How do you stop a 60-tonne aircraft coming down the runway at 200 mph?

You just have to be the right size.

**MEGGiTT** 

# **Contents**

1	Introduction
2	Enabling the extraordinary
3	Who we are
4	Meggitt divisions and group functions
6	Design the future
8	Develop your strengths at the cutting edge
10	Extraordinary opportunities for graduates
12	One programme, two streams: Engineering and Operations
14	What we're looking for and applications timeline
16-32	Profiles







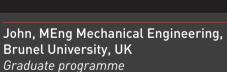












"I stopped applying for other jobs when I heard about the Meggitt programme. You get to travel around the world with an aerospace and energy leader, working with the group's senior experts on cutting-edge research projects. It's the perfect way to kick-start an international career."

# Big enough to lead, small enough to make your mark

From aircraft braking systems and turbine monitoring to mission-critical ice protection, Meggitt has been solving some of the world's toughest engineering challenges for 150 years.

Today, we lead the world in each of our 25+ aerospace and energy capabilities and we develop cutting-edge technologies for the biggest names in aerospace, defence and energy—Boeing, GE and Rolls-Royce, to name a few.

But our game-changing thinking doesn't stop with engineering. We're leading the way in today's manufacturing revolution and continue to pioneer new ways of running a multinational.

# **Enabling the extraordinary**

You will play a critical role in innovation at Meggitt. Working with our most senior technology and operations experts to test new ideas, you'll bring fresh insights to our thinking across the group and help us develop the products and initiatives that will keep us ahead.

And as you travel the world and explore the extraordinary high-tech playground that is Meggitt, you'll find everything you need for a world-class career in engineering or operations:

- stretch your mind on international placements
- push ahead with mentoring from industry leaders
- throw yourself into cutting-edge technology challenges from some of the most demanding customers in the world.

Get on board and design your own future.

# Enabling the Extraordinary

To Fly To Power To Live

Meggitt engineering solves some of our toughest problems, bringing convenience, safety and security to millions of lives.

When you next fly, the chances are you'll see a plane come in to land on Meggitt wheels and brakes. Our crash-worthy fuel tanks can take many bullets and repair themselves, bringing thousands of our brave armed forces back home safely.

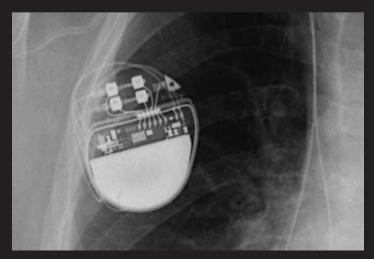
But when everyone switches off, our technology doesn't: most of the world's pacemakers use Meggitt piezoelectric accelerometers, helping millions of people suffering from abnormal heart rhythms to live normal lives. Once implanted, not one of our pacemaker accelerometers has failed.

The scale of what we do and the responsibilities we shoulder create a powerful sense of shared purpose and a deep emotional connection to our work.

Day in, day out, we challenge our thinking to develop the technologies that will enable the extraordinary to happen, today and tomorrow.







# Who we are

Meggitt is a global engineering group specialising in extreme environment components and smart sub-systems for aerospace, defence and energy markets.

Nearly 11,000 employees work across the Americas, Asia, Europe and the Middle East and more than 67,000 aircraft worldwide rely on our critical components as do hundreds of turbines and oil and gas platforms.

The business is divided into five divisions.

> Meggitt PLC is an international engineering group
Aerospace, defence and energy



Global footprint



employees across Europe, the Americas and Asia

> Extreme environment experts
High technology products and systems on



# Meggitt divisions

# **Meggitt Aircraft Braking Systems**

Global leader in aircraft braking systems.

Where: Canada, Mexico, Singapore, UK and USA

Markets: Business jets, commercial transport, fixed and rotary wing

military aerospace.

# **Meggitt Control Systems**

A leading supplier of pneumatic, fluid control, thermal management, fire protection and electro-mechanical equipment and sub-systems.

Where: Singapore, UK and USA

Markets: Commercial, military, regional, business and general aviation;

military ground vehicles, marine and industrial energy and

ground fuelling.

# **Meggitt Polymers & Composites**

Global leaders in complex, composite structures, fuel containment, sealing solutions and ice protection.

Where: China, Mexico, UK and USA

Markets: Civil and military, fixed and rotary wing aircraft; military fighting

vehicles; nuclear, marine, heavy transportation; oil and gas sectors

requiring our specialist technical polymers.

# Leading customers

Airbus, BAE Systems, Boeing, Bombardier, Delta Airlines, Embraer, Finmeccanica, General Dynamics, General Electric, Honeywell, Lockheed Martin, Raytheon, Rolls-Royce, Safran, Textron, United Continental, the US Government and United Technologies Corporation; in the energy sector, Petrobras, Shell, Siemens.

# **Meggitt Sensing Systems**

A leading provider of high-performance sensing and condition-monitoring systems for civil and military aerospace, energy, laboratory measurement and space markets.

Where: China, Denmark, France, India, Switzerland, UK and USA

Markets: Civil aerospace: large, regional and business jets, general aviation and space; energy; military fixed wing and rotary aircraft, ships,

missiles; medical; test and measurement.

# **Meggitt Equipment Group**

Enables a set of strong, technologically distinct businesses to market their offerings to specialist customers, while benefiting from the wider Meggitt group's investment in shared services and common processes.

Where: Australia, France, Netherlands, Singapore, Vietnam,

UAE, UK and USA

 $\textbf{Markets:} \qquad \text{Ammunition handling, military electronics cooling, thermal}$ 

management systems, thermal components, countermeasure launch and recovery systems, live-fire and virtual training systems, heat transfer equipment for off-shore oil and gas,

linear motion control.

# **Customer Services & Support**

More than 67,000 aircraft in service today carry Meggitt parts. Our flexible, fast-moving service keeps them flying at the lowest possible operating cost. The goal is to provide technical support, new or used parts as well as maintenance, repair and overhaul before it's needed.

 $\textbf{Where:} \hspace{1cm} 500 \text{ people across } 27 \text{ facilities in France, Singapore, Switzerland,} \\$ 

United Kingdom, United States.

Markets: Civil aerospace: large, regional and business jets, general aviation and space; ground fuelling. Defense: military fixed wing and rotary aircraft, ships, missiles; ground vehicles; countermeasure launch

and recovery systems; military electronics cooling systems.

# Meggitt group functions

# Applied Research & Technology

To ensure we stay ahead, Meggitt Applied Research & Technology (AR&T) harnesses thinking from around the Group. Our centrally-funded team works with experts within each of our divisions, igniting collaboration across disciplines and capabilities to bring our most promising ideas to life

# **Operations**

Smart engineering demands the best in manufacturing. Built with the very best Lean tools and processes, the Meggitt Production System ensures that every one of us has the power and the responsibility to improve the way we work. MPS is the envy of our suppliers and customers but it's still young. The opportunities for bright, ambitious minds to make it even better are literally endless.

# **Programme Management**

Meggitt programmes are always complex, often cutting-edge and frequently run for decades. Our programme managers lead and integrate across the business managing thousands of actions and balancing conflicting demands to ensure our customers get precisely what they want, when they want it. Rigour, flexibility, technical know-how and a thorough understanding of business are essential.

# Sales & Marketing

We make components for everywhere from the cockpit and the engines, brakes, doors and windows, right down to fire detectors and extinguishers. And that's just for aircraft. Our chosen technologies lead in the defence, energy and medical sectors, too. The breadth of what we do offers a wide range of challenging roles, from selling complex, state-of-the-art systems to managing channel and distributor partnerships for more standard products.

# **Supply Chain**

Every year, we use millions of products and services from thousands of suppliers all over the world. Can we get better ones? Can we get them faster? How do we get the best deal? For the right mind, aerospace procurement is the best puzzle in the world.

# **Strategy**

What do our customers need? Where can we create a competitive edge with intellectual property that can be protected? Are we structured in the right way? Are there merger or acquisition opportunities in the market? How can we improve performance and drive costs down? Continued success means finding the right answers to long-term strategic questions.

# Design the future

Whatever we do, we lead. Whether it's the technology we develop, the way we manufacture our products or run the business, our thinking keeps us ahead.

Thanks to an unprecedented number of wins, we're now ramping up to industrialise more than 1,800 new parts on 15 platforms. But because we're more agile than the giants of the aerospace world, there's a lot more room to make your mark.

Get on board at Meggitt and design the future

# Pioneers in technology

In each of our key capabilities, we are number one or two in the world. Our Applied Research & Technology strategy looks 20 years into the future, guiding our investment to make sure we stay ahead.

The results speak for themselves: R&D projects in areas like mission-critical ice protection are winning funding from global leaders in government, universities and business.

What does that mean for you? Tough challenges, state-of-the-art technologies and seasoned mentors.



# Quieter, lighter, fewer parts 3D printing in action

High pressure air travelling through traditional bleed air valves is one of the biggest causes of noise at landing and take-off.

Graduate engineers Scott Lathrope, Matt Scovell and David Skolnik have developed a radical new design for GE. It's based on a fir-cone design that can cut noise and weight.

