

Transform and Transcend the Safety Case Regime: The NUS MSc SHE Technology Connection

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**Safety Case
Symposium 2019**
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Department of Chemical & Biomolecular Engineering
Faculty of Engineering



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Safety, Health and Environment Technology

Master of Science

Aim:

**Train SHE Leaders
for the Singapore Industry**

INAUGURAL PROGRAM

THE 1997 INAUGURATION PROGRAM

- Year MSc SHE launched: 1997
- Teaching hours of lecturers' involvement
 - Academic: 240 hours
 - Industrial: 160 hours
- Modules: 13
 - Industrial hygiene: 5
 - Process safety: 6
 - Environmental protection: 2

EARLY YEARS OF ENROLMENT SUCCESS & CRISIS

- **Success: 1997 – 2002**
 - **Steady enrolment: ~ 30/ year**
- **Crisis: 2002 – 2005**
 - **Sharp drop in enrolment: ~ 15/ year**
- **Response**
 - **Strengthen curriculum: e.g. Modules on Toxicology & Ergonomics**
 - **Strengthen module content: Increase content relevant to industrial practices**
 - **Strengthen teaching delivery: Academic – industrial co-teaching**
 - **Introduce specializations: e.g. Process Safety & Industrial Hygiene**

PURPOSES OF PROGRAM ENHANCEMENT

- **Maintain**
 - **Scientific integrity**
 - **Academic rigor**
- **Introduce**
 - **Industrial practicality**
 - **Professional judgement**
- **Create & promote**
 - **Scientific/ professional team problem-solving work culture**
 - **Collaborative culture between industrial domain knowledge experts & SHE experts**

CURRENT PROGRAM

THE 2005 ENHANCED PROGRAM

- **Year MSc SHE Enhanced: 2005-2007**
- **Balanced Academic-Industrial Focus**
 - Academic Content & Industrial Practice Relevancy
 - **Scientific Soundness & Industrial Practicality**
 - Academic Rigor & Professional Judgment

PROGRAM OBJECTIVES:

MSc SHE Graduates Are Team Players

- **M.Sc. SHE Graduates are confident in:**
 - **Consultant (adviser):** Advising top management on policy: e.g. organizational culture, strategy, vision, mission, SHE critical decision-making ethics, Corporate Social responsibility (CSR)
 - **Partner (teamwork):** Collaborating with other domain knowledge colleagues to formulate optimal solutions to targeted organizational outputs in productivity, quality, reliability, availability & SHE performance
 - **Coach (leadership):** Assisting lower management to effectively implement the SHE solutions & programs to maintain safety behaviours, minimize human factors & human errors

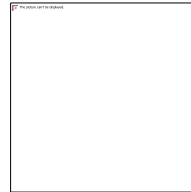
SOME PROGRAM INDICATORS AT 2018



Teaching hours of lecturers' involvement:

Academic: 320 hours

Industrial: 360 hours



Modules offered:

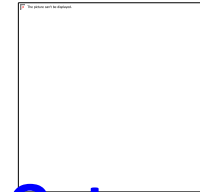
Lecture modules: 15 modules

- **Process safety: 8 modules**
- **Industrial hygiene: 7 modules**

Each module is delivered by teacher(s) having academic or professional qualifications, and relevant industrial experience

Student driven: 2 modules, supervise by both academically & industrially competent staff

- **Independent study: 1 lecture-module equivalent**
- **SHE project: 2 lecture-modules equivalent**



