Where is your Biomedical Engineering Career going to in 2016?

Supported by

- IDC Technologies
- and the
- Engineering Institute of Technology
Presented by Steve Mackay

- Dean of Engineering
- ~40 years experience in electrical, mechanical, chemical engineering and industrial automation
- Did a medical electronics course with Chris Barnard – oh so long ago.
- Experience together with life-long learning is critical for your career.

Engineering Institute of Technology and IDC Technologies

- IDC Technologies – short courses over 25 years with over 500,000 participants
- Led to development of the Engineering Institute of Technology
- Engineering advanced diplomas to Bachelor and Master degrees
- Latest Online Technologies in Engineering Education (remote labs and live sessions)
- +300 highly experienced instructors based in London, Perth, New York, Sydney, Houston, Toronto and…..Kalgoorlie
- Students in over 120 countries around the world
- Truly Practical job-focussed courses
- Award winning company
Rationale for Today

Update your knowledge on the latest trends and technologies so that you can use them

We are on the cusp of significant changes in the way we work caused by:

- Internet of things
- A hyper connected world
- Virtual reality
- Artificial intelligence and
- automation.

Don’t let your Career Opportunities leave you behind at the station
## Topics

1. Welcome
2. Engineering and Technology – Significant trends
   - Cybersecurity and Cybercrime
   - Internet of Things
   - Artificial Intelligence and Increasing Robots/Automation
   - Smart Phones becoming your Primary Tool for Everything
   - Virtual and Augmented Reality Finally working
   - Cloud Computing/Working
   - Virtual Collaboration Increasing
   - Drones
   - Big Data
3. Engineering Employment Trends
4. Your Engineering Education and Training
   - Free and High Quality Courses from online MOOCs
   - Engineering and Technology diplomas, bachelor and Master Degrees
   - N4 to N6
   - Government Certificate of Competency
5. Questions and Answers

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1. Welcome
A Quickly Changing World

- Hyper connected with mobile apps, emails, messages and quickly updating web
- Work environment is everywhere and all the time
- Everything is now transparent from firm’s work practices, remuneration to rating of hotels/cafes/firms
- Analytics and predictive models appearing
- Diversity and inclusion in workplace (esp. part time or contract or project-based)
- Employees demand flexibility, meaning and autonomy at work

The Fourth Industrial Revolution
Industrie 4.0

1. Mechanization of production (steam/water)
2. Mass production using electrical power
3. Digital revolution using electronics and IT

- Six Design Principles:
  1. Interoperability through IoT and Internet of services
  2. Virtualization
  3. Decentralization
  4. Real time
  5. Internet of Services
  6. Modularity
Impact of 4th Industrial Revolution

- Skills required to prosper
- 47% of workers in USA to lose their jobs in next 20 years
- Downward pressure on developing country jobs
- Disappearance of middle skill professions such as clerical work & customer services

2. Engineering and Technology Significant Trends

Chemical Engineers work in a variety of manufacturing operations including oil refineries like this one.
Significant Trends

- Cybersecurity and Cybercrime
- Internet of Things (IoT and superconnected world)
- Artificial Intelligence and Increasing Robots/Automation
- Smart Phones becoming your Primary Tool for Everything – mobile world
- Virtual and Augmented Reality Finally working
- Cloud Computing Working
- Virtual Collaboration Increasing
- Drones (or UAVs) being Applied to Business
- Big Data providing massive detailed information
- Renewable Energy (and battery storage)
- Hype and nonsense trends

Robotics Revolution

Mohammad Mayyas, Ph.D
Department of Engineering Technologies
BOWLING GREEN STATE UNIVERSITY
mmayyas@bgsu.edu
Today's Topic
Is Robotics + Revolution
What means?

What is Mobile robots Articulated arm Humanoid
Construction robot Bee
Future MEMs drone Industrial automation

Autonomous Rover DaVinci Surgical System
Roomba Vacuum Cleaner

What about this?
What about these?
Technology Training that Works

Small UGV - iRobot
Games in Rehab
Simulated intelligent shopping - PR2
Robotic fish - University of Essex

Grasping - Barrett hand
Object-tracking
Robot Writer - KUKA

Healthcare and Medical Robotics

In-clinic and in-home servicing specific tasks
Human machine interaction
Minimally invasive surgical robot - Da Vinci
Human machine interaction
Learning and adaptation
Minimally invasive surgical robot - Da Vinci
Simulated polymer endoscopic surgical procedures

Industrial automation robot - Baxter Rethink Robotics

Learning and Adaptation
Minimally invasive surgical robot - Da Vinci
Simulated polymer endoscopic surgical procedures
Human machine interaction
Minimally invasive surgical robot - Da Vinci
Healthcare and Medical Robotics

- Robotics technologies are being developed toward promoting aging in place, delaying the onset of dementia, and providing companionship to mitigate isolation and depression.