"Our team was tasked with generating and evaluating new concepts enabled by additive layer manufacture (ALM)," says Lathrope. "This design was one of the first. And what we learn about ALM on this project, we'll apply elsewhere: heat exchangers, brake manifolds, integrated metal matrix composites and sensors housings could all benefit."

# Pioneers in manufacturing

Tomorrow's factories will be intelligent and highly responsive —smart components will find their own way to becoming products using the Internet of Things to talk to machines and people.

Meggitt is leading the way, bringing Industry 4.0 to aerospace with a ground-breaking combination of smart tools and big data. We call it M<sup>4</sup> and we believe it will enable us to double revenues in UK civil aerospace and increase employment by 50% by 2025.

# **Pioneers in business**

The Meggitt Production System (MPS) equips each of us with a set of tools to maximise performance and creativity wherever we work, streamlining our efforts from boardroom to factory floor.

So whatever your role, you'll look for better ways of working each and every day. And if your idea can be scaled up, we want you to test it out, spread the word and keep on improving it.



# Benchmark of the future

A ground-breaking intelligent workbench is the first step in bringing M<sup>4</sup> to life. Brainchild of Chief Technology Officer, Keith Jackson and former graduate engineer, Tom Newman, it was designed by Meggitt graduates on placement at the UK's Advanced Manufacturing Research Centre.

Smart, flexible fixturing, laser projection and data capture will drive a quantum leap in output, quality, repeatability and traceability.

- laser and video guides show operators which parts to pick, place and fit in sequence
- built-in cameras connect operators to experts for training and problem solving in real time
- cameras keep detailed records throughout assembly, enhancing traceability and capturing ideas for improvement
- research continues into integrating future technologies such as machine vision and smart glasses



# **Bold plans for new acquisitions**

As a dynamic enterprise, Meggitt regularly buys new businesses to add depth to key capabilities. MPS has to be flexible enough to transform culture and performance in these acquisitions, as well as continually improving productivity in all our existing facilities—currently more than 45 worldwide.

In 2015, for example, Meggitt acquired a specialist in all-electric fuel control valves and actuators.

The vendor had planned to relocate production overseas but Meggitt valued the business's technology, culture and customer relationships. We believed we could use MPS to build on these strengths and transform the factory into a centre of excellence.

By the end of 2016, we were well on the way: on-time-delivery, for example, rose from the high 80s at the start of 2016 to average 99% from July onwards. And by mid-2017, the year-to-date figure was still at 99%.

# Develop your strengths at the cutting edge

With a good degree from a top university, you'll already have a solid idea of your strengths. But with a whole career ahead of you, you need to explore before you sharpen your focus.

Meggitt is the perfect place to do that because we aim to lead in everything we do. There are more than 25 extreme environment capabilities here to pit your wits against as well as world experts to mentor you and tough international assignments to test your mettle.

# **Electric combination breaks** the ice

Ice build-up on aircraft can lead to loss of control and loss of life. Building on 50 years' experience in ice protection, recent research into ultra-low power de-icing systems helped us beat the industry favourites to lead a &6 million European Union research project.

Our existing solution cuts 50% of the energy consumed by a traditional bleed air system. We've now got a 90% reduction in our sights.

Innovations include 'PiezoPaint', super-thin layers of piezoceramic which vibrate at different frequencies when charged with an electrical current. Varying the "tune" unsticks and breaks off the ice.

# **Braking news**

We are the only experienced total braking system supplier worldwide. With 60+ tonnes coming into land at 200 mph, brake temperatures can soar up to 2,000°C—hotter than a space shuttle on re-entry. If a wheel locks for more than a second, the tyre will blow. Yet thousands of aircraft all around the world land safely on Meggitt wheels and brakes every day.

# More air pushing the blade, less going around it

Sounds like a simple brief, but it's taken 30 years and the most advanced sensors in the world to deliver it.

Using a unique application of microwave sensing, we can now tell clearance control systems how far to shrink the gap between turbine tip and fan casing to within 0.25mm of blade contact.

The result? 1% increase in fuel efficiency, 10% reduction in noxious emissions.

# This is Pluto calling

Back in 2005, we shipped an order of cabling from California.

10 years and three billion miles later, the first images of Pluto captured by the New Horizons space probe were beaming back to Earth through its wires. Lightweight and proven in the harshest temperatures, Meggitt's silicon-dioxide insulated communication cabling can be found on almost every extreme environment platform.









Smart engineering enables the extraordinary: [top to bottom] Meggitt accelerometers remain accurate at the speed of sound; turbine tip clearance sensing can increase jet engine fuel efficiency by 1%; thousands of aircraft every day land safely on Meggitt brakes; piezoceramic components are helping millions of glaucoma patients see clearly.

# Mission-critical measurement

Our sensors have been prized by flight test engineers on every major military aircraft since 1947. The Joint Strike Fighter is no exception.

Tiny variable capacitance accelerometers pepper its hot surfaces. They are able to compensate for temperature-related errors occurring between, say, vibration measurement at room temperature and  $105^{\circ}\text{C}$  at the speed of sound.

The global error is below 2.5%—a remarkable achievement for a commercial production unit.

# Shaping the future of nextgeneration turbofan architecture

Tomorrow's jet engines will run hotter than ever. And as the fan gets bigger, space inside the nacelle is at a premium. An EU-funded consortium has been tasked with a 15% reduction. Our experts in thermal management—and young engineers on the programme—are playing a central role.

Breakthroughs include our volumetrically efficient heat exchanger, a new design for aerospace using Meggitt technology tried and tested in oil and gas.

To maximise heat transfer at very high temperatures, we chemically etch channels with highly complex geometries onto individual metal plates, laminated using diffusion bonding.

Unlike traditional plate-and-fin and shell-and-tube exchangers, our laminated heat exchanger design can be formed in more complex 3D shapes to make the best use of available space.

Factoring in apertures for pipework from other equipment and integrating other functions within a single component are planned for the prototype.

# Saving sight, treating cancer

Piezoceramic components developed by Meggitt in Denmark enable a new medical technology for treating hard-to-reach cancer tumours and glaucoma—the second biggest cause of blindness and affecting 60 million people worldwide.

High intensity focused ultrasound, as it's known, can heat tissue with great accuracy. A three-minute procedure reduces pressure on the optic nerve within the eyeball—the cause of blindness in glaucoma. So far 2,000 patients have received this non-invasive treatment.

# Extraordinary opportunities for graduates

Cutting-edge technologies, expert mentoring, on-the-job and formal training—with four rotations over three years, you'll get all the challenges and support you'll need to become a world-class leader in your field.

# Induction

To do yourself justice at the cutting edge you need three things: commercial and business knowledge; technical and personal skills; strong relationships. The programme starts with a week of intensive introductory training to get you off to a flying start in all of them. Key elements are:

- an introduction to Meggitt businesses, values and capabilities
- a day in the life of a Meggitt engineer
- the Meggitt Production System: what, why, when, who, where, how
- a tour of a Meggitt factory
- presentation, communication and leadership training
- team building.

During the programme, you'll draw just as much support and insight from your fellow trainees as from your colleagues, mentors and managers. After a week with them—and a number of senior Meggitt leaders—you'll have the foundations for your key relationships in place. You'll know who to call when the going gets tough in the challenging months and years ahead.

# The rotations: travel, research, deliver, repeat

At the start of the programme, our most senior engineers and operations experts will match your skills and interests with a challenging placement in the business. Your mission is to bring new thinking to our cutting-edge initiatives and combine the latest developments across our capabilities to unlock new potential—yours and ours.

During each placement, you'll get the chance to learn about a Meggitt business from the top down. You'll build up your networks and follow up on your interests. If you're doing it right, your contribution will make a big difference to our business and you'll grow professionally and personally as you travel the world and experience different cultures.

At the end of each placement, we'll work with you to choose projects for the next one, balancing your ambitions with the requirements of the business. Here's what to expect:

- Four placements in total: three technical, at least one international, and one outside your core discipline—in strategy, for example, or sales and marketing or supply chain.
- Custom challenges: each project is designed for you personally to build on what you know and take your skills and your thinking to the next level
- Networking: an overused buzzword maybe, but an essential skill.
   We work with most of the biggest names in aerospace and energy.
   That means you'll develop the relationships you need for an international career: thought leaders, academics, suppliers and customers.
- Personal development: on top of the technical and professional, you'll broaden your horizons personally as you travel and work in different countries. Many of our graduates say the close friendships they develop on the programme are one of the most valuable things about it.

# Transition weeks: build your skills, crack tough business problems

For a week between each placement, trainees gather for another round of in-depth training in California or the UK at an engineering centre of excellence. Expect:

- practical assignments on topical commercial and technical issues; working in small teams, you'll collaborate remotely to prepare before the week starts and then brainstorm on site before evaluating your options and presenting your findings.
- interactive training: Meggitt leaders will run workshops on key technical subjects (e.g. Lean design, gas turbines or additive layer manufacturing) as well as commercial disciplines such as programme management and finance for engineers.

