ILLUMINATE

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New Partnerships Announced at First-Ever Hybrid LUX Networking Event

With the COVID-19 situation in Singapore continuing to improve, LUX's first 2021 Members' Networking Event on 3rd March could proceed as a first-ever hybrid format: with 45 attendees participating in person at the NTU Innovation Centre Theatre, and 58 other members joining via Zoom both locally and from as far as Malaysia, Philippines, and Germany.

LUX Chairman Prof Tjin Swee Chuan shared a piece of good news, that LUX has expanded its global network via partnership with OptoNet and exploring potential partnerships with three other regional trade associations: Semiconductor and Electronics Industries in the Philippines, Inc. (SEIPI), Malaysian Autonomous Intelligence & Robotics Association (MyAIRA), and Thai Automation and Robotics Association (TARA).

LUX Chairman Prof Tjin addresses the 103 attendees of the first quarter networking event, 45 of whom were present in person.

OptoNet represents the interests of 100 companies of Germany Thuringia's photonics cluster, where 90% of them are SMEs. They specialised in areas such as Freeform Optics, Laser Technology, Optical systems, Metrology, Advanced materials, Optoelectronics and Biophotonics.

OptoNet's International Affairs Manager, Ms Anke Mank attended the event and gave a brief introduction.

Next, Prof Tjin Swee Chuan introduced seven new industry members (DEMCON, EXFO, KIAST, SG Laser, SG Dynamic Optronics, SMART Illumination, and Swiss Ranks) and two new faculty members from A*STAR: Dr Derrick Yong from SIMTECH whose research areas are optical spectroscopy. biophotonics and label-free cell monitoring; Dr Teo Ee Jin from IMRE whose research areas are fast switching LEDs and photodetector, quantum dots, plasmonics, optical wireless communications, Li-Fi, silicon photonics and ion beam irradiation.

New Industry members

DEMCON EXFO KIAST LASER

SG Dynamic Optronics SMART ILLUMINATION SWISS RANKS CYCLE OF INNOVATION

On the research front, Prof Tjin informed attendees that a team led by Prof Nikolay Zheludev, Director of NTU's Centre for Disruptive Photonic Technologies, had received the President's Science Award (Team) for their breakthroughs in topological nanophotonics. The other members of the team are Assoc Profs Chong Yidong and Zhang Baile, both of NTU's School of Physical & Mathematical Sciences.

Message from the Chairman/Co-director:

As the first quarter of 2021 comes to a close, it is heartening to see the COVID-19 situation in Singapore continue to improve.

LUX held our first-ever hybrid format Members' Networking Event on 3rd March and I was pleased to be able to interact with over 40 of you in person at the NTU Innovation Centre Theatre, with another 58 attendees joining via Zoom. I hope that more of us will be able to meet physically at future events soon!

The session saw us joined by our seven new industry members (DEMCON, EXFO, KIAST, SG Laser, SG Dynamic Optronics, SMART Illumination, and Swiss Ranks) and two new A*STAR faculty members (Dr Derrick Yong from the Singapore Institute of Manufacturing Technology; Dr Teo Ee Jin from the Institute of Materials Research and Engineering).

March was certainly a productive month for LUX: partnering with Enterprise Singapore, we also held the first in a series of workgroup outreach sessions on silicon photonics. The 24th March session brought together local SMEs in the areas of Integrated Circuit design, semiconductors and photonics (including optical communications) with members of academia and MNCs to jointly create new solutions to meet future needs in this fast expanding topic.

Held in accordance with COVID-19 safe management measures, this in-person, by-invitation-only event proved to be an effective platform for idea exchange and networking, and we look forward to hosting more of such workgroup outreach sessions in the future.

Indeed, there is now light at the end of the COVID-19 tunnel, so let us continue to display the resilience and adaptability that served us so well over the past 1 year!

Prof Tjin Swee Chuan
Chairman, LUX Photonics Consortium
Co-Director, The Photonics Institute

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NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | The Photonics Institute | LUX PHOTONICS CONSORTIUM SINGAPORE

The event's highlight was the Tech Talks by faculty members. To view the videos, simply scan the QR code.

