SMT PROSPECTS & PERSPECTIVES

2014: Year-End Review

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For this year-end column, we will check on how my January 2014 column, New Year Outlook: What Can We Expect in 2014, actually panned out. As usual, I will go through the key sub-topics that directly or indirectly impact our industry in terms of macroeconomics, business environment, technology and global marketplace. It is comforting to say that my 2014 outlook was, by and large, on or close to target.

GLOBAL ECONOMIC OUTLOOK

From January 2014 Outlook:

"In 2014, the countries with the first and second largest economies, U.S. and China, respectively, are expected to show improved outlooks over 2013, while the third largest economy, Japan, launches bold new fiscal policies and economic stimuli.

With Japan holding the highest debt levels in the world (at 230% of GDP), Abenomics needs to show real progress; it will be a tricky maneuver. China and Japan both happen to have recently installed new leadership, which will exert new influences and economic policies. Across the Atlantic Ocean, progress has been made. The signposts indicate that the financial crisis is ending in the Eurozone. Countries such as Italy and Spain are exiting recession. However, the ECB is pondering the challenge and impact of the worryingly low inflation rate. The U.K. sees recovery gaining pace. The Bank of England believes the U.K. economy is recovering so quickly that it will likely consider raising interest rates in 2014[1].

However, a sound economy exists only if there is political and social stability. To that end, the standoff between China and Japan over territorial disputes could skew the global economies if it escalates to a dangerous stage. Such an escalation is unlikely, but not impossible. Eschewing any adverse complications calls for one of the most sensitive and intricate executions of the U.S. diplomacy and the foreign policies. Navigating between the two disputing countries takes more than the assessment of the current parameters and environments. It also needs both retrospective and prospective understanding of the two countries in relevant

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economic, political and cultural terms, which are profoundly complex. Brinkmanship would not be an effective tactic. A gingerly and delicately executed treatment is in order.

The year 2014 appears to be an extension of another relatively low interest rate economy even with a modest interest rate increase, which is good for borrowing money to conduct business and corporate-finance activities. The 2013 U.S interest rate of 0.25% was at a historical low, far below the average (6%, with the all-time high of 20% in the 1980s), and the Eurozone was at 0.25%, also a record low, and U.K was at 0.50%.

In corporate America, a rising tide (stimulus and low interest rate) has raised all boats in the stock market. But many premier companies are taking a hard look at their business strategy and focusing on enhancing operating margin and profitability. It is an arduous and critical thinking process, but it has to be done in order to be competitive. This process includes where and how the cash-rich multinational corporations (collectively holding more than $1 trillion in cash) are going to invest—overseas or domestic; dividend increase or share buyback; operation expansion or mergers and acquisitions. The strategic outcome will impact the job market and the U.S. economy, as will government policies and tax reforms. At the date of this writing, December 1, 2013, the U.S. fiscal policy's holding pattern poses uncertainty and risks to the 2014 economy, and thus to corporate actions.

Judging from the Chinese government's decision not to pump funds into the economy and its implementation of new reform policies, the commodity prices, tightly linked with the supply and demand dynamics, are expected to stay flat or decline further. Another good sign is that U.S. manufacturing activity is in upward trajectory[2].

Going into 2014, the U.S. unemployment rate should see moderate improvement, hovering around 7%, but reaching the 6.5% milestone is perhaps a stretch, unless the new Fed Chair's emphasis on employment out of the central bank's dual mandate—maximum employment and stable prices—exerts "miracle" muscle on reducing unemployment. And the Eurozone continues to struggle with a double-digit high unemployment rate.

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With increased underlying strength, the U.S. economy is expected to grow at a faster pace than 2013, barring political debacle in Washington. There is a good chance that the U.S. GDP may recover to 3% or better. Overall, for the first year since 2008, you don't have to be an optimist to see the glass as half full. And China's economy (as does its politics) continues to be a factor!"

What Happened in 2014:

Indeed, the U.S. economy improved in 2014. As of this writing, the U.S. GDP expanded at a seasonally adjusted rate of 3.50% in the third quarter over the previous quarter, according to the Bureau of Economic Analysis. It looks that 2014 will conclude with a GDP at 3.0% or better. With the improved economy and the controlled spending, the U.S. budget deficit has pushed down to 2.8% of GDP, the lowest level since 2008—a pleasing record!