Fresh insight from graduates has inspired ideas and solutions that, so far, have generated enough revenue to pay for the whole graduate programme for the next ten years.

Find out more in Lauren's profile on page 22.

# **Business placements**

Programme alumni don't just shape the future of our technology, they drive the whole business ahead. So whether you specialise in engineering or operations, one of your placements will focus on a commercial discipline such as:

- business acquisitions
- customer support and aftermarket
- factory relocations
- programme management
- sales and marketing
- strategy

# **Professional qualifications**

As you progress through the programme, you'll build up the knowledge, skills and experience you need to gain the most relevant professional qualification for your field— chartered engineer, for example. You'll complete annual and quarterly reviews with an experienced mentor to help you build up your technical knowledge and master the discipline of analysing your performance, mapping progress, pinpointing areas for development and plotting your future— key skills that will continue to open doors for the rest of your career.

# Fast-track careers, long term

Prove your worth during training and you'll stay on the fast track, long-term. The mentoring from Meggitt leaders will continue and so will the opportunities to lead the cutting-edge international projects that are so critical to our future.

Find out what one of the programme's alumni is doing now on page 24.

# One programme – two streams

Staying at the cutting-edge in our chosen sectors demands brilliance in engineering and operations. The programme helps us find and develop leaders who will keep us ahead in both disciplines.

Explore what's on offer in each stream

 Read the profiles in the following pages and at www.meggitt-graduate.com to find out more

# Technical leaders

# Design your own future

Meggitt is global number one or two in more than 25 aerospace and energy capabilities. As you explore our high-tech playground, you'll learn how to take your hard-won knowledge out of the lab and onto the production line.

With personalised training throughout your four placements, you'll develop world-class skills in the following areas:

- new product development
- project and programme management
- supply chain support
- research and development
- strategic growth projects
- · operations strategy, systems and planning
- bids and proposals

Stretched and supported by senior leaders across the business, you might easily unlock a new solution to one of the many pressing challenges facing aerospace and energy today.

Longer term, engineers who want the challenge of more management and commercial responsibility work towards managing the engineering function at division or group level.

Those who prefer to deepen their technical expertise become Technical Fellows (see page 13), collaborating with world experts on their specialist subjects to keep Meggitt technology ahead.

Either way, if you've got what it takes, you'll find all the opportunities and support you need to get to the top.

# Test your mettle

Recent graduate engineering projects include:

- new product designs using 3D printing
- intelligent manufacturing technologies
- researching the latest composites
- next-generation lithium battery design
- microelectromechanical (MEMS) sensor design
- algorithm design
- ultrasonic diffusion bonding techniques
- photo-chemical etching
- group-wide common software initiative

# **Operations leaders**

# Join a business revolution today, build smart factories tomorrow

We are leading a revolution. From San Diego to Shanghai, the Meggitt Production System (MPS) gives every single one of us a set of tools to maximise performance and creativity wherever we work, from boardroom to factory floor.

At the same time, our pioneering work on intelligent manufacturing is taking us closer to performance gold by bringing the benefits of Industry 4.0 to Meggitt. Looking ahead, smart components in our factories will turn themselves into products using the Internet of Things.

Working with a crack team of the industry's finest, you'll get a once-in-a-generation opportunity to help implement the performance revolution across our factories in the Americas, Asia and Europe before managing your own site.

As you travel around the world from placement to placement, you'll develop world-class skills in the following areas:

- continuous improvement, Lean Six Sigma
- operations strategy, systems and planning
- manufacturing engineering
- strategic procurement and supply chain
- quality management methodologies and applications
- capacity planning
- supply chain management strategy

Master these disciplines and you'll be ready to manage one of our factories and lead Meggitt manufacturing into the future.

# Mastering manufacturing

Recent graduate operations projects include:

- 'plan for every part' strategy design
- standard work generation for multiple production lines
- Lean training for staff at every level
- daily layered accountability management
- demand management kaizen
- inventory reduction kaizen

# Learn from the leaders



Our programmes are designed and led by the most senior engineers and technical experts in the business. They take a personal interest in you and your development, stretching and guiding you to help you get the most out of the programme and, longer term, your career.

With such a breadth of world-class technologies within the group, you'll find that your mentors are leading industry figures in their field, if not world experts. They include:



Mark Hancock
Technical Fellow, Composites
and Ice Protection Systems
Pioneer in electro-thermal ice
protection, ultra-low power de-ice
systems and ice-phobic surface
materials.



Dr Mike Boost Technical Fellow, Power Conversion and Energy Storage World firsts include: first certified

wireless safety critical system, first lithium battery charger, first application of power harvesting technology.



Phil Walsh, Director of Technology
World expert in jet engine technology.

Author of industry bible *Gas Turbine Performance.* 

# What we are looking for

Good potential leaders are hard to find—particularly ones who can get their ideas across clearly and apply their expertise commercially.

But they are the lifeblood of our business.



# Applications timeline September: Applications open February - March: Interviews April: Offers made June: First placements confirmed September: Programme starts with induction and first placements Visit www.meggitt.com/careers to apply.

# Engineering—the ideal candidate

We're looking for the brightest and best—engineers who can show us they have the technical and commercial potential to lead our business tomorrow.

You will most likely be a final year undergraduate at a leading university but applications from postgraduate and PhD students with relevant experience are also welcome.

# **Education**

We are particularly interested in graduates from the following disciplines:

- systems engineering (with the ability to think big, complex systems)
- power electronics
- aerospace engineering
- mechanical engineering (fluid, thermal, structures, controls mechatronics)
- electrical/electronics engineering
- material sciences
- design engineering
- candidates who have taken business or physics electives are especially welcome

#### Ambitions and interests

Successful candidates will also demonstrate:

- interest in the aerospace industry
- interest in emerging areas such as:
  - additive layer manufacturing
  - bridging mechanical to electrical systems
  - higher temperature materials
  - aeronautics, e.g. laminar flow, anti-icing
  - polymers and composites—materials research

# Operations—the ideal candidate

You are an exceptional graduate with a good grasp of manufacturing processes and methodologies.

Fascinated by factories of the future, you have the drive and energy to play a leading role in our future. Critically, you're also a systems thinker— you can connect the dots and deal with ambiguity.

## **Education**

We are particularly interested in graduates from the following disciplines:

- aerospace engineering
- manufacturing management/systems
- operations management
- manufacturing engineering
- production management
- supply chain management

Masters and MBA graduates are very welcome, as is some engineering or manufacturing work experience.

# **Ambitions and interests**

You can demonstrate interest in one or more of the following areas:

- advanced demand/supply/logistics: operations research, complex linear and goal programming, min/max problem solving, queuing and constraint theories
- advanced manufacturing engineering innovations both for original equipment (OE) or maintenance, repair and overhaul (MRO):
  - new product introduction
  - design for manufacture
  - design for excellence
- Lean management

# The right stuff

Whether you're applying for Engineering or Operations, you'll have the same strong personal characteristics:

- energetic, proactive and ambitious
- flexible and adaptable
- quick to learn
- global outlook

- network builder
- self-developer
- resilient in tough times
- effective decision maker



# Caltech, EPFL Switzerland, Georgia Tech, Sheffield, Warwick ...

Why do some of the most promising graduates from the world's best engineering schools come to Meggitt?

What do you learn when you get here?

What impact do you have on our business?

What does it take to make it at Meggitt?

We talk to a number of the programme's bright stars and alumni to answer the questions you most often ask.

# **Profile**

# **Charlton Johns**

# Operations Graduate

#### 2017 - present

Operations Engineer, Meggitt Control Systems' San Diego, California, USA

#### 2016

Operations Engineer, Meggitt Aircraft Braking Systems, Akron, Ohio, USA

#### Education

BSc Biomedical Engineering, University of Akron

#### Interests

American football, reading, weight-lifting, cooking

#### **Nationality**

United States of America



Above right: After a month in a 30ft furnace at 1,000°C in a near total vacuum, Meggitt carbon brake discs are removed, ready for machining, painting and a final quality test.

# Take off with a global leader

How do you get the best out of people and technology at the same time? That's the challenge that inspired biomedical engineer Charlton Johns to specialise in operations at Meggitt.

"There's only one way to manufacture at the cutting edge and improve performance, day in day out. You've got to optimise everyone's contribution and that means giving them the best tools and, crucially, the power to change things."

bout 45 years ago, the first carbon aircraft brakes were designed and manufactured at what is now a Meggitt factory in Coventry. Since then, the process has been painstakingly refined step by step.

It is enormously complex. To give just one example, during the chemical vapour infiltration process, a carefully balanced mix of three gases is forced through the carbon components to add density. The exact temperature and gas composition must be maintained at each stage so the molecules separate and deposit into the carbon matrix. If the temperature is too low, the gases blow straight over. Given temperatures range from about 1000–3000°C, keeping the level right at each stage is a huge challenge.

Today, Meggitt manufactures 6% of the carbon brakes for the original equipment market, 69% of the aftermarket and 25% of the military market. To join a business that invented and still leads such an important cutting-edge capability is extraordinary in itself. Every day I walk through aerospace history. But the fact that my first assignment here is to unpick that history and shape the future of carbon moulding takes the challenge to a whole new level.