- Robots are also being used for surgery, rehabilitation and in intelligent prostheses to help people recover lost function.
- More than 11 million people live with severe disabilities and need personal assistance
- 40+% annual growth in the number of medical procedures performed using robots.

The Future of Robotics @ BGSU

[Pictures courtesy of Robotic Division, M. Mayyas, UTARI]
ITU Workshop on “ICT Security Standardization for Developing Countries”

(Geneva, Switzerland, 15-16 September 2014)

IoT (Internet of Things) and Security

Mikhail Kader,
DSE, Cisco
mkader@cisco.com

Geneva, Switzerland, 15-16 September 2014

What Is the Internet of Things?

- The Internet of Things is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth, and quality of life”
Relationship to the Internet of Everything (IoE)

People
Connecting People in More Relevant, Valuable Ways

Process
Delivering the Right Information to the Right Person (or Machine) at the Right Time

Data
Leveraging Data into More Useful Information for Decision Making

Things
Physical Devices and Objects Connected to the Internet and Each Other for Intelligent Decision Making

IoT Is Here Now – and Growing!

"Smart Objects"

Rapid Adoption Rate of Digital Infrastructure: 5X Faster Than Electricity and Telephony

Source: Cisco IBSG, 2011
Connected Rail Operations

PAASSENGER SECURITY
- In-station and onboard safety
- Visibility into key events

ROUTE OPTIMIZATION
- Enhanced Customer Service
- Increased efficiency
- Collision avoidance
- Fuel savings

CRITICAL SENSING
- Transform "data" to "actionable intelligence"
- Proactive maintenance
- Accident avoidance

Smart City

CONNECTED TRAFFIC SIGNALS
- Reduced congestion
- Improved emergency services response times
- Lower fuel usage

PARKING AND LIGHTING
- Increased efficiency
- Power and cost savings
- New revenue opportunities

CITY SERVICES
- Efficient service delivery
- Increased revenues
- Enhanced environmental monitoring capabilities
The Connected Car

WIRELESS ROUTER
- Online entertainment
- Mapping, dynamic re-routing, safety and security

CONNECTED SENSORS
- Transform data to "actionable intelligence"
- Enable proactive maintenance
- Collision avoidance
- Fuel efficiency

URBAN CONNECTIVITY
- Reduced congestion
- Increased efficiency
- Safety (hazard avoidance)

What Can Breach IoT Networks?

Billions of connected devices
Secure and insecure locations
Security may or may not be built in
Not owned or controlled by IT … but data flows through the network

Any node on your network can potentially provide access to the core
Grab These Opportunities Today

- Think of how new technology can be applied in a workable way to your business from smart phones / automation / apps / drones to IoT.....
- What are some ideas?
- Continually upskill yourself.

3. Engineering Employment Trends

The future is yours
Engineer it!
Different Strokes for Different Folks

- Every country has different requirements
- USA with strong design & manufacturing
- South Africa and Namibia with primary type activities such as mining/agriculture… utilities
- Different number of colleges/universities
- Different schooling systems with STEM
- Different corporate and government attitudes to training at different levels.

USA Experience – what courses?

- 1.6m engineer(ing) jobs
- Civil engineers account for the majority; followed by mechanical, industrial engineers and electrical engineers.
- Job growth strong (since 2104 overall 7%):
  - Petroleum (30%)….but oh oh
  - Geological engineers (12%)…but oh oh
  - Biomedical engineers (10%)
  - Industrial engineers (10%)
USA Experience – what courses?

- 450,000 technician jobs (adv. dip or associate degree)
- Electrical engineering technicians biggest
- Mechanical engineering/environmental technicians strong growth
- Younger workforce than for engineers

USA Experience – what courses?

- STEM Degrees overall rate the highest
- Top Bachelors in demand:
  - Accounting
  - Computer Science
  - Finance
  - Business
  - Mechanical Engineering
  - Information Sciences
  - Electrical Engineering
  - Logistics/Supply Chain
  - Marketing
USA Experience – what courses?