The Federal Reserve ended its monthly bond-purchasing program and dropped a characterization of U.S. labor market slack as significant.

The U.S. unemployment rate reached below 6.0%, per the Labor Department, down to 5.8% as of November 7, 2014, which is better than I predicted. But whether the 5.8% accurately reflects the level of improvement is uncertain. This is due partially to the change in the labor participation rate as many unemployed may

have stayed out of the labor force, and some young people are staying in school for a longer period.

In other parts of the world, the Eurozone's recovery has been sluggish and Japan's Abenomics is still a work-in-progress, despite the stimulus programs. As expected, trouble spots with the standoff between China and Japan over territorial disputes in South China Sea did not blow up. Nonetheless, geopolitical risk has risen in 2014, especially with the resurgence of the Islamic State of Iraq and Syria (ISIS) and the escalating complexity of the Middle East politics vis-a-vis U.S. foreign policies.

Commodity prices, tightly linked with the supply and demand dynamics, have declined, also as predicted.

In corporate America, a rising tide (stimulus coupled with low interest rate) has raised all boats in market capitalization although stock prices have fluctuated far more than logic can justify. Companies that have not ridden the tide to take a hard look at their business strategy and to execute on enhancing operation efficiency and profitability are losing a precious opportunity. New evolving events toward the later part of the year (e.g., stronger dollar and lower oil prices) are expected to generate mixed forces in driving the corporate earnings in the fourth quarter.

For 2014, with lower energy prices and declining commodity prices, the impact of BRICS countries is largely supported by one country—as well said, for year 2014, the "brick" was China.

CHINA FACTOR

From January 2014 Outlook:

"China is gaining traction in global trade. The country has just hit another milestone as the use of the yuan (renminbi) in trade finance overtook the euro and the yen, although the yuan is still far behind the U.S. dollar. This is not to say that China's banking and financial systems are well established. However, this milestone indicates that foreign (non-Chinese) companies are getting more comfortable trading in yuan, in addition to garnering some pricing advantages.

It is crucial for China's new leadership to implement structural reforms in 2014. Within the context of "planned reform," the timing happens to be good from the standpoint of the state of the world economy.

With all three of its largest trading partners in a slow-growth mode, China has more a reason to gear up its consumption-oriented economy to spur long-term growth, sustainability and social stability. Its government increasingly recognizes the market role in economy in order to move to a sustainable path that will depend more on domestic demand and less on exports and government spending.

The country has just formed the National Development and Reform Commission to design and coordinate its reform. The new leading group's duties, apart from economic reforms, are to plan and carry out reform on modernizing China's "governance system" and "governance capability." The core issue of the reform is "to better handle the relationship between government and the market"[3]. With the formidable task in hand, the country's stability is the new leaders' number one "wants and needs." Consequently, the official growth target is not expected to be higher than 7%. However, take note that in practice, China has always exceeded its target in recent years. China's twelfth Five-Year Plan is the national master blueprint to achieve medium term economic and social objectives. The country must stay on its course to develop seven strategic priority industries: new energy (e.g., nuclear, solar, wind); energy conservation and environmental protection (e.g., energy reduction target); biotechnology (e.g., drugs, medical devices); new materials (e.g., high-end semiconductors, rare earth); new IT (e.g., broadband network); high-end equipment manufacturing (e.g., aerospace, telecom equipment); clean energy vehicles. China plans to provide financial and tax support to these industries over the next decade in hopes of making these sectors account for around 8% of China's GDP by 2015 and 15% by 2020. The broad-based goals to be achieved are: sustainable growth; moving up the value chain; reducing disparities; scientific innovation with R&D spending increase to 2.2% of GDP; environmental protection; energy efficiency; and domestic consumption.

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To foreign companies, these goals bear a plethora of business implications. I see specific opportunities in individual areas and industry sectors.