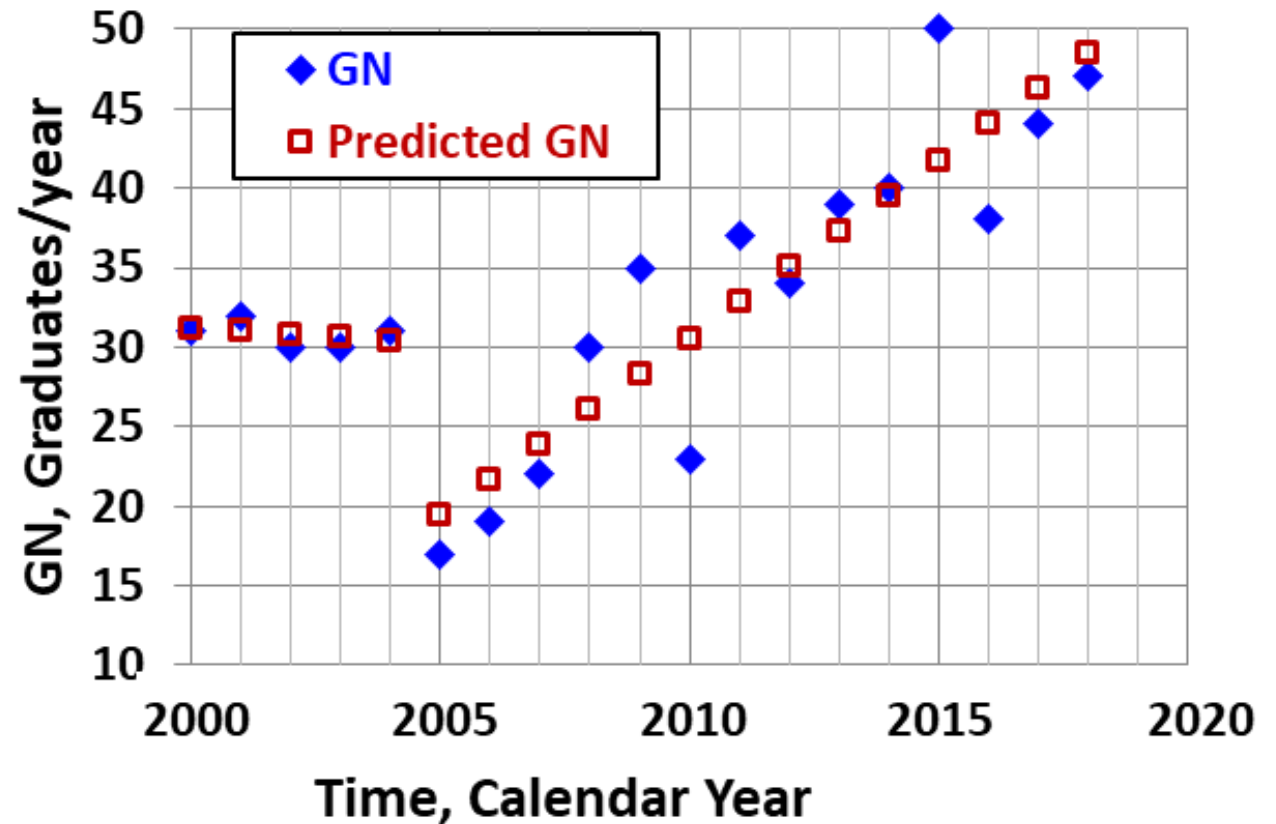
Outcome:

Steady increases in annual graduate trend

Well-received Transformation

TREND OF ANNUAL GRADUATES

- Data of 1999 (one single graduate) is omitted in the segmented time series regression analysis
- The dip observed in annual graduates in year 2005 corresponding to the dip in intake during year 2002 – 2003
- The regression model is both statistical and real world significant
- Total 630 graduates at 2018



MODULES FOR PROCESS SAFETY SPECIALIZATION

- Among other degree requirements, 5 out of the following modules listed below are required for graduation with M.Sc. (SHE) with specialization in process safety
 - **SH5201** **Hazard Identification & Evaluation**
 - **SH5202** **Quantified Risk Analysis**
 - **SH5203** **Emergency Planning**
 - **SH5204** **Safety Engineering**
 - **SH5205** **Incident Management**
 - **SH5206** **Human Factors in Process Safety**
 - **SH5401** **SHE & Quality Management Systems**

FUTURE PROGRAM...