- Engineering generally is offering the fastest growing job opportunities
- Biomedical engineering (e.g. artificial organs/imaging systems)
- Energy production changes (e.g. batteries for domestic and industrial usage/oil price collapse)

The Australian Job Market

- Big slide since 2012
- Bottom reached in 2014
- Still not returned to levels before resources boom
Changes over past 10 years

- Engineering vacancies less stable than general employment
- Construction phase of resources boom peaked in 2008
- Big drop off after Dec ‘12 as boom ended.
- Still well below peak of 9159 in Jan’12
Promising Prospects

Employment Level (thousands)

Stats from Jobs Outlook

- Anaesthetic Technician
- Cardiac Technician
- Medical Laboratory Technician
- Operating Theatre Technician
- Pharmacy Technician
- Medical Technicians

(from http://joboutlook.gov.au/)
4. Your Engineering Education and Training

Your Career

- What do employers want?
- Get the education first or the job?
- Will it fast track?
A few further comments on skills

- Change in technology is accelerating
- Business know-how critical
- Communications skills essential
- Computer literacy a given
- Foundation skills are useful – electrical / mechanical / instrumentation / physics
- Project & Cost Management
- Lifelong learning
- Informal learning – 70% of skill acquisition

Other Useful Engineering Skills

- Skills that are useful in a variety of engineering roles
  - Project management
  - Systems management and maintenance
  - Financial management
And is it internationally recognised?

Choices...choices with Education & Training

Blended Learning

- Face-to-face Course
- Video E-learning
- Asynchronous E-learning
- Synchronous E-learning
- Books, Web & Articles
Choices choices......

- Informal – self-study / on-the-job / mentoring
- Online with a MOOC or similar
- Local residential university and college
- Online college

Informal Learning

Impact on Job

Informal 87%
Formal 13%
### Local Residential College/University

<table>
<thead>
<tr>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known and low risk</td>
</tr>
<tr>
<td>Pockets of excellence</td>
</tr>
<tr>
<td>Accreditation good and acknowledged.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Often weak expertise (apart from theory)</td>
</tr>
<tr>
<td>Limited numbers of students in STEM</td>
</tr>
<tr>
<td>Lack experienced instructors.</td>
</tr>
</tbody>
</table>

### Massively Open Online Courses

<table>
<thead>
<tr>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheap or free</td>
</tr>
<tr>
<td>Easy access to worldwide</td>
</tr>
<tr>
<td>Top instructors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ‘free lunch’</td>
</tr>
</tbody>
</table>
Online College

- Advantages
  - Often high level of expertise
  - Easy

- Disadvantages
  - Happy hunting ground of thieves
  - Poor delivery – ‘too flexible’

New learning technologies……..

- Don’t compromise with the quality of your education
- Demand the best and most flexible
- Distance learning and e-learning is the new kid on the block
- But still very amateurish from many institutions
- Quality of instructor/lecturer is absolutely critical
- Course materials are more than a “book on the web”
- Worldwide reach critical
State of Play with Online Learning

- So much effort in quality e-resources
- But we lose the Instructor and interactivity
- Result is high attrition rates & poor learning outcomes
- One major provider has 70% attrition rates
- Sure the profits are supersonic but surely there is a better way.....

Online Engineering Education

- Virtual (or simulations) or Remote Labs
- Great solution is Blended Solution = synchronous (“face to face”); virtual and remote labs
- The Instructor is absolutely key
- This is considerably more expensive than the traditional online approach (“Book on the web”)
INTRODUCTION

Contribution to engineering and technical education & training:

- Students in over 120 countries around the world
- Trained 500,000 students over the past two decades in two-day short courses in classrooms

25 - 60 yrs. old

95% Males

0% 0%

48% 52%

International Australians

STUDENTS FROM 120 COUNTRIES
PROGRAM OFFERING

- Professional Certificate of Competency – 3 months
- Advanced Diploma – 18 or 24 months
- Graduate Certificate – 6 months
- Graduate Diploma of Engineering (Industrial Automation) – 12 months
- Master of Engineering (Industrial Automation) – 24 months
- Engineering National Technical Diplomas (N4, N5, N6)

... plus many additional programs being developed, such as Master of Electrical Engineering and a Bachelor of Science (3yr)

PARTNERSHIPS & AFFILIATIONS

EXAMPLES

- The New Zealand Qualifications Authority
- The Engineering Council of South Africa (ECSA)
- IEEE, based in the USA
- The Institute of Measurement and Control in the United Kingdom
- Engineering Institute of Canada (EIC)
- International Society of Automation (ISA)
- Hull University
- State University of New York
- Central TAFE
- Murdoch University
- Civil Contractors Federation

And we continue to develop more...!
Outcomes

- Options for deferring
- Beyond the course
  - Industry recognition
  - Accreditations
  - Career opportunities

Does the recognition apply to...