For Chinese companies, iconic branding is a dream come true. Many have gained understanding on what it takes to globalize through the thoroughly planned strategy executed relentlessly over sustainable years—Samsung and Singapore Airlines are two admirable models. As more indigenous companies aspire to be a global brand, more global competition in all industry sectors is in the works."

What Happened in 2014:

China's growth rate in 2014 was the slowest in five years, yet still above 7.2%. Their GDP target was around 7.5% and a figure slightly below this is acceptable to Beijing. It looks like it will finish the year with 7.2%, plus or minus 0.2%.

The country is moving from an investment to a consumption economy. A weaker yuan has flooded the financial system with cash, but it is expected to be transitory. China started working on the next Five-Year Plan (2016–2020)—specifically refining its original technologies and weeding out corruption.

Alibaba made history by listing its shares on the New York Stock Exchange and becoming the biggest IPO in history with a value of $25 billion. As one of the largest e-commerce companies in the world, the company is not a Chinese company any more, rather spreading its influence around the world by indeed becoming a global brand.

ELECTRONICS INDUSTRY—HARDWARE

From January 2014 Outlook:

"Five words cover the essence of electronics hardware: smart, mobility, connectivity, wearability and innovation. Technology never holds still. Technology advances will prop further mobility and connectivity in 2014. The growth and volume of electronics hardware will be driven by mobile devices, and high-reliability and high-performance electronics will propel new materials innovation. In semiconductor sector, Intel, the top captive semiconductor manufacturer since its inception, made an astounding announcement that the company will open up its fab factories to outside business, serving as foundries as well. The company will compete head-on with other giants, such as Samsung and Taiwan Semiconductor Manufacturing Company (TSMC). Its unprecedented strategy of giving up its long-standing captive status will change the dynamic of foundries business among the top players, and may spill over to the industry.

In manufacturing technology, 28 nm node has demonstrated high yield and low-cost manufacturing. Samsung and TSMC reportedly will use the 20 nm node technology to manufacture Apple chips in 2014. Additionally, the manufacturing prowess in 14 nm node will be unveiled by Intel. As the 20 nm is being established, 2014 is also the year to lay the ground work for developing 10 nm capability on 450 mm wafers. Building chips on 450 mm wafers in volume production is moving forward by both OEMs and foundry manufacturers. Establishing 450 mm wafers are a major technological move, so is to further shrink transistors below 20 nm. These plans and commitments will lead to further advances in the chip industry to deliver increased functionalities and reduced cost in electronic and optoelectronic products that serve abroad spectrum of industries. In the wafer fab equipment market, a year-over-year growth rate of more than 30% brings 2014 to the projected spending of $39.5 billion. In optoelectronics, new materials for LEDs, such as gallium nitride-on-silicon, is expected to see market penetration in 2014. As ICs move to 20 nm and below, a continuing effort to make the next levels of connections to reach the end-use products calls for new designs and new materials in the second level IC packages and the third level connection in PCBs.

In 2014, major new thrusts are not in sight for the second and third levels of inter-connections, yet activities are abundant that offer gradual technological advances, including optical inter-connections, embedded devices and printed electronics. The development in high-density packages, including 3D packages, system-in-package and BTC packages will continue. Overcoming the design and manufacturing

hurdles, the packages with 0.3 mm pitch BGA architecture will be entering into the mainstream. To maximize the yield and reduce cost, PCBs' thermal stability, under the high manufacturing temperature imposed by the assembly process, continues to be the most critical performance parameter. Although a PCB possessing a higher glass transition temperature (T_g) is readily available, T_g, per se, does not represent the PCB's heat tolerance ability. Other properties, such as mechanical properties, thermal decomposition temperature, thermal expansion over a temperature range, out-of-plane and in-plane thermal expansion and moisture absorption all contribute to the overall performance (i.e., internal structure integrity)."

What Happened in 2014:

On technological innovations, both "big ideas" and "incremental advances" have happened in 2014. Prominent among them are the plans of two leading companies. IBM announced that it pledged to spend $3 billion over five years on semiconductor research toward two major tasks—tackling technical obstacles to the miniaturization of circuitry on conventional silicon chips, and developing alternative materials and technology to keep boosting computing speed while consuming less energy. The latter includes replacing silicon with graphene—a thin film of pure carbon or structure called nanotubes. Other research includes neurosynaptic computing—a departure from the conventional computer designs that is expected to work more like a human brain and quantum computing. The ultimate goal is to overcome obstacles to shrink circuitry to seven nanometers.