BUILDING BLOCKS OF THE DIGITAL REVOLUTION



Impact of I4.0: Future Workplace in 2028

(Boston Consulting Group, 2017)

WSH Landscape in 2028

(Ministry of Manpower, 2018)

Industry 4.0 (I4.0) relies on 9 digital technologies that recently have reached mass market maturity

DIGITAL TRANSFORMATION IN MANUFACTURING

EXAMPLES:

Improve: Productivity
Product Quality

Reduce: Human errors
Human-factor accidents

Industry 4.0 challenges, opportunities, drivers and outlook



HUMAN FACTORS IN ACCIDENTS



Human error as a cause of vehicle crashes: > 90%

<http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes> Accessed 14/02/2019




Leading cause of commercial airline accidents: ~ 80%

<http://www.bbc.com/travel/story/20130521-how-human-error-can-cause-a-plane-crash> Accessed 14/02/2019



Five Common Causes of Workplace Accidents

<http://www.gcaservices.com/aboutus/news-results/2015/08/24/watch-out!-five-common-causes-of-workplace-accidents> Accessed 14/02/2019
Overexertion: number-one cause of workplace injury. It follows by Slips, trips, and falls; Poor housekeeping; Taking shortcuts; & Distractions.



Accidents involve “people safety behaviour at every hierarchical levels”: Human Factors in Accidents, D Cooper, Institute of Quarrying, North of England CoalPro Seminar, Ramside Hall Durham, UK 12 March 2002

FUTURE PROGRAM DIRECTION

New Specialization

Build & Infuse Technology-enabled Competence

Align & Strengthen Industrial Focus

Corroborate & Embed Professional Accreditation

**Time for a new M.Sc. (SHE) with
specialization in Human Factors?**

SOME HIGH IMPACT HUMAN FACTORS ACCIDENTS IN SINGAPORE

- **Aloysius Pang: 4th SAF training fatality in 18 months**
 - <https://www.channelnewsasia.com/news/singapore/alloysius-pang-saf-training-related-death-in-18-months-mindef-11160364> Accessed 14/02/2019
- **8 SMRT staff fired for Bishan MRT tunnel flooding incident**
 - <https://www.channelnewsasia.com/news/singapore/8-smrt-staff-fired-for-bishan-mrt-tunnel-flooding-incident-9444934> Accessed 14/02/2019
- **Remembering the hero of the Nicoll Highway collapse whose body was never found:**
<https://mothership.sg/2018/04/nicoll-highway-collapse-history-14th-anniversary/> Accessed 14/02/2019
 - **Fallout:** <http://news.asiaone.com/News/The+Straits+Times/Story/A1Story20080420-60781.html>
 - **3 Nishimatsu executives, 1 LTA project director fined: \$8,000 - \$160,000 each.**
 - **Admitted design errors, Nishimatsu fined \$200,000 under the Factories Act**
 - **Nishimatsu to pay rebuilding & realigning part of Circle Line: \$300 millions**
 - **Several senior LTA officers left service; some Nishimatsu executives replaced**

AREAS OF SPECIALIZATION

**M. Sc. SHE
students can
choose to
graduate as:**

- M.Sc. (SHE)
- **M.Sc. (SHE) with specialization in Industrial Hygiene**
- M.Sc. (SHE) with specialization in Process Safety

**Future
addition?**

- **M.Sc. (SHE) with specialization in Human Factors**



Emerging Needs
to Embrace...