Tech Talk Highlights

1. **The Emerging Technology of Topological Photonics**
   Assoc Prof Zhang Baile, NTU
   This talk explored the new science that merges topology into photonics. Assoc Prof Zhang shared his group's research direction towards robust lasers and efficient sensors. Topological lasers display unprecedented robustness and are robust against defect, temperature change and integration, while topological sensors can beat the fundamental sensitivity limit.

2. **Laser Scanning Endoscope for Disease Diagnosis**
   Assoc Prof Liu Linbo, NTU
   Assoc Prof Liu explained how Optical Coherence Tomography (OCT) works and provided an overview of clinical OCT. He discussed in vivo histology and the "holy grail" of micro-OCT, which will not just be non-invasive, with real-time video, but also offer subcellular resolution and point-of-care diagnosis. Applications include micro-OCT for coronary artery disease, where there is a need for visualizing human coronary atherosclerosis at the subcellular level.

3. **Li-Fi Communications: From Development to Applications**
   Dr Teo Ee Jin, A*STAR (IMRE)
   Li-Fi is a bidirectional technology that uses visible or infrared light for wireless communications. Applications include indoor networking, intelligent transportation systems, aviation, and underwater communications. Dr Teo's team has demonstrated real-time streaming of HD video from server to laptop over a distance of 2 metres, achieving speed of 10 Mbps.

4. **Towards compact, versatile and high-quality nanophotonic X-ray sources**
   Asst Prof Wong Liang Jie, NTU
   Nanyang Assistant Professor Asst Prof Wong discussed the drawbacks of standard X-ray tubes: lack of tunability, directionality and coherence. This is as compared to large-scale free electron X-ray lasers, which are tunable, directional, coherent, and very intense. However, these X-ray facilities are often kilometres-long. He suggested that nanofabrication and few-cycle lasers could hold the key to miniaturizing these sources.

Series of Photonics Research Capabilities

Meet the SUTD team making light work of Nano-Optics

Most of us are familiar with the way light interacts with materials through reflection, refraction, and absorption. As materials are more finely patterned, more advanced effects such as diffraction, waveguiding, and scattering emerge. Fascinatingly, structures with dimensions much smaller than the wavelength of light can still be effective in altering certain properties of light. Notable examples include color-altering properties of nano materials in nature, e.g. the color of the day and evening sky, and colorful iridescence of opals, certain bird feathers, and insects.

The team at SUTD led by Assoc. Prof. Joel Yang (Fellow of OSA The Optical Society, and Principal Scientist at IMRE, A*STAR) is passionate about the manipulation of light using nanoscopic materials in the exciting field of Nano-Optics. They have developed core capabilities in high-resolution patterning using self-assembly, 2D and 3D printing approaches, coupled with optical characterization methods.

Operating out of the SUTD cleanroom that boasts state-of-the-art equipment, the team routinely uses the Electron Beam Lithography (EBL) from Raith GmbH for printing features as small as a few nanometers, and an advanced femtosecond laser Two-photon Polymerization Lithography (TPL) system from Nanoscribe GmbH for nanoscale 3D printing. These tools are suited for research and prototyping small-area samples typically no larger than a few millimeters.

Here are some examples of the SUTD team's efforts broadly organized into design, fabrication techniques, and materials research.

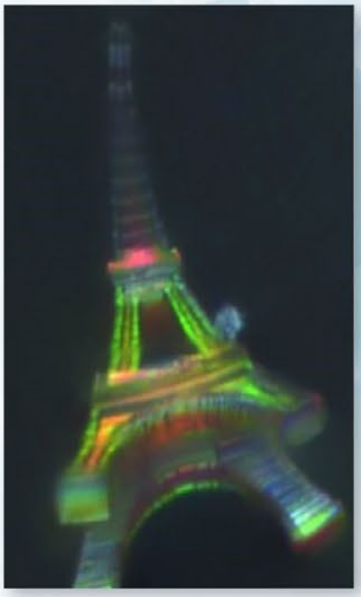
In the area of design, Assoc. Prof. Yang's team has developed algorithms to design holograms and structural color prints using various approaches including Deep Neural Networks. They recently demonstrated a sophisticated diffractive optical element integrated with structural color filters. This optical device masquerades as a microscopic colorful print while secretly encoding holographic information in three separate RGB channels. Directing red, green, and blue laser pointers at this device results in the projection of 3 distinct images onto a screen. Perhaps such devices could find use in anti-counterfeiting applications or in customized product branding and identification.