In response to market demands, Intel is incorporating more advanced technology into tablets and smartphones. To pack more computing capability into a smaller space, a new manufacturing process that creates chips with circuitry measuring 14 nm is rapidly improving yields. Intel plans to advance two generations of chip production process, which are expected to reduce circuit dimensions to seven nanometers. Intel opened up its fab factories to outside business, serving as foundries. Panasonic, as one of Intel's customers, will make SoCs in a low-power flavor of Intel's 14 nm process technology.

In looking at electronic hardware, this year's story cannot be complete without mentioning the unprecedented and unparalleled performance of F-22.

F-22 made its combat debut in September 2014. The all-weather stealth tactical fighter jet developed for the U.S. Air Force offers air superiority, ground attack, electronic warfare and signal intelligence. A headline that ran in the Wall Street Journal, September 24, 2014: "F-22 Flies its First Combat Mission" excited and energized me immensely. The Pentagon's most advanced fighter plane made its combat debut in the U.S.-led strikes on Syria serving a crucial mission that depends on stealth. The fulfilment of this insurmountable (at least currently) technology is incumbent upon the advanced electronics and sensor technology. Our industry plays a crucial part in the technology and I have, in a tiny part, contributed to establishing one of the many electronic parts. Personally and professionally (perhaps with some bias), I view this as the technology of the decade that truly shows force and power—an epitome of the beauty and brain combo!

SOLAR VOLTAIC MARKET AND TECHNOLOGY

From January 2014 Outlook:

"The painstaking rebalancing, consolidation and shakeout are ending. All signposts indicate that 2014 is looking brighter throughout the solar industry and the "healthy" companies that have served the solar sector during the boom and bust times will win big and the sustainers will be handsomely rewarded. Companies that have a solid strategy and have thus survived the last two-year "massacre" have raised their shipment guidance.

Overall, 2014 will be a rebounding year, with the explanation below. In 2014, the global end-use market will be growing or stabilizing—U.S., China and the rest of Asia-Pacific will grow and Europe will be stabilizing. Japan's lucrative feed-in tariff scheme will accelerate its solar deployment. Solar global GW installation will

hit 45–55 GW level. In the U.S., more than 9.4 GW of cumulative solar electric capacity was installed in 2013. The Federal Energy Regulatory Commission (FERC) stated that solar is one of the fastest-growing sources of new energy in the United States. To spur new solar deployment nationwide, FERC issued a new order that allows solar projects that meet certain requirements to qualify for a "fast track" interconnection process, thus eliminating the need for costly and time-consuming studies. This new development will help reduce interconnection bottlenecks. China's Bureau of Energy proposed to increase solar power installations from the previous target of 10 GW to 12 GW in 2014. The prevalent view is that reaching 15 GW is likely. This time around, on top of the elevated installation target to help the industry, Beijing is accelerating its build-up of solar power plants, which will undoubtedly help the solar panel sector. This action is expected to rectify any residual imbalance that wrecked the industry for the last two years in an extraordinary way. Obviously, this action is good for "healthy" pure-solar players who survived the two-year downturn, such as Canadian Solar, Trina, Yingli, and First Solar, but not the "unhealthy" companies, who are goners.

In photovoltaic cell technology, while thick film and thin film are co-existing in the marketplace, the quantum dot technology is burgeoning in the laboratory prototype, which is poised to leapfrog the existing technologies. In the marketplace, thin film has lost market share during last two years due to the market turmoil and lack of scale.

Going forward, the advanced thin technology coincides well with the future growth of mobile devices. In terms of regional market, there will be a market re-distribution geographically. The solar PV market is shifting from Europe to Asia Pacific. However, not to ignore Europe; it remains overall a vast pool of end demand for solar energy, accounting for nearly a third of global demand at 10–12 GW in 2014. Europe will be stable in 2014 and will remain a key region for business."