In my first six months, I was given several big projects to improve performance. Each was designed to give me an in-depth introduction to the overall process of manufacturing carbon brakes and through that to the Meggitt Production System—the group's Lean business system.

# Map the line, boost performance

My first project was to create a value stream map of the whole carbon brakes product line, reviewing every step in the manufacturing process. Where do the raw materials come from? And the supplier components? Who does what to them at each stage? It took two weeks to get the full answers, working with a team of 15 across sites in Akron, Ohio and Danville, Kentucky.

One of the big findings was the number of inefficiencies in the transfer of information and materials between our two main sites. There's a hand-over of furnace tooling that gets built and rebuilt in a certain orientation, for example. But the two sites were handling the process differently, causing unnecessary additional work at each end.

After the project, I led a week-long kaizen to share our learnings.



We had everyone, from the director of carbon operations to maintenance and health and safety people, as well as individuals from the factory floor. It was daunting but I'd had some outstanding communications and presentation training during the induction week (see page 10).

In the end, I felt it was the best continuous improvement event I'd ever done.

It consisted of a process failure mode effects analysis (PFMEA), which deepened my understanding of the overall production process and highlighted smaller continuous improvement projects I could run myself. With so much energy harnessed in the plant, there are many layers of risk mitigation in terms of safety, process and materials. We broke down the production line into 29 unique steps in eight locations and analysed each one, scoring for severity, frequency and detection to create an overall risk score for each step. Once you've got all that, you can prioritise improvements.

Every day I walk through aerospace history ... and then try to shape its future.

# Mission-critical projects from the start

A key finding was the variance in aspects of the carbon moulding. I was tasked with increasing overall efficiency in the area, while also decreasing ergonomic risk. It was an ideal challenge for me and it was selected as part of my formal Lean Six Sigma training.

After the initial evaluation, I worked with the accounting team to estimate potential cost savings. We then used a range of classic Lean

tools adapted for this process and location using MPS. They included 6S—a workplace organisation tool—time observations, spaghetti diagrams, standard work and process mapping. We also used studies on measurement systems and process stability. The lessons we learned in Akron—around tool storage for example—I took to the Kentucky site and lessons learned in Kentucky were applied in Akron.

I drew heavily on the experience when it came to teaching my first MPS class, another important part of the operations training here. Teaching immediately after learning deepens your own understanding dramatically.

# Found a problem? Go fix it

In addition to these bigger projects, you're also expected to start additional improvement initiatives as and when necessary. My MPS teaching on problem solving, for example, led to a project to reduce the maintenance cost of machining parts. On one of the machining chucks we use, carbon dust can wreak havoc on the internal mechanisms that tighten down the part in the machine. I facilitated a meeting with all parties involved and used the MPS tools to walk through the problem-solving steps.

Other projects I'm leading now include site-wide initiatives to track and audit 6S as well as scoping procedures to limit foreign object damage, whether at general workstations or in a particle-sensitive environment.

I think the programme here is unique in that you get the opportunity to develop your skills and understanding on so many different live projects, many of them critical. A lot of that comes down to the size and flexibility of the group: it's big enough to lead in a number of key capabilities worldwide but it's small enough that you get to make a real difference yourself.

Precisely the reason I became an engineer in the first place.

## **Profile**

# Ypatia Limniati

**Operations Graduate** 

# 2017 - present

Operational Excellence Engineer Meggitt Aircraft Braking Systems Akron, Ohio, USA

#### 2016 - 2017

Global Manufacturing Strategy and Integration, Meggitt PLC, Coventry, UK

#### 2015 - 2016

Operational Excellence Engineer, Meggitt Sensing Systems, Fribourg, Switzerland

#### 2015

Management Information Syster Analyst, European Organization for Nuclear Research, CERN, Geneva, Switzerland

#### Education

Diploma (MSc)Civil Engineering National Technical University of Athens, Greece

MSc Management, Technology and Entrepreneurship, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

#### Interests

Basketball, swimming, travelling literature, dancing

# **Nationality**

Greek

# From ground level to 30,000 feet: mastering operational excellence with an aerospace leader

Ypatia Limniati is learning about optimised manufacturing in the best possible way: by making it happen at the cutting edge.

arm-up techniques, kinesio tape for boosting muscle elasticity, joint protection, video performance review ... as the vice-captain of the Greek U20 basketball team, I had to look everywhere for incremental improvement. We had tricks and tools for improving every aspect of individual and team performance.

It's very similar, in fact, to my first assignment on the programme. Based at the Meggitt Sensing Systems facility in Fribourg, Switzerland, my brief was to deepen and widen the practice of Daily Layered Accountability (DLA)—the series of tiered meetings that kicks off each working day.

DLA ensures that any operational issues are identified and addressed immediately—at the right level by the right people. As problems get solved, employees gain confidence that their skills and experience give them the authority to own their team's performance: it's their knowledge that shape the tools and processes we need to succeed

# Closer collaboration, more competitive bids

During my stay in Fribourg I helped teams beyond the factory floor implement DLA, driving process improvements with daily standard work.

The sales team, for example, was finding that lack of coordination and clear role definition in the bid process was putting bid quality at risk. By integrating key deliverables and milestones into their DLA, the team ensured that all stakeholders—inside and outside sales—were clear on their responsibilities. Any issues that might compromise a deliverable are now escalated and solved more quickly. Closer collaboration between sales and engineering means more accurate cost and price estimates which in turn means more competitive bids.

Observing the evolution of DLA first-hand was the best introduction to corporate change management I could have had. Working with site leadership, I supported the establishment of a standard assessment process, which we then used to coach the leader of each DLA and share best practice. We also helped bring the total number of employees participating in DLA to more than 70% of the total.

# New machining produces complex parts, faster and at low volumes

One of the strategic goals at Fribourg last year was to reduce inventory. Our 'planning for every part' process corroborated what many of our operators were saying: old turning and milling machines were taking too long to set up—several hours in some cases.

Working with the plant's manufacturing director and two in-house experts, I was tasked with putting together the business case for an investment in new machinery. By sourcing a second-hand machine, we estimated savings of more than \$400,000, inventory savings of more than \$80,000 and return on investment within two years. It's now installed and producing parts with an average reduction in machining and set up time of 75%.





*Above:* Bombardier's C-Series was the first aircraft to fly on electric only brakes, pioneered by Meggitt.

# High altitude operations strategy

My second placement took me to Coventry in the UK where I worked on a footprint rationalisation initiative looking at how we can maximise the use of our existing factory network globally. In 2016, we announced the closure of four sites and we plan to reduce our manufacturing footprint by a further 20% by 2021 as part of a continuous effort to improve our efficiency.

Working with the manufacturing strategy and integration team, I initiated a new approach, creating a consolidated view of all the potential factory transition projects. I developed an analytical tool to assess the strengths and weaknesses of each one in financial, operational and risk terms through a standard process to support overall decision making at Group level.

I also worked on the business case for a large-scale transition project, exploring potential synergies in blended factories which combine various capabilities and technologies to manufacture multiple product lines from different divisions, ultimately reducing overall footprint.

Each transition project is an investment opportunity. Exploring these opportunities is one of the key high-level operations initiatives running at Meggitt at the moment. It was a great contrast to the work I did at Fribourg where I was focusing on operational excellence at the factory and production line level. Here we were exploring ways of improving productivity, maximizing return on assets and boosting synergies at the strategic level.

# **Division focus**

Right now, I'm just beginning my third placement which will give me the experience I need to understand operational excellence at the division level, filling in the gap between the factory-level work in my first placement and the group-level work in my second.

I'm based at Meggitt Aircraft Braking Systems (MABS) in Akron, Ohio and I'm working on a Lean initiative to identify, measure and reduce the cost of poor quality through the whole lifecycle of a product. Known as a cost of poor quality (COPQ) programme, it will help drive down costs in areas such as rework, scrap, re-design, warranties and concessions.

My brief is first to develop a standard system for data collection, tracking and reporting to consolidate COPQ impacts and then work with relevant teams across the functions to lead some process improvement projects.

Aircraft braking systems are a great contrast to sensing systems in terms of size, volume and manufacturing or supporting processes. In some cases, products are 10-20 times bigger in MABS and volumes 5-10 times smaller. In Fribourg, it was exciting to see how our piezoelectric discs are manufactured, whereas in MABS I'm learning about their unique carbon heat treatment manufacturing process.

Talking to others on the programme, it's clear that these kind of opportunities are the standard—and so is working closely with Meggitt leaders. It's that combination that drives our rapid growth and development as well as our understanding of all levels of the business.



# **Profile**

# Lauren Won

# Graduate Engineer

#### March 2017 - present

Mechanical Engineer, Sensors Meggitt Sensing Systems – Fribourg, Switzerland

# June 2016 – March 2017

Mechanical and Materials Engineer Meggitt Control Systems – North Hollywood, California, USA

## **September 2015 - June 2016**

Research Engineer, Sensor Test and Calibration Meggitt Sensing Systems – Irvine, California, USA

# Jan 2015 - Aug 2015

Systems Engineering Intern, NASA Jet Propulsion Laboratory

# Education

BSc Mechanical Engineering, California State
University-Fullerton

#### Interests

Snowboarding, basketball, cooking, literature, arts and crafts

# Nationality

United States of America

# Transition mission

etween each placement, trainees gather in the US or the UK to complement their on-the-job training with an intensive week of product innovation workshops, networking and commercial and technical training.