New fabrication techniques are constantly being explored to enhance print resolution, throughput, and precision. One of the major limiting factors of TPL is the current 3D printing resolution. To improve the resolution, the team invented a post-processing method to heat shrink structures. The method allows shrinking at nanoscopic dimensions without having the nanostructures coalesce into a blob, thus producing structures that could not have been printed directly with standard methods. The team demonstrated the world's smallest full-color Eiffel Tower, consisting of woodpile photonic crystal structures that were shrunk down to 280 nm pitch resolution, almost 2x smaller than machine specifications.

Beyond 3D printing, the team extends their research by exploring new materials to achieve 4D printing, i.e. 3D prints with stimuli-responsive features. They developed a shape-memory polymer resin and used it to demonstrate sub-micron 4D printing. Going sub-micron with these materials results in color generation. Despite the fine features produced, these nanostructures can recover their shapes and structural color even after being mechanically flattened into a colorless and transparent state.

The SUTD team seeks to engage with companies and colleagues in academia in meaningful partnerships to tackle technical challenges and gain competitive advantages. In particular, they are looking for partners with complementary capabilities in nanofabrication and scale-up technologies to discover new technologies and solve industrial challenges by developing various nano-3D-printed devices such as holograms and plug-and-play optics, while integrating machine learning into the design of complex 3D nanostructures.

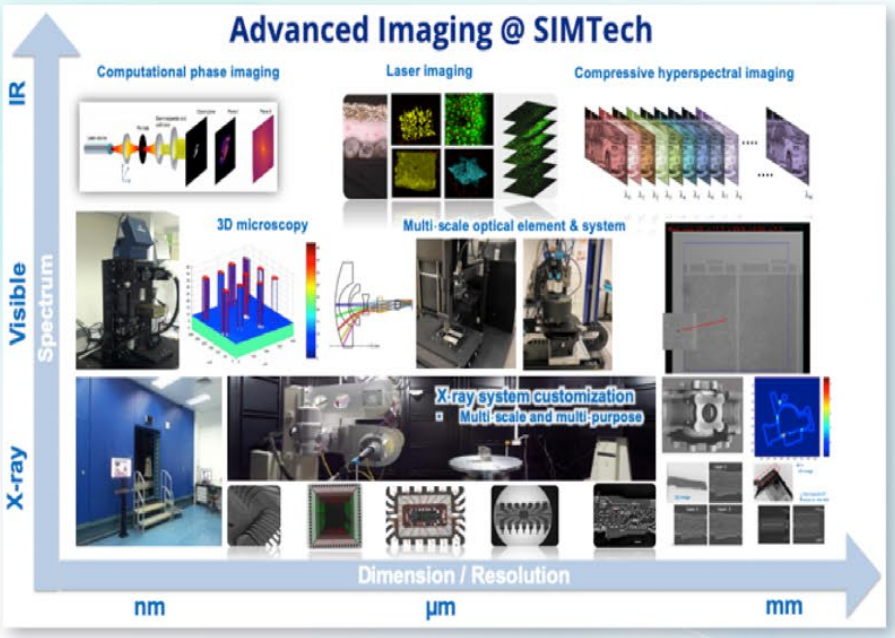
3D printed hologram with nanoscopic elements.



Probably the world's smallest 3D printed full-color Eiffel Tower replica with a height of 39 µm and a resolution of 280 nm printed with shrinking technology.

Advanced Imaging at SIMTech, A*STAR

The Advanced Imaging and Machine-vision (AIM) Group at SIMTech, rebranded from Precision Measurements Group (PMG), focuses on advanced imaging technologies covering multi-scale (nm to µm to mm) and multi-spectrum (X-ray, visible and IR) requirements of the industry. In addition to traditional imaging techniques, the group also specializes in computational imaging, laser imaging and 3D imaging. AIM is always looking to engage in meaningful collaborations with both industry and faculty members.



Research Themes

The group's work on advanced imaging technologies covers 3 key areas:

1. **Multi-scale imaging** provides information-rich inspection with large field of view and high-resolution. AIM has developed a wide range of advanced methods in the fields of HD imaging, data stitching, real-time image correction, anomaly identification and phase retrieval algorithms. The image can be retrieved and processed in multi-scale and real-time for end-to-end solutions.