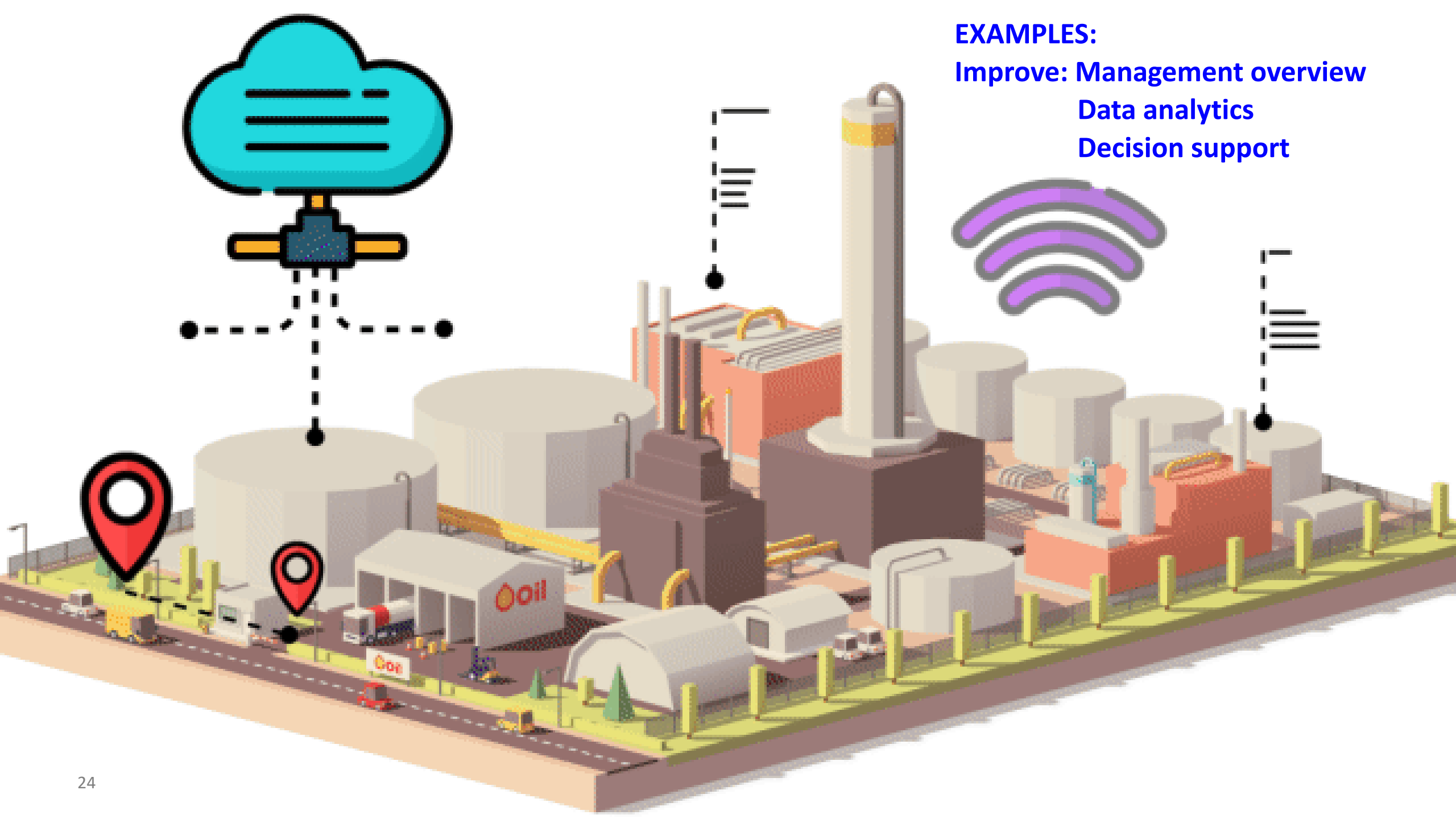
LEVERAGE ON EMERGING TECHNOLOGIES

- **The fourth industrial revolution, or commonly called Industry 4.0 (I4.0) and the liberation of Industrial Internet of Things (IIoT)**
 - **Technologies and methodologies will become more reliable & Reaching mass market maturity**
 - **The rapid development of virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR) technologies: Enabling**
 - ❖ **The elimination of human factors in process design**
 - ❖ **The prevention of human errors in operation and maintenance.**
 - ❖ **The improvement human reliability through**
 - ✓ **Facilitated training & simulated practices in immersive space**
 - ✓ **Provide for interactive operations in real-time environment.**
- **These technologies: key driver in the prevention of process incidence from**
 - **Unsafe work behaviours**
 - **Unethical decision-making**

