labour productivity, and quality by investing in new technologies. Assistance will also be provided to companies augmenting manufacturing activities in profitable niche areas. MTI will also help companies investing in public R&D electronics projects that develop critical capabilities in disruptive or new technologies.

Electronics companies will have to weather the significant industry disruption while the supply chain is restructured. Production costs for new technologies will drop, forcing companies to lower prices to remain competitive.

Digital manufacturing allows a high degree of personalization for cost-competitive products with standard implementations. Cheap robotic assembly lets parts be printed in segments, eliminating tiers in the supply chain.

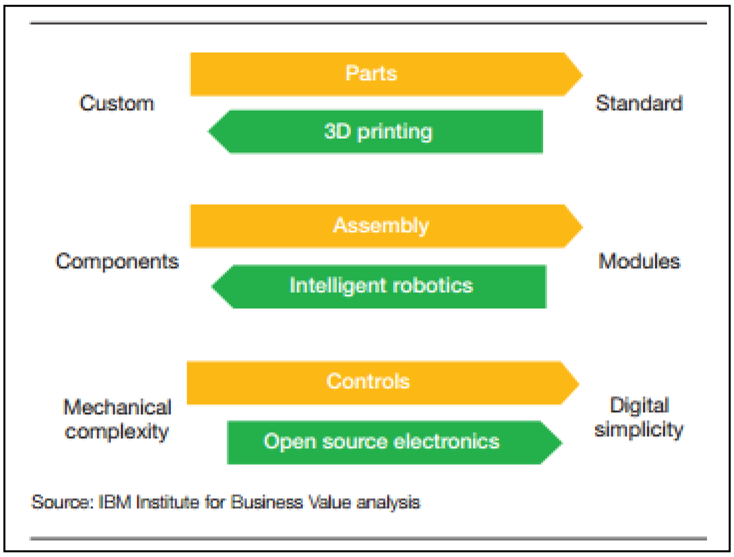

Figure 6: Traditional product design and manufacturing rules are being rewritten today in the digital era.
Source: http://www-935.ibm.com/services/multimedia/The_new_software-defined_supply_chain_Exec_Report.pdf

Electronics enterprises need to analyse and understand the far-reaching implications of a software-defined supply chain. It will change to a simpler, localised, and more flexible entity as customers become more tech-savvy and engaged in the chain process.

Product designs and retailing are going to be greatly influenced by customer interaction. Utilize the expanded online ecosystems to create customized designs that reflect product themes as well as the input of consumer and company choices.

Expect and prepare for a radical change in competitive dynamics. Uncomplicated small products may be referred to distribution centers for manufacturing purposes, an increase in business at one end and a loss at the other.

Trends are accelerating at this moment. What can be done? Change product design and retail strategies. The landscape has changed. Learn the new rules of the arena and become the champion by allowing for a great deal of flexibility in modernized supply chains.

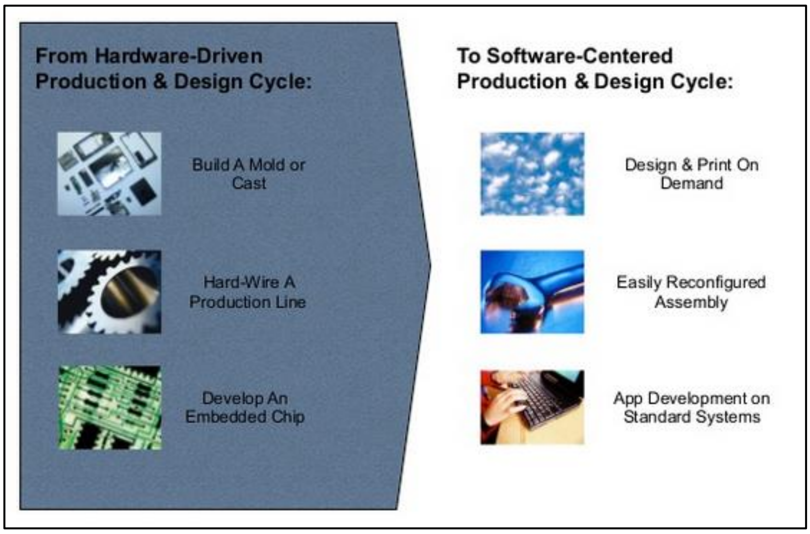

Figure 7: Software-defined Supply Chain
Source: http://www.slideshare.net/pbrody/the-software-defined-supply-chain