"It's turbo-charged learning," says mechanical engineer Lauren Won. "You get exactly what you need to put your placement work in context and prepare for the next big leap. It's a lot of fun too."

# Innovation is the key to long-term success in engineering. Is it a skill you can teach?

Well, I'm an engineer so I believe that if you get the right components in place, you can do anything. In my first transition week, we looked closely at successful innovation strategies by some of the world's leading companies, breaking them down into 10 different areas. Creativity is essential but it's not the only thing: discipline, communication and good process are also critical.

We split into teams to explore the subject further. My group looked at how Tesla had developed one of the best electric car offerings in the US by combining complementary products and services—a market-leading battery, an extensive charging network and regular updates for both engine and software. Product systems and a high level of service also give Meggitt the edge so it was a very useful comparison.

# But it's not all theory, is it? You're there to crack some live challenges the business is facing too, right?

In my first transition week, we worked on a new nozzle for aircraft fire extinguishers—fire protection is a core capability here. Today the most widely used suppressing agent is called Halon. It has a very low boiling point so you can release it from a simple cylindrical pipe without any kind of nozzle and it chokes flames very quickly. But it also damages the ozone layer. Finding a 'green' replacement is a big challenge for the aviation industry

The fluid blends being considered are much denser and have to be distributed using a nozzle. We were challenged with creating a 3D-print design with the right curvature to create a spray profile that can put out a fire, ideally with less fluid.

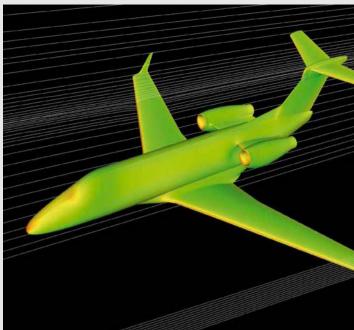
By the end of the week, we had printed up our design and the results looked promising. The engineers working on the project full time are now investigating further.

# And there are some assignments you have to prepare for upfront?

On the programme, we get to work at every level of the business, from factory floor to board room so we probably see more than a lot of people. Plus we're new so we get to ask the most basic questions. Why is that done like that? What's that for? Once you've been around for a while, you're more likely to accept things as they are.

So Tony Wood, Meggitt's Chief Operating Officer, asked us to feedback on our experience in a range of areas including technology, operations, customer focus and culture. I was on the technology and operations team. We started two months before the transition week





*Above:* In her second placement, Lauren worked on redesigning a valve for a jet engine ice protection system, one of 25+ capabilities in which Meggitt leads the world.

and had a weekly meeting online to discuss what we'd found and how we'd present it.

Having to gather that information and make recommendations—even if they're not always the best ideas!—is a great way to learn about change management. How do you balance R&D with the daily focus on getting product out the door, for example? How do you sell in the need for change and get people on your side?

Tony's feedback on our presentations made much more sense because we'd already had a go at tackling the problems ourselves. Chris Allen, President of Meggitt Sensing Systems, and Chief Technology Officer Keith Jackson were also there so you're getting the view from the very top but in a very discursive, interactive way.

# What about the commercial and technical training?

The transition weeks are a perfect partner to our work on placements which is often very specialised. On my first one, for example, we explored the principles of Lean design by redesigning a simple fire door latch assembly. Which components can you remove? How can you redesign what's left to simplify manufacture? Those are the essentials no matter how complex the product.

We also had a day of training with the group head of programme and project management. Between my second and third placements, we had a fascinating day on jet engines with Phil Walsh. He spent 30 years at Rolls-Royce (see page 30) before coming to Meggitt so he really knows what he's talking about.

I'd been working on redesigning a valve in my second placement but it was only when I got the big picture that I could see exactly where it actually sat in one of its applications—in a piccolo tube in the engine's ice protection system.

We finished up that week with a session on finance for engineers. We might be skilful mathematicians but not many of us have financial experience! It's a critical discipline for any top engineer though. They've boiled the learning right down into a custom package that's perfect for what we need.

# It's turbo-charged learning ... and it's a lot of fun too.

# What about the networking? Isn't that just a cliché?

It's a misunderstood word, I think, but for me it's one of the best things about these weeks. Most of the company's senior technical leadership come through at some point, as well as other experts from around the business.

There's a big investment in this programme so they're all genuinely interested in how you're doing professionally and what you're like as a person, too. We're the future of the business, after all, and creating a legacy is something they really care about.

Just as important, though, is the chance to get together with the other trainees and compare notes. Everyone here is smart but we all have different ways of thinking, different passions, different experiences. So in almost any conversation you have, you'll get some new insights and perspectives.

That's fascinating in itself but it's also hugely bonding. You build strong relationships you can call on during your placements and, judging by the calibre of the people here, for the rest of your career, too.





*Above:* Meggitt's composite experts are pioneering new materials for tomorrow's aircraft like Lockheed's SR-72; a succession of graduates have worked on perfecting our next-gen aerospace heat exchanger.

.....

## **Profile**

# Maxime Dempah

Director of AR&T and Engineering Services

## 2016 - present

Lead Engineer, Applied Research & Technology, Meggitt Polymers & Composites Director Engineering Services, Meggitt Polymers & Composites Atlanta, Georgia

#### 2013 - 2016

Materials/Mechanical Engineer on the programme

## **Education**

MSc Materials Science and Engineering, University of Delaware

BSc Mechanical Engineering, Delaware

#### **Interests**

Soccer, artificial intelligence cooking, yoga

Nationality



# Out of the lab, into the factory

Extreme environment engineering requires a complex combination of cutting-edge research and smart industrialisation. "It's fast and it's demanding," says Maxime Dempah, "But if you really want to push yourself as an engineer technically and commercially, Meggitt is the place."

loved my time at university. I was in a new country, at one of the best places in the world to study composites. I grew massively as a result, both as an engineer and as a person. I wanted to find that same experience in my first job. I could have found something safe in my field but I feel more alive when I've got something new to tackle.

I've just finished the programme here and I've definitely made the big leaps I'd hoped for.

Take my first placement, for example. Tomorrow's aircraft, like Lockheed's SR-72 concept, could eventually fly at Mach 6 (4,500 mph). And that of course means higher temperatures and pressures than ever.

# Stretched and stretched again

To meet flammability tests on these next-generation aircraft, some of our composites have to withstand temperatures up to 1,100°C for short periods. But continuous use, hour after hour, is another matter, even at lower temperatures. My job was to find and develop a relationship with a suitable academic partner and create a new material with superior thermal resistance and structural properties.

Working with a team at Georgia Tech, we successfully evaluated a new composite for continuous 700°C heat. Unfortunately, we weren't able to meet all the desired properties. But three years later, during my final placement on the programme, I was able to put this experience to good use working on a ceramics matrix composite for high temperature systems. They are low weight compared with metals and often offer a temperature resistance up to 2,000°C.

That's how R&D works in aerospace. You might not get it right first time but if you keep focused, stay on top of market developments and work with leaders in the field, you get there.

# Manufacturing the future

For my third placement I moved to a Meggitt company in the UK. The role was similar—evaluate, design, build, test—but the technology totally different. I joined a group-wide initiative to develop an advanced heat exchanger for aerospace using a pioneering etched plate additive layer manufacturing (ALM) technique.

I worked on a third-party ultrasonic diffusion bonding technique that allows manufacture from aluminium, the ideal choice for its strength-to-weight ratio. A prototype was developed by a fellow trainee. It's now in testing and could potentially give us a competitive edge in this area for many years to come.

For me, it's this kind of opportunity that makes the programme stand out. Meggitt is always looking for ways to build on the latest research and take the technology to the next level. On the programme, you're tasked with making that happen. It's the perfect way to explore what's on offer across the business and decide where you want to take your career.

# Learning the business of engineering

Meggitt is a very dynamic business, too, so there are always interesting commercial opportunities to learn from. In my fourth placement I worked on the acquisition of two advanced composites businesses from global aerospace leaders.

Working with the integration director, my first task was preparing and implementing a 90-day action plan to ensure business continuity post-acquisition. We had a spreadsheet with around 20,000 essential actions across all the key functions—from HR and finance to engineering and procurement.

Acquisitions always bring uncertainty so good communication is critical for a smooth transition—that's easy to say but to get it right requires a complex combination of imagination, focus and emotional intelligence. I was way out of my comfort zone but I learned fast.

Explore Monday, learn Tuesday, develop Wednesday, test Thursday, deliver Friday. That's my perfect week. At Meggitt, I get it month in, month out.

Then, just months into the process, I was asked to lead a team of engineers from both sides of the newly integrated business to develop a new material for our next generation of radomes. It was a \$250,000 project and we had a prototype within four months. The budget has now doubled and the materials are undergoing tests to obtain certifications from the Federal Aviation Administration (FAA). We could have a product on the market within another 10 months.