2. **Hyperspectral imaging (HSI)** offers an additional dimension of information in the wavelength domain, which provides higher content to enhance decision-making. In contrast to conventional scanning-based HSI, the group exploits a compressive sensing scheme to provide a fast and motion-free HSI suitable for complex characterisation, inspection and sorting applications.

3. **Active imaging** visualises hidden information by exciting the object of interest with various types of illumination such as x-rays or high-energy lasers. AIM's developed capabilities in techniques such as fluorescent imaging and two-photon imaging enables the extraction of molecular and cellular information with high contrast and resolution whilst minimizing alteration and destruction to the sample.

AIM has applied advanced imaging in the manufacturing sector for:

- **Inspection** of silicon wafers, microelectronics (wire bonds and encapsulated components), optical lenses and contact lenses.
- **Monitoring** of stem cells and immune cells in cell manufacturing.
- **Diagnosis** of tissue samples and food items.

LUX-ESG Semiconductor and Photonics IC Design Workgroup Discussion

On 24th March, LUX Photonics Consortium and Enterprise Singapore held the first in a series of workgroup outreach sessions.

LUX Chairman Prof Tjin Swee Chuan (left) and Enterprise Singapore, Advanced Manufacturing Deputy Director Mr Gaius Lim (right) giving welcome address to the attendees.

It brought together local SMEs in the areas of Integrated Circuit design, semiconductors and photonics (including optical communications) with members of academia and MNCs, with the aim of jointly creating new solutions to meet the needs of tomorrow.

Held in accordance with COVID-19 safe management measures, the event saw 43 attendees. There was also a luncheon with the attendees lunching in groups of eight.

The in-person, by-invitation-only event sought to be a platform for the invited MNCs to share problem statements that can potentially be addressed by the local enterprises with their unique in-house capabilities. A total of 17 SMEs and MNCs were present.

Academics from the various institutes of higher learning also shared research projects that have garnered industry interest, giving the local SMEs present an early opportunity to collaborate with the MNCs to commercialise the technology.

The event also saw eight speakers from academia and industry cover a variety of topics:

- Assoc Prof Zheng Yuanjin, Director of NTU's VIRTUS: IC Design Center of Excellence, discussed "Advanced Integrated Circuits and Systems for Emerging Autonomous, IoT and Healthcare Applications".
- arQana Technologies' Dr Sean Wu gave an overview of 4G and 5G wireless infrastructure and shared arQana's perspectives on its market and technology positions.
- Assoc Prof Ranjan Singh, of NTU's Division of Physics and elected Fellow of the Optical Society, spoke about the university's efforts in developing chip-scale solutions towards THz 6G communications
- Dr Patrick Lo, the Co-founder and President of Advanced Micro Foundry, covered a brief history of Silicon photonics, state of the industry and AMF's disruptive technology and services that are enabling the development of path-breaking products.
- Mr Terry Teh, co-founder of Advinno Technologies, and Assoc Prof Fan Weijun of NTU's School of Electrical and Electronic Engineering discussed the two organisations' collaboration on Silicon Photonics Simulation platform.
- Dr Chen Jing Hao, MediaTek Singapore's Deputy Director of Product & Testing Engineering, spoke on the topic "Observation of Current Si Photonics Ecosystem of Singapore".
- Assoc Prof Kim Tae-Hyoung, Deputy Director of NTU's Centre for Integrated Circuits and Systems, discussed the opportunities of the resistive memory for embedded systems and neural networks, and the key challenges to be tackled for commercialisation.

In closing, Mr Gaius Lim, Deputy Director Advanced Manufacturing from Enterprise Singapore sums it up: "ESG organised this event with LUX in order to bring the local IC design/semiconductor community together – this includes not just the SMEs and MNCs, but IHLs, RIs, and government agencies as well. This event has helped to raise awareness of the presence and capabilities of local SMEs. ESG hopes that both MNCs and SMEs can tap on one another for complementary capabilities, and that the IHLs/RIs can commercialise new technologies through the SMEs." Both ESG and LUX are pleased that this event has planted the seeds for potential collaboration and will be looking forward to catalysing more of such opportunities.