IIOT

INDUSTRIAL INTERNET OF THINGS

Improve: operation efficiency
operational reliability
Reduce: Data overload
Operator fatigue



EXAMPLES:
Improve: Management overview
Data analytics
Decision support

SMART CITY DASHBOARD

CHOOSE YOUR PILLAR

EXAMPLES:

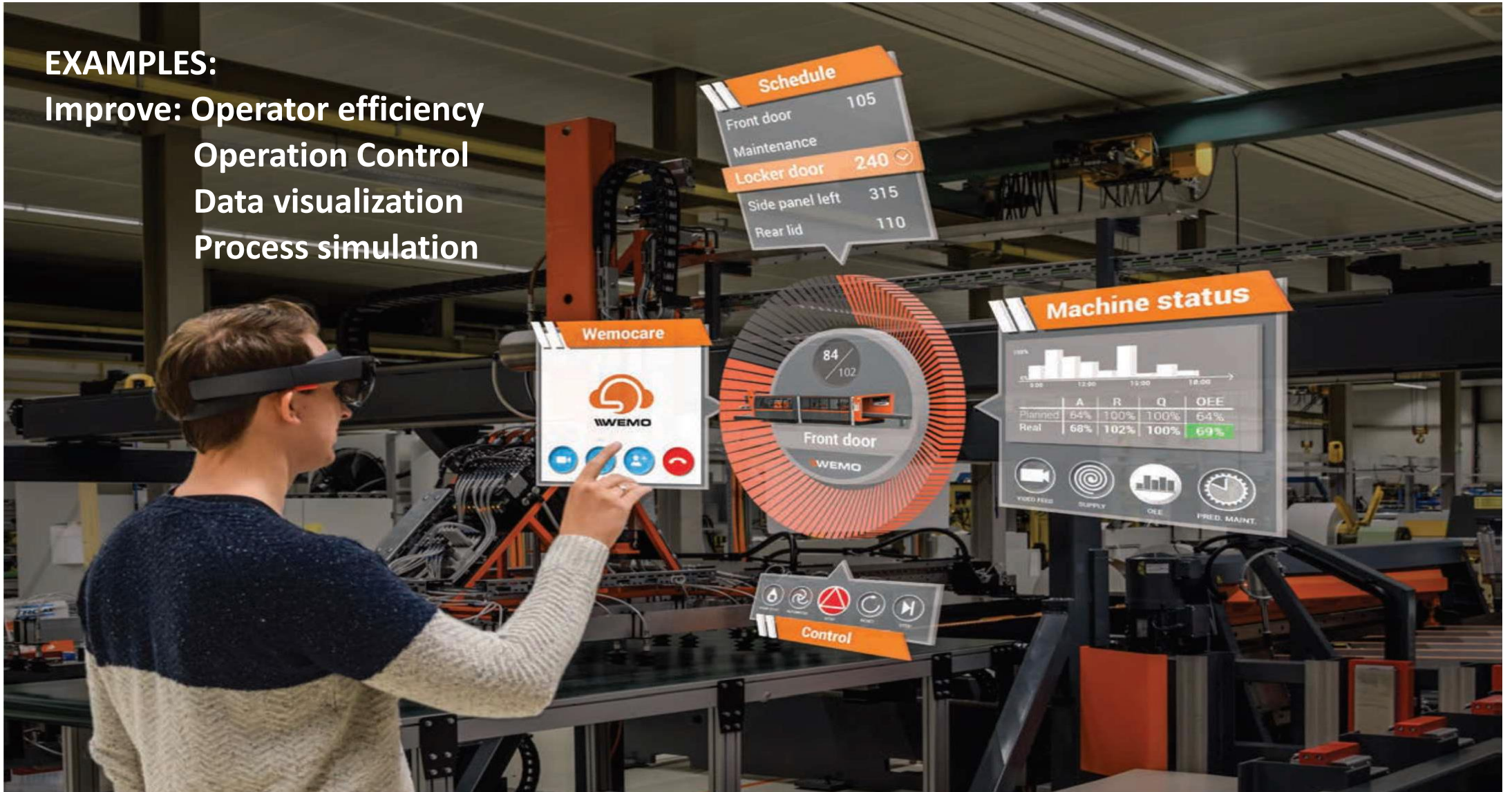
- Improve: Production planning
- Maintenance scheduling
- Turnaround management
- Safety case outcomes