# Fast-track programme, faster-track career

Now I've finished the programme, I'm even more impressed with how carefully it was put together. Take the Chartered Engineering qualification, for example. That's useful for professional development in itself, clearly. But writing quarterly reports and discussing them with your mentor is the perfect way to develop an ability to self-evaluate.

Then there's moving to different sites—sometimes different countries—every nine months, plus the extraordinary exposure you get to senior management throughout. I now meet senior buyers and vice-presidents when I visit customers. Working with Meggitt leaders for three years has given me the experience I need to meet them with confidence and adapt quickly wherever I am.

But perhaps most importantly of all, there's a constant expectation that as you develop your skills, you're also thinking about the next stage. Where are the opportunities—in the market and within the business? What technologies will give us an edge with customers?

When it comes to finding your first permanent role, you draw on the whole of your three years' training—what you did and who you worked with—to pin down what you'd like and what's possible.

I wanted to continue with new product development and the supply strategy work I'd done and I've found a role which combines the two: I oversee the majority of new technologies in composites as lead engineer for Applied Research and Technology in the polymers and composites division and I'm also helping to evolve the engineering services division across all our product lines.

The pace is just as fast, if not faster, than during the programme. And looking ahead over the next three to five years, I'm confident that will continue. The challenges and opportunities are here, the support and mentoring are excellent and there's something new to tackle, literally every day.

Constant change isn't for everyone but I couldn't live without it.

# **Profile**

# Matthew Scovell

Graduate Engineer

# 2017 - present

Programme Management Office, Meggitt PLC, Bournemouth, UK

# 2016 - 2017

Systems Engineer, Meggitt Aircraft Braking Systems, Akron, Ohio, USA

#### 2014 - 2016

Mechanical Engineer, Meggitt AR&T, Coventry, UK

#### **Education**

MEng Mechanical Engineering University of Bath

#### Interests

Snowy mountains, five-a-side football and curry

#### **Nationality**

**Rritish** 

# Out of the future, on to a plane

In his four nine-month assignments, Matt Scovell lived and breathed cutting-edge in every domain: individual products, complex systems, factories and programmes. "It's been the best introduction I could have had to commercialising new technology in aerospace. Can't wait to see how the story unfolds from here."

# What has been your biggest challenge so far?

Buying a second hand car in Cleveland, Ohio ... I joke, but moving every nine months was my biggest test. Repeatedly getting confident in one role before downing tools, handing over and setting off on a new adventure is tough. You have to step into the unknown again and again to build relationships with new people and learn about new technology and processes. The engineering is the easy bit—I do that for fun.

## What's the key to success?

Energy, enthusiasm and lots of questions. Plus a long-term view: you've got to remember that this broad array of experience is the foundation for a lifetime's work. The great thing is there are people around you that can help—it's a team game. The first line of defence is your fellow graduates; the second, your mentors, experienced individuals who help you build your professional skills.

## Where did you start?

Exploring how to grow and commercialise our capability in metal additive layer manufacturing. It was 2014 and there was a lot of talk about ALM but not much action, certainly in aerospace.



We needed a product to showcase what could be done—something knock-out but realistic. We had to convince our CEO and CFO to invest and convince our customers that we are a force to be reckoned with. That brief was given to graduates the year before I joined. Working with our CTO, they decided on a redesign of a jet engine air bleed valve.

High pressure air travelling through conventional bleed air valves is one of the biggest causes of noise at landing and take-off. Creating a quieter valve will improve life for millions of people around the globe living near airports and could help smooth the way for airport expansion.

Designing a quiet valve isn't too hard but conventional design and manufacture would make it big and heavy, therefore unsuitable for aircraft.

As a team of three graduates, we developed an ALM design based on a fir cone which not only cuts noise but is also lighter and has fewer parts.



*Above:* Inspired by a fir cone: a team of three graduates developed a quiet ALM design for a bleed air valve—the biggest cause of aircraft noise pollution on landing and take-off.

## What was your impact?

Knockout! Our design was taken to a series of executive leadership meetings that lead to a \$1m investment in a Meggitt additive manufacturing facility in California.

For me personally, it was the best insight possible into how you bring a new technology into the aerospace sector, not just at Meggitt but more broadly. Unusually for a research project, there was a lot of customer contact, meetings at a high-level about once a month. And as the customer was GE, that was a pretty good introduction.

# Hard to beat! But your next assignment sounds impressive, too.

I was very fortunate to get involved with Meggitt's first major digital manufacturing research project, known as Meggitt Modular Modifiable Manufacturing (M<sup>4</sup>). Work started on the three-year initiative in 2014, in partnership with the UK government's Aerospace Technology Institute, we worked with IBM, the UK's Advanced Manufacturing Research Centre and the Manufacturing Technology Centre.

My role was to review current manufacturing processes. I visited three Meggitt factories and looked at three products, exploring how they could be designed and manufactured more efficiently and profitably in a digital factory.

One of my toughest challenges was to work with our operational leaders, manufacturing experts and the software engineers from IBM and gather every possible piece of data about a particular product. Nothing too complex in the first instance—a heat exchanger with only a few moving parts.

But at every stage of production, we needed to establish who does what to it, where, and how long it takes. The result was an increase in data by a factor of a million. However, data on its own is noise. Using

# The programme has given me a full introduction into making the latest new technology profitable. Totally fascinating.

it to enable decision-making is the next step and that's what we're working on now. The ultimate destination is full factory autonomy—a self-governing system that can identify and solve its own problems. That really will require some smart engineers!

## What other challenges did you face?

Traditional Lean thinking tells you that production lines should follow a logical sequence of building a product, step by step. But that's not always the most efficient use of resources. Our M<sup>4</sup> research suggests that the more competitive solution is to use common resources for a mixed flow line which is rich in sensing and applies advanced software algorithms. Selling the power of these solutions to our team of lean experts wasn't easy, but combining ideas and processes from our different worlds brought out the most innovative thinking.

Two years later, our first digital assembly line powered up. I still pass through that site and it's amazing to see the fruit of our labour in action.

# With programmes often running for 30 years, timescales in aerospace can be long. How have you found that?

My last assignment has been a real test for precisely that reason. It was my non-technical placement and I have been working with the Group Vice President of Programme Management. My brief was aligned with our strategic goals around competitiveness, technology and customers: I helped evolve the processes and working practices that maximise return on investment as we deliver the cutting-edge technology that keeps our customers delighted.

On a typical technical R&D project, you can see pretty clearly what you have to do most days. If your work isn't up to scratch, it shows up fast. You're constantly on the hook and that's very motivating! Here, I was given my brief two months before I started and I could see where I had to be in a year.

I had to work out how to get there, who I needed to talk to and then get on with it. I'd meet my manager once a week and had one other close colleague. There was no immediate sense of urgency but it's the biggest responsibility I've had so far. And as the delivery date grew nearer, the pressure was intense.

It's a very tough mindset to get into and I'm not sure I've got my head round it yet. But I'm surrounded by great people who have a vested interest in my success. That's very reassuring.

# And finally, what's next?

I'm looking at opportunities across the group. Some have emerged as a direct result of my assignments and some through connections I have made along the way. All I know so far is that it will be another challenging and stretching role at Meggitt.

# **Profile**

# Karl Elkjaer

Operational Excellence Leader

# January 2016 - present

Operational Excellence Leader, Meggitt Sensing Systems, Denmark

## January 2015 - November 2015

Operational Excellence Engineer, Meggitt Sensing Systems, Denmark

# May 2014 - December 2014

Research Engineer, Meggitt Aircraft Braking Systems

## September 2013 - May 2014

Research Engineer, Meggitt Polymers & Composites

## September 2012 - September 2013

Research Engineer, Meggitt Sensing Systems, Denmark

# Education

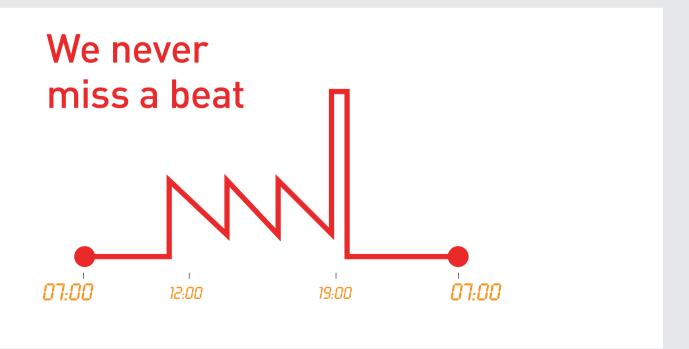
MSc Physics and Nanotechnology, Technical University of Denmark

# **Nationality**

Danish



If you keep delivering after the programme, so does the Meggitt fast-track. There are always more opportunities ahead.



# Onwards and upwards

n the third of a series on Karl Elkjaer, one of the first engineers on the programme, we find out about his last two placements and how he's now combining his talents for operational excellence, technical troubleshooting and product development. Visit www.meggitt-graduate.com to read about his earlier experiences.