Indeed, the session was well-received by the participants and majority of them feedback that it was well organized, informative and great initiative to interact with the community. Says AMF's Business Development Director, Ms Kavitha Buddharaju: "This session was an excellent networking & partnership platform for all local photonics players. It was a great idea to have a focused discussion with a diverse group of participants. Thank you ESG and LUX for connecting us all for this informative session. We hope to see more of such interesting group events."

Assoc Prof Zheng Yuanjin

Dr Sean Wu

Assoc Prof Ranjan Singh

Dr Patrick Lo

Mr Terry Teh

Assoc Prof Fan Weijun

Dr Chen Jing Hao

Assoc Prof Kim Tae-Hyoung

Accolades

Prof Tjin appointed President's Chair in Photonics at NTU

LUX Chairman and The Photonics Institute Co-Director Prof Tjin Swee Chuan has been appointed to the newly-created NTU professorship, President's Chair in Photonics – one of 26 new Named Professorships in 2021.

The professorships are part of the university's ambitious plan, announced in August 2018, to create up to 100 new term chair professorships over five years to attract, nurture and retain outstanding faculty at NTU.

The appointments also serve to recognise outstanding achievement at early, mid-career and senior faculty levels.

Research News

LUX Faculty-Industry partnership leads to novel sunlight harvesting 'smart' device

Inspired by how the magnifying glass can be used to focus sunlight into one point, a team of NTU researchers has developed a daylight harvesting device.

photo credit: NTU

The 'smart' device created by LUX faculty member Asst Prof Yoo Seongwoo, from the School of Electrical and Electronics Engineering, and Dr Charu Goel, Principal Research Fellow at The Photonics Institute, can harvest daylight and channel it to underground spaces.

Said Asst Prof Yoo: "Our innovation comprises commercially available off-the-shelf materials, making it potentially very easy to fabricate at scale. Due to space constraints in densely populated cities, we have intentionally designed the daylight harvesting system to be lightweight and compact. This would make it convenient for our device to be incorporated into existing infrastructure in the urban environment."

photo credit: NTU

The device comprises an off-the-shelf acrylic ball, a single plastic optical fibre – a type of cable that carries a beam of light from one end to another – and computer chip-assisted motors. It is compact enough to be mounted on a lamp post (Right image).

The acrylic ball concentrates the solar energy, enabling parallel rays of sunlight to form a sharp focus at its opposite side. The collected, focused sunlight is then transported along the fibre cable to the end that is deployed underground.

Light is emitted via the end of the fibre cable directly. The device's luminous efficacy has been demonstrated at 230 lumens/Watt, far exceeding that of commercially available LED bulbs (typical output of 90 lumens/Watt).

Assisted by computer chips, the small motors automatically adjust the position of the fibre's collecting end, tracking the sun's position and ensuring the maximum amount of sunlight is harvested.

The device, which was featured in the peer-reviewed scientific journal Solar Energy, overcomes several limitations of current solar harvesting technology. For instance, conventional solar concentrators require large, curved mirrors to be moved by heavy-duty motors.

LUX industry member Technolite, a design-focused agency specialising in lighting, also collaborated on the research study. Said its Managing Director, Michael Chia: "It is our privilege and honour to take this innovation journey with NTU. While we have the commercial and application knowledge, NTU in-depth knowhow from a technical perspective has taken the execution of the project to the next level that is beyond our expectations."

Industry News

Acquisition of Hylax Technology by JPT Electronics

From left: Dah Khang, M&A specialist, Yang Lee & Associates; Soh Guang Sheng, Technical Director, Hylax Technology Pte Ltd; and Penn Cheng, Vice President, Shenzhen JPT Opto-Electronics.

Listed company Shenzhen JPT Opto-electronics Co., Ltd, via its subsidiary JPT Electronics Pte Ltd, has wholly acquired Hylax Technology Pte Ltd to expand its presence in the Smart Manufacturing industry.

Hylax is Southeast Asia's biggest industrial laser application and process development center and has a unique mix of core capabilities in the areas of laser & laser applications, vision, optics, software, electronics & electrical, controls, mechanical & automation. Its proprietary Scanvision™ Technology combines a vision camera system and laser system to offer high precision with high speed laser processes. Hylax's large customer base includes applications in electronics, semiconductor, flat panel displays, hard disk, plastics, biotech, jewellery and machining industries.