Case Study

Case Study: Local – Texas Instruments (TI), DHL Supply Chain, and Swisslog
Automated warehouse developed to raise productivity

Texas Instruments (TI), DHL Supply Chain, and Swisslog unveiled Asia's first distribution center featuring the AutoStore® automated storage and order picking system on September 5, 2013. The facility is located in Changi within DHL's Supply Chain hub at the Free Trade Zone. A new benchmark for the logistics industry and giant leap in warehouse management, TI projects it will raise productivity by 40 percent and raise capacity fourfold.

The centre uses 36 robots to extract and store products, eliminating the need for aisles between the shelves and allowing a huge operation in a minimal amount of space. Goods move swiftly through this structure, a huge grid that utilizes an 800-metre conveyor system to connect the shipping and receiving areas.

The automated warehouse is the result of an upgrade to DHL Supply Chain's US$19.5m (SGD$25m) facility and provides an increase in storage capacity from 500 million to two billion semiconductor units. The complete inventory flow is controlled by warehouse management software.

Growth in demand led TI to seek a solution for electronics storage in the form of semiconductor units. Two objectives were the use of existing space and increase of productivity through automation. Quek Swee Kuan, Deputy Managing Director, Singapore Economic Development Board (EDB) noted that the project demonstrated that Singapore's logistics industry is prepared to achieve growth in global distribution capabilities through innovative solutions.

There are 250 people employed at TI's Singapore distribution centre, its largest centre globally. Inventory is received from 20 inbound countries and shipped to 54 countries.

Figure 8: Texas Instruments, DHL and Swisslog unveil Asia's first AutoStore® automated warehouse
Source: https://www.edb.gov.sg/content/edb/en/news-and-events/news/2013-news/Texas-Instruments-DHL-and-Swisslog-unveil-Asias-first-AutoStore.html

Case Study: Global – United States Nanorobotics Platform for Nanomanufacturing

Nanoengineers at the University of California San Diego have invented a new nano-patterning approach. Called Nanomotor Lithography, it is a twist to conventional static optical fabrication systems. The autonomous movement trajectories of nanomotors, or nanorobots, are translated into controlled surface features.

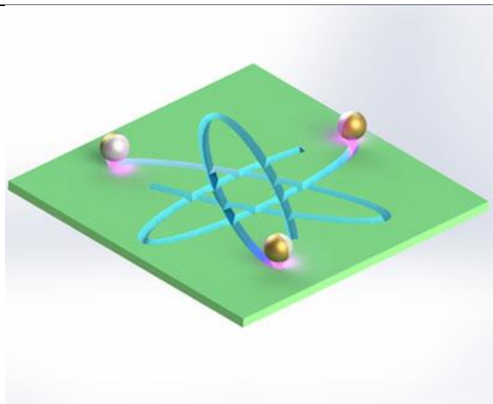

Figure 9a: Schematic of nanomotor lithography by using a Janus sphere motor as a self-propelled nanolens. (Image: Jinxing Li, UC San Diego)
Source: http://www.nanowerk.com/spotlight/spotid=37884.php

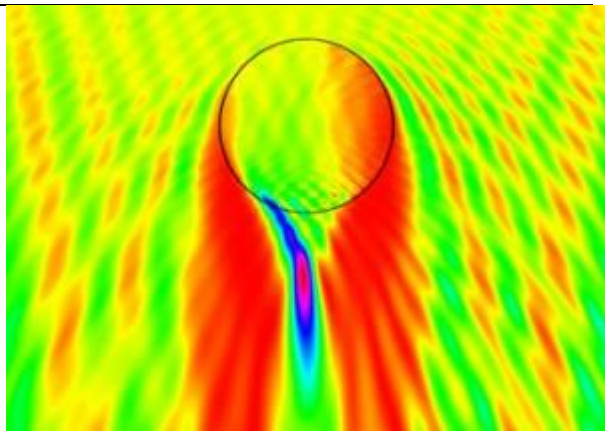

Figure 9b: Spherical nanorobot made of silica that focuses light like a near-field lens to write surface patterns for nanoscale devices. The red and purple areas indicate where the light is being magnified to produce a trench pattern on light-sensitive material.
Source: http://nanocomputer.com/?tag=university-of-california