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What Happened in 2014:

After three years of overcapacity and declining profits, global PV end-market demand set new records in 2014, varying with regions and nations. This does not mean PV has become a challenge-free sector. In terms of installation, the top five market leaders are China, Japan, U.S.A., U.K. and Germany. Other countries, such as Turkey, India, and Thailand, also started showing increased activities.

Companies that steered through turbulent waters in recent years continue to reap economic dividends. Among the new or innovative business alliances, Canadian Solar has joined a growing field of Chinese solar panel makers entering the risky business of speculative development in China, with its launch of a new locally-based fund for solar power construction. This business venture demonstrates the restored confidence in solar industry.

Solar cell technology is also moving forward. The applications of quantum-dot films and the technology of low-temperature, solution-processed, quantum-dot photovoltaic cells have made progress. Although there is still a long way to go before quantum-dot solar cells are commercially viable, the advances made are encouraging.

From January 2014 Outlook:

"The industry's technology and manufacturing are expected to move ahead with incremental improvements. On conflict mineral disclosure requirements, 2014 will be the first filing year to comply with the Securities and Exchange Commission (SEC) rule. The rule requires supply chain due diligence and specialized reporting by companies that manufacture or are contracted to manufacture products that contain certain minerals originating from the Democratic Republic of the Congo and adjoining countries. Conflict mineral disclosure re-

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quirements include specific elements—tungsten, tantalum, tin, gold and their derivatives. Make a note that the category of derivatives is a tricky area.

In 2014, more electronics sectors including medical devices will join the world of lead-free electronics to comply with RoHS. Additionally, RoHS will be deployed to more countries. Introduction of new or modified lead-free solder alloy materials will continue through sound scientific (metallurgical) execution in an effort to improve the performance and reliability and to alleviate production and reliability issues of tin-copper and tin-copper-silver systems. On reliability, high-quality work has been conducted and abundant data generated. One challenging effort is not to make a conclusion when a conclusion is not ready to be made. Publications that deviate from this principle are not in short supply. Going forward, it is hoped that this necessary principle would be followed so that reliability means reliability.

Overall, environmentally friendly electronics is becoming a given. Corporations' environmental stewardship for global sustainability, driven by regulations or other causes, continues to be one of important corporate business policies in 2014.

The conflict mineral disclosure requirements are being met in due course by the requiring companies. Lead-free has made incremental improvements and lead-free electronics is expanding to more industry sectors including medical devices, which will be outlined in 2014 forecast column. And the global sustainability is robust and marching on."

What Happened in 2014:

During 2014, a further deployment of lead-free electronics to a wider array of electronic products was on track. The implementation of conflict mineral disclosure requirements is also on schedule.

Global sustainability is robust and marching on. Corporations' environmental stewardship for global sustainability in 2014 was on their business agenda. According to the Governance & Accountability Institute, many American companies have published their own sustainability report. In 2013, 72% of the S&P 500 index filed such reports, up from 53% in 2012 and 20% in 2011.

Reportedly, legislation in Europe will soon require companies to disclose their impact on the environment and society. European investors are used to challenging corporations' sustainability goals around environmental, social and governance strategies. The belief is that if a company has strong sustainability or a good corporate responsibility performance, then financially it will outperform.

Upcoming Appearances

Dr. Hwang will present a lecture on "Preventing Manufacturing Defects and Product Failures" at IPC APEX EXPO on February 22, 2015 in San Diego, California. **SMT**

Dr. Hwang, an international businesswoman and speaker, and business and technology advisor, is a pioneer and long-standing contributor to SMT manufacturing since its inception, as well as to the global lead-free electronics implementation. Among her many awards and honors, she is inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and CEO of International Electronic Materials Corp., she is currently CEO of H-Technologies Group, providing business, technology and manufacturing solutions. She has served on the U.S. Commerce Department's Export Council, Chairman of Assessment Panel on DoD Army Research Laboratory, various national panels/committees, and the board of Fortune 500 NY SE companies and civic and university boards. She is the author of 400+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For further info, visit JennieHwang.com. To read past columns, click here.