JPT currently focuses on the R&D, production, sales, and technical services of lasers, intelligent equipment and optical devices. The acquisition of Hylax is aligned to its strategy to expand overseas, deepen its technology level and increase its market share. It will also enable JPT to strengthen its capabilities in one of its key focus areas: semiconductor and medical products micro-nano processing.

In the future, there are plans to integrate the two parties' resources to build a laser and intelligent equipment platform with industry-leading R&D capabilities, positioning JPT as a global leader in intelligent equipment solutions.

New Industry Members Introduction

DEMCON is a privately-owned independent (opto)mechatronic Design & Assembly House with facilities in Singapore, Germany and the Netherlands (HQ), employing over 700 engineers globally. The business focuses on R&D, industrialization and assembly of high-end innovative equipment, in which (sub)nanometer accuracies, high-vacuum, thermal stability and fast throughput are common design criteria. Among many disciplines, DEMCON has thorough knowledge of high precision optics, optoelectronics and optomechanics. DEMCON's customer base comprises high-demanding clients active in e.g. semicon, (aero)space, medical devices, and defense.

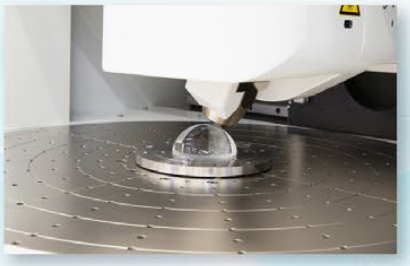


Photo courtesy of DEMCON

The core way of working at DEMCON is system engineering and development, where innovation and close collaboration with (OEM) companies offering new or specific expertise is imperative. This collaboration works in two ways: for a system integrator, specific expertise such as for example in photonics, is build-up in collaboration with a third party, and vice versa, third parties offering a novel technology or expertise, such as in photonic integrated circuits (PICs), can benefit from system engineering expertise at DEMCON in order to arrive to a complete product.

Recently, DEMCON joined the European PhotonDelta ecosystem to reinforce the integrated photonic systems supply-chain with their system-level design, development and engineering services across various markets.

SG Dynamic Optronics

At SDO we strive to deliver high quality optical components, modules and sub-assemblies for the precision optics industry, both local and overseas. SDO is driven by highly competent and dedicated staff, each with many years of rich experience in the precision optics arena.

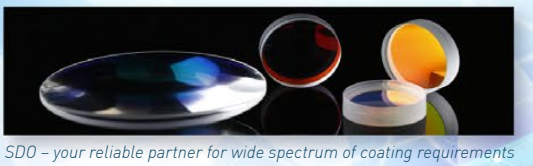
Our core competency is in thin film vacuum coating. This process is the key to unlock the full potential of an optical component. Using industry-leading coaters, supporting metrology equipment and ancillary processes, we conduct this highly value-added process in SDO. The team prides itself in having a complete production experience encompassing the pre and post processes of coating. This ensures we innately understood the intended functionality of the optical component such that we deliver coatings to the optimum performance of price and quality.

Combining experience and capable machinery, the result is high quality coatings

Being a fully compliant "Made in Singapore" company and located in this country, we are also well-positioned to be a reliable, strategic global sourcing partner. Our small but agile operation ensures we can meet the varied needs of our customers, in this ever-evolving business landscape.

Our passion and commitment to deliver the best products and services, continue to spur us to greater heights and innovation.

Our Strength – Your Advantage. Welcome to the New Dynamic.



SDO – your reliable partner for wide spectrum of coating requirements

Upcoming Events

2021 2nd Quarter Members Meeting

Theme: Virtual Delegation Visit of Germany - Optonet to Singapore - LUX Photonics Consortium

Date : **18th / 19th May 2021, Wednesday / Thursday**

Time : **3.00pm to 5.00pm**

Venue : **NTU Singapore (To be Confirmed)**

Mode of Participation: Hybrid (in-person, via Zoom)

- **Mark your calendar and join us for this hybrid session**
- **Meet OptoNet delegation from Germany Jena region**
- **Highlights – Company presentations and Business matching**
- **Contact us to find out more!**

LUX Member Directory

We are pleased to announce the publication of first edition of LUX Members Directory. The directory provides the listing of our industry members with a brief company introduction, website and contact information. We will be distributing a hardcopy to all members via postal mail. Keep a lookout for it!