- The education system?
- Professional status?
Is it about a short course, a certificate, an advanced diploma, degree or above?

The EIT Approach

- Electrical Engineering
- Industrial Automation / Instrumentation
- Industrial IT and Communications
- Mechanical Engineering
- Chemical Engineering
- Oil and Gas
- Civil Engineering

- Advanced Diplomas and Pathways to Bachelor of Engineering and Master degrees
<table>
<thead>
<tr>
<th>PROGRAM TITLE</th>
<th>CODE</th>
<th>DURATION</th>
<th>STARTING MSG</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master of Engineering (Industrial Automation) ...</td>
<td>EIM</td>
<td>12 months to 2 years</td>
<td>10th Jan 2016</td>
<td></td>
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<tr>
<td>Advanced Diploma of Mechanical Engineering ...</td>
<td>DMC</td>
<td>12 months</td>
<td>10th Jan 2016</td>
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<tr>
<td>Professional Certificate of Competency in Process Control</td>
<td>PCPC</td>
<td>3 months</td>
<td>28th Feb 2016</td>
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<tr>
<td>Professional Certificate of Competency in Instrumentation, Automation &amp; Process Control</td>
<td>PCIPC</td>
<td>6 months</td>
<td>10th Feb 2017</td>
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<tr>
<td>Diploma of Electrical Supply Industry (LESI)</td>
<td>LESI</td>
<td>24 months</td>
<td>28th Feb 2020</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Advanced 17th Edition National Wiring</td>
<td>PCNCW</td>
<td>3 months</td>
<td>28th Feb 2020</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Radiation Design (Non-Equipment)</td>
<td>PCRDNE</td>
<td>3 months</td>
<td>7th Mar 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Civil and Structural Engineering</td>
<td>ADCSCE</td>
<td>24 months</td>
<td>7th Mar 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Applied Electrical Engineering (Electrical Systems)</td>
<td>ADAEES</td>
<td>18 months</td>
<td>7th Mar 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Applied Electrical Engineering (Electrical Installations)</td>
<td>ADAEI</td>
<td>24 months</td>
<td>7th Mar 2021</td>
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</tr>
<tr>
<td>Advanced Diploma of Industrial Automation - 36 months</td>
<td>AIDA</td>
<td>36 months</td>
<td>7th Mar 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Programmable Logic Controllers (PLC's) &amp; Supervisory Control and Data Acquisition (SCADA) Systems</td>
<td>PCPLCSCDA</td>
<td>24 months</td>
<td>7th Mar 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Process Control: In-House: Design and Advanced Control Strategies</td>
<td>PCPCICDAC</td>
<td>3 months</td>
<td>18th Mar 2021</td>
<td></td>
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<tr>
<td>Professional Certificate of Competency in Electrical and Instrumentation (E&amp;I) Engineering for Oil and Gas Facilities</td>
<td>PCCEI</td>
<td>12 months</td>
<td>18th Mar 2021</td>
<td></td>
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<tr>
<td>Professional Certificate of Competency in Electrical Power Systems Protection</td>
<td>PCCEPS</td>
<td>3 months</td>
<td>7th Apr 2021</td>
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<tr>
<td>Professional Certificate of Competency in Nuclear Engineering</td>
<td>PCCN</td>
<td>3 months</td>
<td>7th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Civil Communications, Networking &amp; IT</td>
<td>ADCNI</td>
<td>24 months</td>
<td>8th Apr 2021</td>
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</tr>
<tr>
<td>Professional Certificate of Competency in Engineering and Industrial Mobile Applications Development</td>
<td>PCCI</td>
<td>6 months</td>
<td>8th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Electrical Wiring Standards AS/NZS 60364:2015 (Australia and New Zealand only)</td>
<td>PCCEWS</td>
<td>2 months</td>
<td>8th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Business Analysis, Operations and Information Systems</td>
<td>PCCOIAS</td>
<td>2 months</td>
<td>8th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Electrical and Instrumentation (E&amp;I) Engineering in Mining</td>
<td>ADCEI</td>
<td>15 months</td>
<td>11th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Chemical PLANT (Chemical)</td>
<td>PCCP</td>
<td>3 months</td>
<td>11th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Mechanical Engineering</td>
<td>PCCM</td>
<td>3 months</td>
<td>11th Apr 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in E&amp;I/SCADA Design, Calculation &amp; Commissioning</td>
<td>PCCEI</td>
<td>3 months</td>
<td>24th May 2021</td>
<td></td>
</tr>
<tr>
<td>Professional Certificate of Competency in Management Using Applications in Telecommunications</td>
<td>PCCMUAT</td>
<td>3 months</td>
<td>24th May 2021</td>
<td></td>
</tr>
<tr>
<td>Advanced Diploma of Mechanical Engineering</td>
<td>PCDME</td>
<td>12 months</td>
<td>24th May 2021</td>
<td></td>
</tr>
</tbody>
</table>
**Program Structure**

The program is comprised of 18 modules. These cover the basics of electrical, electronic and software knowledge and skills to provide you with maximum practical coverage in the biomedical engineering field.