# On your third placement, you spent nine months at the cutting edge of aircraft wheels and brakes. What were you doing?

I had some fascinating challenges. How do you reduce braking noise on a business jet, for example? The answer we developed there was to change the geometry of the brake discs so you're hitting non-audible frequencies.

Aircraft manufacturers are always looking for ways to reduce noise pollution and emissions. One of our customers asked us how we would integrate an electric taxiing system into an aircraft's wheels so there's no need to use the main engines when manoeuvring a large passenger jet around an airport.

Inside an aircraft wheel hub is a pretty extreme environment for an electric motor—big changes in temperature, highly corrosive because of all the de-icing fluid on the runway plus very limited space. It was a great challenge to be involved with.

I also looked at an electronic replacement for brake wear pins. Mechanical pins need mechanics to check them so that adds maintenance time. A digital device using laser or ultrasound can trigger a cockpit indicator as soon as the discs need replacing.

I love these problems. You have to gather the information you need from experts all round the business and then do some intense thinking yourself before you present what you've found.

# In your final placement, you looked at how to run a factory rather than what to make in it ...

You can't really understand one without the other. So it's a good discipline for all engineers. In my final placement, I was responsible for launching the Meggitt Production System (MPS) in our Danish facility.

We're about 100 people in total so not as large as some factories in the group but for six months I was solely responsible, working with the production managers, gaining their respect and selling in MPS. Like any big change, it needed careful selling. I liked that combination of process and people and realised I had a real talent for it.

# What were the big challenges?

Some teams picked up MPS quickly. Elsewhere the short-term gain was less obvious so we had to tailor things. I worked with the group MPS leads to adapt the system for Denmark. That meant negotiating how we use standard work, for example, and the supplier toolset

as well as what we call daily layered accountability—the series of interlocking meetings we use to maximise continuous improvement.

Sometimes the view from the top is that DLA boards—the displays we use for tracking live operational issues and metrics—should be designed primarily with management in mind. But I believe the most important thing is that the employees use it to identify issues and solve them in good order.

Getting buy-in for change from the factory floor is the key to success so I worked hard to adapt our DLA boards to reflect that.

## Two years later, you're carrying on this work in your permanent role?

Yes, I'm really enjoying the sense of progress and achievement. The priority now is on reducing arrears and improving on-time-delivery. We've just introduced a new operations DLA board to help do that.

It adds a new layer of scrutiny between the production cells and the site overview. Now that MPS has matured to cover the commercial functions as well as operations, the site level board focuses more on overall business issues and metrics. Our new board takes some of the more detailed operations KPIs that were on the site level board before.

# And in addition to your MPS role, you're troubleshooting technical customer complaints?

Decreasing customer returns is always a priority and I really enjoy this kind of detective work. Our piezoceramic components are used in some extraordinary ways—in sensors to test pressure and vibration in aero engines and industrial gas turbines, for example. And for underwater sonar for trawlers tracking fish shoals, as well as sea bed mapping plus medical and cosmetic treatments. (To find out more see the 2013 Meggitt Review).

One of our underwater acoustics customers reported some faulty products and I led the investigation to find out what was going on, analysing furnace data and brainstorming with a team internally. We found that a furnace that had been opened too soon caused internal cracking in the piezoceramic plates.

Sometimes the solutions are simpler but you have to know where to look. A lot of engineers and academics tend to overcomplicate things as they don't ask the people doing the assembly work. But they're often the best source. For example, we were getting too much scratching on our shear tube product line. Working with the operators, we figured out that changing the holder during polishing fixed the problem.

## What's next on the horizon?

I've just started mentoring an engineer who began on the programme this year. I'll be coaching him through to becoming a chartered engineer. I'm about to qualify so I know exactly what you need. For me it's great as it cements my learning and it's very satisfying helping someone else through the process.

Looking ahead, I'd like to get more involved in business development. It'll be a new area for me but given the breadth of my experience working with different customers and the range of applications our technology has, I'm sure there'll be plenty of opportunities coming up.



# Modelling the future

Winning public funding for key programmes is a sure sign our Applied Research & Technology strategy is on the right track. But to make sure we can give our customers even better advice on core technologies, Director of Technology Phil Walsh is piloting an advanced model of technology development. First up is the future of thermal management and fluid control in tomorrow's jet engines.



# **Profile**

# Phil Walsh

Director of Technology, Meggitt

# 2016 - present

Meggitt UK
Technical Fellow

#### 2002 - 2016

Various including Head of Rolls-Royce Strategic Research Centre and Head of Environmental Technology, Rolls-Royce Corporate, Engineering & Technology, UK

# 1991 - 2002

Business Development Director, Customer Solutions; Chief of Design Technology & Advanced Engineering, Rolls-Royce, Energy & Marine, UK

#### 1986 - 1991

Manager of Concept Design Department, Noel Penny Turbines, UK

## 1984 - 1986

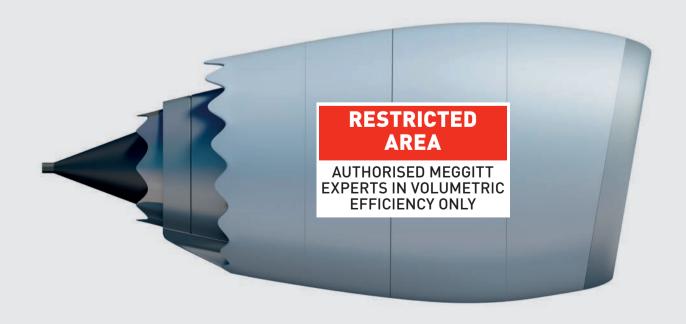
Senior Control System Engineer GE Aero Engines, USA

#### 1983 - 1984

Performance Engineer, Rolls-Royce Aero Engines, UK

## 1981 - 1983

Graduate Trainee, Rolls-Royce Aero Engines, UK



hil Walsh has aerospace form. He's spent 35 years in the business, first at GE Aviation and then Rolls-Royce, where he combined business development and technical expertise. As a Rolls-Royce Fellow, he joined an elite group of around 30 of their most senior technical experts. He also helped author *Gas Turbine Performance*, the industry bible.

Phil joined Meggitt in 2016 as we began gearing up to compete for positions on the next cycle of new aircraft. Given our specialist technologies are on board more than 20 of today's new aircraft feature and we want to improve our record on the next generation, there's quite a bit of work to do.

But the signs are already promising. With next generation jet engines running hotter than ever to improve efficiency, the demands on heat management—a core Meggitt capability—have increased dramatically. However, our ideas for advanced thermal systems technology passed the first external test in the spring of 2017 when a key R&D project met the full technical approval of the UK's leading aerospace funding bodies.

# Problem ... and solution

Cutting fuel consumption and noise are the highest priorities for airlines and engine manufacturers the world over. Engine fan diameters are increasing to produce thrust at the lower velocity required to do this. Nacelles are shrinking to reduce cowl drag. Power gear boxes are being installed on the engine's low pressure shaft.

For Meggitt, the challenge is to deliver products that can cool double the amount of heat in oil while also being small enough to fit in the reduced space available. Nothing less than a radical improvement in volumetric efficiency will do.

Considerable advances were made in two earlier projects: *Novel Integration of Power Plant Equipment* (NIPSE) funded by the European Union, and a next-generation heat exchanger project funded by the UK government. The challenge now is to de-risk the technology and prepare for certification before full production.

The key to a good solution is an intimate understanding of changing customer requirements. In the past, Meggitt has been highly successful in deciphering customer needs simply by listening very carefully to what they need. And that strategy will continue to deliver.

But as Walsh points out, getting involved earlier in the decision-making process is a very useful additional string to our bow.

"If you turn up to see a customer with a blank sheet of paper to take down their requirements, you won't get the best out of the relationship," he says.

"We've got to show how a combination of Meggitt products, optimised in mini-systems rather than discrete components, will help enginemakers get the best performance from their jet engines."

# Climbing the food chain

The answer, he believes, lies in advanced models developed by dedicated systems integration and preliminary design teams.

# "I would struggle to think of a company with this selection of complementary technologies."

"With highly developed models, we can have better conversations and understand customer requirements in more detail. We can then use our expertise to influence new solutions at an early stage rather than waiting for supply chain requirements that are flowed down much later."

The ultimate aim is to fast-track technology developments while customers focus on their own in-house developments.

One of the reasons for this diversity, Walsh believes, is Meggitt's culture. "From engineers to sales and marketing and business development experts, there's a real passion at Meggitt for collaborating. It's the key to optimising the total value of our potential offer."

Critical systems and processes within the company, such as the Meggitt Production System and our AR&T strategy, strengthen this collaborative culture with rigorous process that started out as highly integrative and are continually evolving to be more so.

"Our new approach to modelling is the same. It'll be a big step forward in the way engineers across sites work together," says Walsh. "They are ready. We just need to provide the integrated project team structures to harness their considerable talents and creativity."

Of course, brilliant innovation has to be matched by operational excellence. Given the years of painstaking work and investment that go into new aircraft, customers will not accept new technologies for their programmes unless they are at specific technology and manufacturing readiness levels.