Advanced fabrication techniques are a result of the miniature machines and devices used in this technology. Using the high-resolution lithographic systems is a complex and expensive procedure. Experiments demonstrated that synthetic nanorobots have amazing functionality and performance.

Led by Professor Joe Wang, Chair of Nanoengineering, the team presented their findings in an online edition of Nature Communications. The efficient, yet simple nanomotor-based nano-patterning technique relies on self-propelled nanomasks and nanolenses. Wang noted the nanomotor-fabrication strategy combined light focusing or blocking with controlled nanorobots movement for direct surface writing.
One benefit is the freedom to create a variety of shapes, sizes and features. Surface patterns are developed that correspond to the nanorobots' predetermined path, delivering highly structured features with complex patterns.

A higher order of nanorobot organization and modular motor design delivers an even greater diversity. Two different kinds of nanomotors move across the water that has been placed over photoresist surfaces. Janus spheres are used as near-field nanolenses and concentrate the processing light while harnessing near-field optical effects for direct writing. Self-propelled platinum nanowires replace the traditional photomask.

The new nanomotor approach is cost-effective and simple because of the magnetically guided control that is used. The ordinary surface patterning techniques do not require extensive or expensive control systems. The research indicates a wide-open opportunity in surface science by tracking and understanding responses of nanorobots to patterning and lithographic techniques.

5. Conclusion

Nimble start-ups could integrate the new technologies to drive big disruptions in business models and re-write competition to enjoy lower design cost, reduced scale for competitive pricing, much faster time to market, few suppliers and tiers required and far less capital required. To realise these benefits, companies have to rethink the supply chain, rethink the design process and deliver on-going value to your customers through services beyond products.

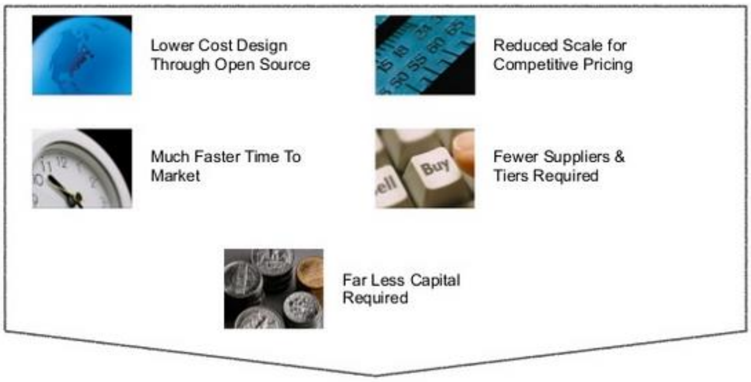

Figure 10: Impact of Disruptive Technologies
Source: http://www.slideshare.net/pbrody/the-software-defined-supply-chain

Recommended Readings

Title: Fabless: The Transformation of the Semiconductor Industry
Author(s): Daniel Nenni (Author), Paul McLellan (Contributor)
Publisher: CreateSpace Independent Publishing Platform
Year of Publication: 2014
ISBN: 978-1497525047

Title: Compact Models for Integrated Circuit Design: Conventional Transistors and Beyond
Author(s): Samar K. Saha (Author)
Publisher: CRC Press
Year of Publication: 2015
ISBN: 978-1482240665

Title: Colloidal Quantum Dot Optoelectronics and Photovoltaics (1st Edition)
Author(s): Gerasimos Konstantatos (Editor), Edward H. Sargent (Editor)
Publisher: Cambridge University Press
Year of Publication: 2013
ISBN: 978-0521198264

Publications which are in the holdings of the National Library or Public Libraries are denoted by [call number] at the end of each reference. Please check the library's online catalogue to confirm the availability.

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