APPLICATION OF BIG DATA ANALYTICS IN SIA

- **SIA aims to soar ahead; goal to become 'leading digital airline in the world'**
 - <https://www.todayonline.com/singapore/sia-aims-soar-ahead-goal-become-leading-digital-airline-world> Accessed 14/02/2019
 - **Preventive maintenance: IA collaborating with several government agencies and the National University of Singapore (NUS) in digital research and development. Some of the new capabilities SIA is looking into include technology to better predict when critical aircraft components need fixing or replacing**
 - **Business: tailoring direct mailers based on customers' travel patterns to replace sending out a mass email**

EXAMPLES:

Improve: Operator efficiency
Operation Control
Data visualization
Process simulation



EXAMPLES:

Improve: Inspection documentation
Technical troubleshooting
Engineering support



EXAMPLES:

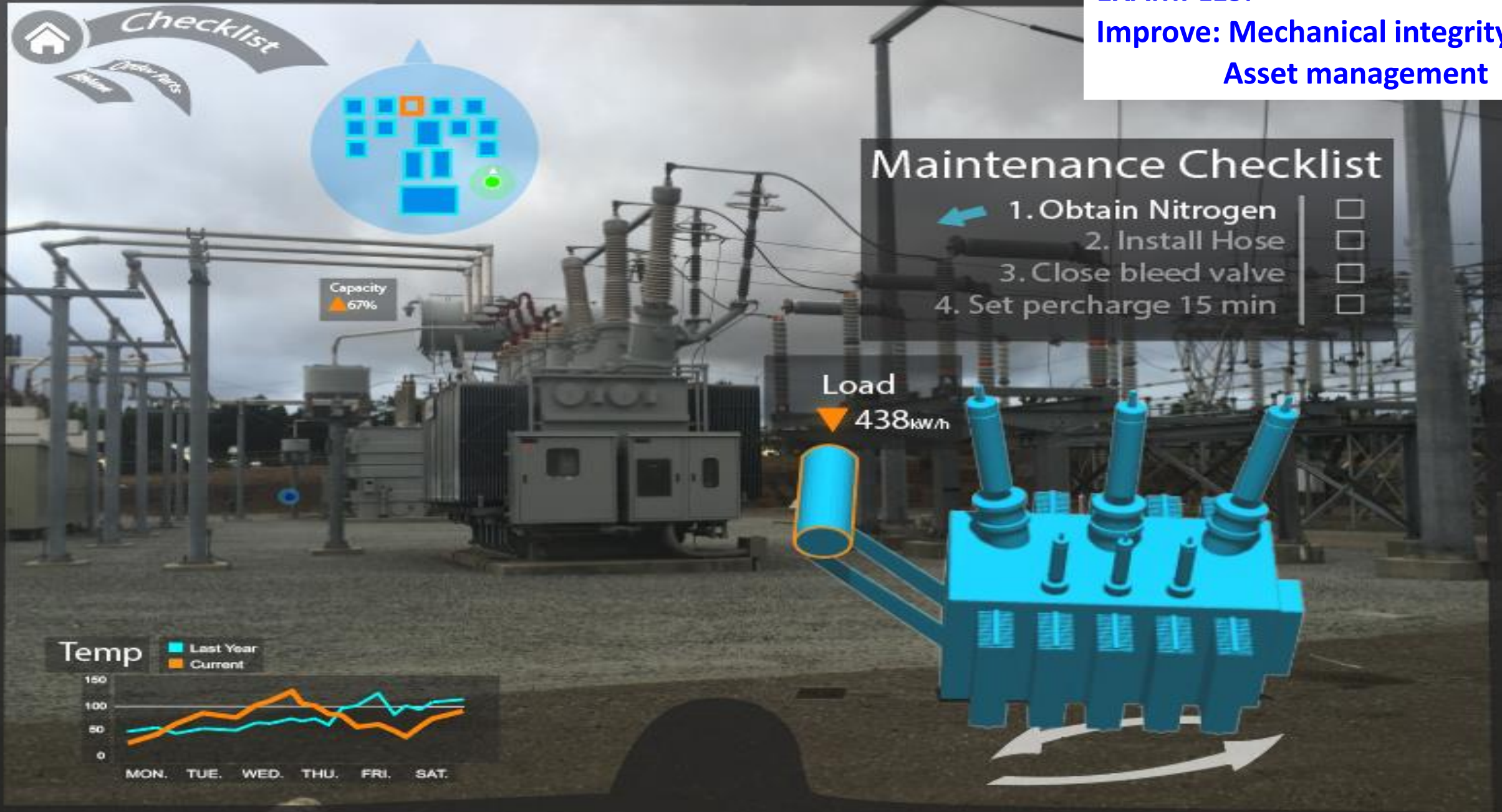
Improve: Maintenance efficiency

Technical competence

Decision support



EXAMPLES:
Improve: Mechanical integrity
Asset management





EXAMPLES:

- Improve: Operator Training
- Training effectiveness
- Workforce upskilling

LTA TO TAP ON TECHNOLOGY TO ENHANCE TUNNEL INSPECTIONS

- **A drone zipping along the tunnel, completing the same inspection much more quickly and safely**
 - <https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=8c205baa-6ee5-4cfd-a152-66ba6943bc11> Accessed 14/02/2019
- **Develop trials involving Unmanned Aircraft Systems (UAS), Unmanned Vehicle (UV) or other technology for the inspection of road tunnels**
 - **Incorporate 360-degree video mapping of the tunnels**
 - **Software to automatically detect defects from the video taken and provide their location.**

Artificial Intelligence

Drones Autonomously Inspecting Pipelines

**Future MSc Program will
Embrace Technology – enabled
Safety Practices**