"More than ever, we have to prove our innovations will work. We also have to show we can make them cost-effective," says Walsh. And with his extensive experience at two of the world's biggest jet engine manufacturers, he's the ideal man for the job.

# Meggitt design: a new template

Plans are underway for new design teams for each key Meggitt capability.

They will work in partnership with all divisions to model customers' own systems. Given the extent of our engine technology portfolios, there's plenty to work with beyond thermal management: air systems, for example, and smart composites, sensing and health monitoring, as well as power and motion products.

# **Profile**

# Amir Allahverdi

**Group Operations Director** 

#### 1996 - 2007

Honeywell Global Sourcing

#### 2007 - 2010

VP, Integrated Supply Chain, Europe Middle East, Africa and India

#### 2010 - 2012

VP, Integrated Supply Chain, Asia Pacific, Honeywell

#### 2012

Group Operations Director, Meggitt

#### **Education**

BSc, Mechanical Engineering and Associate in Applied Science in Aeronautical Technology, Wentworth Institute of Technology

MBA, Technology Management and MSc, Management New Jersey Institute of Technology

# Louis Chavez

Continuous Improvements
Director

# 2000

VP/GM Electronic Engine Controls, Honeywell, USA

#### 2003

VP Six Sigma Plus Specialty Materials, Honeywell, USA

#### 2005

VP Quality Aerospace, Honeywell, USA

#### 2007

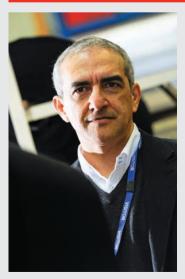
VP Honeywell Operating System, Honeywell, USA

#### 2011

Director of Meggitt Production Systems

#### Education

BSc Electrical Engineering, University of New Mexico





# Can everybody be the best at what they do?

Our customers want fewer, higher performance suppliers. To hit their ever more stringent quality and delivery standards, every one of us needs to continuously improve our game. The Meggitt Production System is the way to do it.

roup Operations Director Amir Allahverdi and Continuous Improvements Director Louis Chavez talk about what they learned at GE and Honeywell and what happens when you turn a business on its head.

Amir: Back when I was studying aeronautics at Wentworth in the '80s, I ran a sheet metal press for industrial heating equipment. I pressed metal, ran copper tubes through it, water tested it and piled it up, day after day. I was doing 10 hours' overtime a week, building too much and building it the wrong way. There was a better, faster way but nobody asked me: 'Hey, what do you think?' There was no system, no process, no supervision and no leadership.

**Louis:** Sounds like a classic worst case scenario. Even if you'd managed to improve on what you were doing, your product would most likely run into trouble elsewhere because there was no leadership or system in place.

When I was an engineer at Honeywell in the '90s, I had no awareness of how the things I was doing, or not doing, had an impact on the factory floor. We'd design something for a Boeing or a Lockheed and get it operational on a few test planes. But then we'd move straight on.

It was only when I became general manager of Honeywell's military avionics division that I could see the whole picture. Producing the best technology in the world doesn't matter if you can't manufacture it to the required quality day after day and get it to the customer on time

Interestingly, though, half of all production issues are not found amongst the machines and materials. Bad or confused sales and order entry flows can cause chaos.

You have to make sure that everyone from sales to shipping is aiming at the same thing.

Amir: But change is such a complicated thing, isn't it? I had a few bosses who said 'go kick ass and fire a few people'. But I quickly realised that if you drive too hard, you get a one-time result followed by burn-out.

I was lucky enough to learn how to get it right at the hands of a master. At GE in the '80s and '90s, Jack Welch built on what Motorola had developed with Six Sigma to transform an underperforming, very traditional American company into one of the largest in the Fortune 100.

I was a dedicated student of the big man's methodology. It was about single-mindedly driving whole systems—people, parts and processes. I will never forget the discipline of going into work every day at 5 am and saying: 'OK, where are the parts and where are the people?'

We solved problems at our daily production meetings in real time.

Louis: That sounds like total common sense, of course. Where else would you want to solve things? Yet everyone knows how traditional organisations work: directors at the top, shop floor at the bottom, as if everything exists to support the work of the boardroom. To make sure that problems are visible and solvable at the most efficient level, you've got to turn the pyramid upside down. Re-locate the centre of the universe at the point where things are actually being made—the shop floor.

Amir: Yes! Something very exciting happens when you devolve decision-making to the right level. More people make suggestions about how to improve things because they know they'll get listened to. Even better, their ideas will get acted on. People take more pride in what they do. They try and beat their own record. It's personal.

**Louis:** But to make that happen in a global business with nearly 50 sites and 11,000 people is complicated. You need a set of processes which are robust enough to support change but flexible enough to work in many different environments.

Amir: More than anything else, you've got to engage people. When Lean first became fashionable, the experts would come in with all the buzzwords—kaizen, poka-yoke, kanban, andon and all the rest—and write up the policies.

It would work fine for a while. But three years later, you went to the same factory and found things had fallen apart, the supervisor had left, the production line had lost its disciplines and quality had taken a nosedive.

# 'Thou shalt do it that way' is no good. Continuous improvement has to come from within.

Louis: And now we've got processes in place to support that. Perhaps the single most important thing we have in the Meggitt Production System (MPS) is a series of interlocking meetings at the start of each day which flow accurate performance and operational information up and down and side to side in each of our businesses.

Each production cell, maybe five or so people, meets first thing every morning for 10 minutes. 'Did yesterday go according to plan?', they ask. If not, it's 'Where are the gaps? What's being done about them, who's doing it? What help do we need? What's expected today and what's due tomorrow?'

Cell leaders then report in to their managers, escalating anything the cell can't solve for itself. These managers go on to meet the value stream leaders before they, in turn, meet the site leaders.

All along the way, any issues are written down on notice boards for all to see. By 9.30 am, the plant leadership knows exactly what happened yesterday, who is working to close the performance gap, when it will be done and what help they need.

Amir: I've found that these daily layered accountability (DLA) meetings, as we call them, can take a bit of getting used to. Coaching is critical as most people can be suspicious around change.

I was at AlliedSignal when the Honeywell integration happened. One of my roles was to improve and standardise production systems at 17 sites across Europe from the company's Swiss hub. It wasn't easy to deal with the suspicion in one factory that a rise in efficiency meant job losses or that analysis of existing processes was a lever to modify employee terms.

Sometimes the only way to allay fears is to get on with it and show the results.

Louis: When we started, I used to ask site leaders how much of their time they spend on the shop floor. They'd say '5%, maybe 10'. And when I used to say 'Tomorrow it will be 50,' they'd think I was crazy. But the best answers are often tucked away inside the head of the person who lives the problem every day. Frequently they either don't know it or someone is not listening to them. It's a Lean leader's job to help them release the power of what they've really got up there.

Amir: I remember how people would say 'How will I find the time to do my real work?' I'd flip that and say 'This is your real work. Do it properly and you'll free up hundreds of hours of ad hoc meetings and waste.' That used to get a smile!

**Louis:** As organisational capability has matured, we get as much as 90% of challenges solved at the first cell level.

Amir: That's because we've fundamentally changed the way people think and, just as importantly, feel about their work. We've learned that from the Japanese—finally! Some people think it's extraordinary that companies like Toyota open their doors to factory tours. But the thing is, even if you take all the tools and processes from a successful business, it's very hard to replicate culture. It is in the hearts and minds of every employee.

**Louis:** We're definitely getting there. There are lots of examples of how we've created our own mature culture right across the group. Look at what they've achieved already at the Meggitt Sensing Systems site in Fribourg, Switzerland: on-time-delivery is up to 96% and they're now focused on slashing inventory by 50%.

Amir: Once we have a full group-wide production system in place, in 'carpetland' as well as in manufacturing, all Meggitt facilities will be equipped to hit the performance standards our customers are demanding.

And that's crucial: we're now at a point where key customers can be serviced by several group facilities. A shortfall in the performance of one detracts from the reputation of another. Yet we've shown time and again that once we're all on the same page, we improve across cost, delivery, inventory, quality, productivity, and safety—the six fundamentals of performance excellence.

**Louis:** And over the whole group, that really adds up. All from ensuring that every single one of our people has the chance to do things better.

Amir: Imagine if all revolutions could deliver that, what would the world look like then?

Louis: One step at a time, my friend! One step at a time.

# Factories of the future ...

In tomorrow's factories, smart components will find their own way to becoming products using the 'Internet of Things' to talk to machines and people.

Meggitt Modular Modifiable Manufacturing (M4) is leading the revolution, turning traditional factory layout and flow on its head with a ground-breaking combination of smart tools and big data.

www.meggitt.com/M4

# ... and news of the present

From tough challenges in the office to competing in Formula Student racing, fundraising for NGOs and travelling the world, find out what our graduates are up to now and where they go once they finish the programme.

Keep up with the latest from around Meggitt and the wonderful worlds we inhabit.

- f www.facebook.com/meggittglobal
- in www.linkedin.com/company/meggitt-plc
- 💆 @meggittglobal