The 18 modules will be completed in the following order:

1. Basic Electrical Engineering
2. Technical and Specification Writing
3. Fundamentals of Professional Engineering
4. Engineering Drawings
5. Printed Circuit Board Design
6. Anatomy and Physiology for Engineering
7. Power Electronics and Power Supplies
8. Shielding, EMC/EMI, Noise Reduction and Grounding/Earthing
9. Troubleshooting, Electronic Components and Circuits
10. Biomedical Instrumentation
11. Biomedical Signal Processing
12. C++ Programming
13. Embedded Microcontrollers
14. Biomedical Modelling and Simulation
15. Biomedical Equipment and Engineering Practices
16. Biomedical Image Processing
17. Biomechanics and Assistive Technology
18. Medical Informatics and Biomedical

For detailed information on the content and breakdown of modules, see pages 10 to 28
Some strengths of the EIT:

- Wide and deep resources, continually refined & updated
- Broad choice of lecturers
- International connections
- Entrepreneurial = fast response
- Track record
- Significant number of graduates globally

Two major points:

1. Regular scheduled classes…:
   “inflexible learning”

2. Dedicated Course Coordinators
EIT Courses

- Advanced Diplomas
  - Recognised by many professional bodies (TAC, ECSA, ASQA, IEEE, InstMC UK)
  - Expert instructors on each topic
  - 18 months long, require 6-10 hours per week (including live webinar)
  - Advanced Diplomas in Mechanical, Electrical, Data Communications, Industrial Automation, more

Typical e-Learning structure

- Time commitment required
  - Between 5 and 8 hours per week

- The weekly routine:
  - Learning Management System (e.g. Moodle)
  - Reading and assignments
  - The live, interactive webcasts with experienced instructors
  - Communicating with the instructors
  - Grading and feedback
  - Recordings
How eLearning works

- Virtual classroom
- Assignments and marks
- Course structure
- Systems & procedures

Virtual Classroom

- How the virtual classroom works
  - Presentation format
  - Asking questions
  - Tools available to instructors and students
  - Interactive discussions
Assignments and Marks

- Assignments for each module
  - To ensure understanding of the topic
  - To test your ability to apply the concepts
  - Attendance requirements
  - Pass marks

Course Structure

- Advanced Diplomas
  - 72 topics over 18 months
  - Generally 15 modules per course but each course is different
  - One webinar per week
  - Different instructors for each module depending on their area of expertise
Course Structure

- Professional Certificate of Competency
  - 3 month course
  - 12 modules per course with 2 modules covered per webinar
  - One expert instructor for the duration of the course

Remote Labs

Diagram showing a network setup with the instructor in Houston, USA, connected to the Internet, which connects to learners in Paris, France, Sydney, Australia, and Johannesburg, South Africa.
Online Labs

- Give more credibility to lectures
- Can be set up anywhere with broadband

Engineering labs can go remote
Remote Lab Practical exercise on four pole squirrel cage induction motor. Measuring phase voltage and neutral current.

PRACTICAL LEARNING VIA VIRTUAL LABORATORIES

Students & instructors have remote access 24/7
Successful Strategies and the Future
References

- Thanks for the reference information on which this presentation has been built. This includes:
  - Top careers in demand in South Africa in 2016
  - http://www.jobsindemand.co.za/2015/01/09/occupations-in-high-demand-
  - SA’s engineering shortage widens
  - Of 51 564 enrolments in engineering disciplines from 1998 to 2010, only 14% graduated.
  - http://www.moneyweb.co.za/archive/sas-engineering-shortage-widens/
  - Occupations in high demand – South Africa
  - http://www.jobsindemand.co.za/2015/01/09/occupations-south-africa-high-demand
  - Top 100 scarce skill occupations in South Africa
  - SA’s economy desperately needs high-skilled workers
  - http://www.adcorp.co.za/News/Pages/SA%E2%80%99seconomydesperatelyneedshigh-skilledworkers.aspx
  - Department of Labour national skills shortages list.
  - Look specifically at page 17. I know there is a list of all of them but you will see a lot from the engineering sector.