Paper: Goel P; Datta A; Mannan MS. Application of big data analytics in process safety and risk management, 2017 IEEE International Conference on Big Data (Big Data), 11-14 Dec. 2017: <https://ieeexplore.ieee.org/document/8258040> Accessed 18/02/2019

- **Objective of study: discuss the potential of big data analytics in process safety and risk management in the energy industry. The paper**
 - **Outlines systemic framework with stakeholders, data sources, challenges**
 - **Discusses benefits of big data analytics in process safety**
 - **Four case studies**
 - ❖ Incident database analysis
 - ❖ **Predictive modelling for pump failures**
 - ❖ Dynamic risk mapping of operating plant, and
 - ❖ **Image analysis to gain insights are demonstrated**
 - **Conclusion: Application of big data analytics would provide valuable insights for**
 - ❖ **More informed policy, strategic, and operational risk decision-making**
 - ❖ **Safer and more reliable industry**



SCHEDULED MAINTENANCE

DATE	TIME	LOCATION	DESCRIPTION
01/01/2024	08:00	001	Check and replace filter
01/01/2024	09:00	002	Check and replace filter
01/01/2024	10:00	003	Check and replace filter
01/01/2024	11:00	004	Check and replace filter
01/01/2024	12:00	005	Check and replace filter
01/01/2024	13:00	006	Check and replace filter
01/01/2024	14:00	007	Check and replace filter
01/01/2024	15:00	008	Check and replace filter
01/01/2024	16:00	009	Check and replace filter
01/01/2024	17:00	010	Check and replace filter



EXAMPLES:
Improve: Process Automation
Safety management
Change management

EXAMPLES:

Improve: Efficiency analysis
Technical analysis
Equipment connectivity





EXAMPLES:
Improve: Predictive maintenance
Preventive maintenance
Schedule assurance



EXAMPLES:
Improve: Equipment inspection
Workforce mobility

This is your pilot speaking.
I'm working from home today



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**Thank You &
Have a Wonderful Seminar...**



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