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Birmingham

Reforming Engineering Education for the needs of a Global Economy – Developments in the UK

Hangzhou
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www.aston.ac.uk



An Inspirational Place

Vice-Chancellor is Professor Dame Julia King, DBE, FEng .
 >An important advisor to the British Government.

- Committee on Climate Change.
- The UK's Low Carbon Ambassador
- Governor of the European Institute of Innovation and Technology.
- Author of the RAE report; "Educating Engineers for the 21st Century"



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Aston University


- ▶ Based in Birmingham, the UK's 2nd largest city.
- ▶ Founded in 1895 and a University since 1966.
- ▶ A reputation for teaching excellence, applied research, and graduate employability.



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Working With Employers


- "Not even Oxbridge can boast a higher proportion of students gaining graduate level jobs on departure. Aston's 87.7% is bettered by just four institutions and shows a clean pair of heels to the likes of Oxford, Cambridge, Bristol and Durham." Sunday Times University Guide 2012.



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The City of Birmingham

The home of the industrial revolution



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Iron Bridge



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Student population

Total student population: just over 10,000
 Non-EU International students: just under 2,500

A multicultural university with a rich, cultural diversity
 Students from over 120 countries





Four Executive Schools

Aston Business School
 Consistently highly ranked overall, as well as top ranking MBA and MSc programmes in both UK & Europe

School of Engineering & Applied Sciences
 Leading edge engineering and applied science education since 1895

School of Life & Health Sciences
 UK leading research and teaching within areas of pharmacy, optometry, biology, psychology, neurology

School of Languages and Social Science
 Range of professional English language programmes, French, German, Spanish, translation, international relations, sociology






School of Engineering and Applied Science

- ▶ Six Subject Groups:
 - ▶ Chemical Engineering & Applied Chemistry
 - ▶ Computer Science
 - ▶ Electronic, Electrical and Power Engineering
 - ▶ Mechanical Engineering & Design
 - ▶ Engineering Systems and Management
 - ▶ Mathematics
- ▶ & Aston Professional Engineering Centre (APEC)




EAS World Class Research Themes

- ▶ Science of Sensing and Devices
 - ▶ Photonic device fabrication and applications in sensing and telecommunications systems
 - ▶ Communications networks: sensors and systems
 - ▶ Biomechanical engineering
- ▶ Science for the Environment
 - ▶ Environmental Sustainability
 - ▶ Bioenergy
 - ▶ Smart Power Grids

National "Centre of Excellence" Research


- ▶ Science of Materials
 - ▶ Nanoscale carbon based materials
 - ▶ Biomaterials and bio-molecular science engineering.
 - ▶ Synthetic chemistry
- ▶ Science of Information
 - ▶ Nonlinear and Complexity Science
 - ▶ Knowledge and Software Engineering
 - ▶ Biomedical/Healthcare Informatics
- ▶ Engineering Education
 - ▶ CDIO (Conceive, Design, Implement, Operate)
 - ▶ Professional Engineering





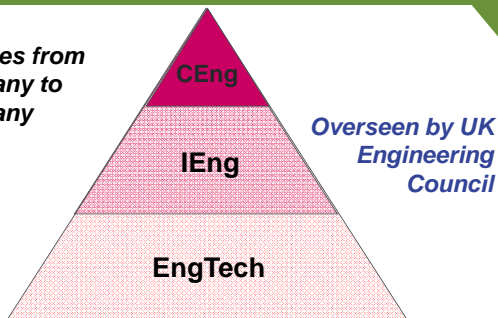
UK Engineering Professional Structure

- ▶ 36 Professional Engineering Institutions (PEIs)
- ▶ Overseen by Engineering Council
- ▶ Who hold the national register of Professional Engineers
- ▶ 3 levels
 - ▶ Chartered Engineer (CEng)
 - ▶ Incorporated Engineer (IEng)
 - ▶ Engineering Technician (EngTech)
- ▶ Based on a set of national competence standards (output based)



UK Professional Status Structure

% varies from company to company



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EC-UKSPEC

- ▶ Requires demonstration of five areas of competence:
 - A. Knowledge and understanding
 - B. Design and development of process, systems, services and products.
 - C. Responsibility, management or leadership.
 - D. Communication and inter-personal skills.
 - E. Professional Commitment
- ▶ Requires assessment by Professional Review
- ▶ Usual process of development of competence by a combination of engineering education followed by professional practice.

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Accreditation

- ▶ Accreditation is the process of reviewing an engineering degree programme to judge whether or not it meets the defined standards set by the Engineering Council.
- ▶ Accredited engineering degrees provide a mark of assurance that the degree programme meets the standards defined and set by the engineering profession.
- ▶ Engineering employers as well as academics are involved in the setting of standards, in reviewing degrees and in the decision-making process about whether to confer accredited degree status.

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The UK's Engineering Talent Shortage

- ▶ If the UK is to remain one of the world's top manufacturing economies it needs more engineers.
- ▶ The forecasts are that Britain needs around 90,000 new engineering graduates every year.
- ▶ And nearly half of all employers say current graduates are not skilled enough.

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Engineering Gateways Project

- ▶ Started in 2006.
- ▶ Sponsored by UK Government.
- ▶ Objective to find a way to create more better qualified engineers.
- ▶ The project would bring together both universities, the professional bodies and employers to develop new approaches.
- ▶ The plan was to use work base learning as a means to both widen access and accelerate engineering talent development.

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Key Features

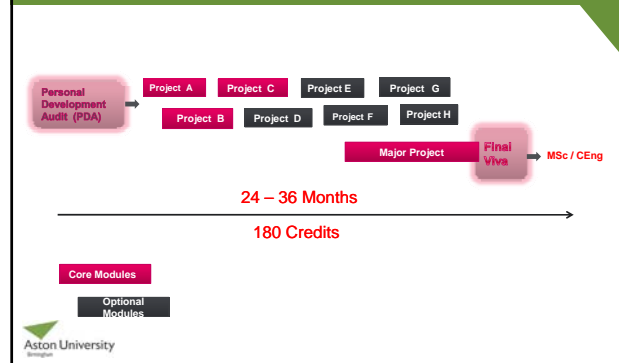
- ▶ A series of real work projects instead of classroom based study.
- ▶ Participants are working whilst studying so the learning takes place in the workplace.
- ▶ Concurrent academic learning and engineering competence development in a single programme.

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Engineering Council Website



The UK MSc PE Programme Model



2000 to 2014 – A period of change

- ▶ Changing role of UK in global economy
- ▶ Changing graduate employment market.
- ▶ Changing HE environment in UK
 - ▶ Introduction of student fees.
 - ▶ League tables.
 - ▶ Expansion to 30% + participation in HE.



Skill shortage paradox

- ▶ The UK is producing a lot more graduates than in the past, so many that a lot of them are unemployed, and yet we still have a skills shortage !

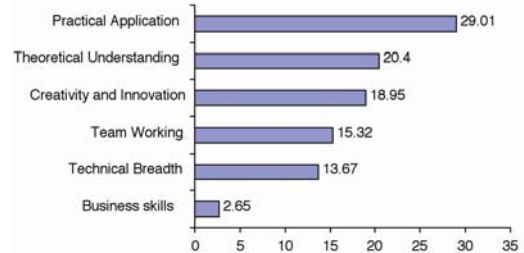


The engineering skills gap problem

- ▶ Our analysis is that this arises from a fundamental problem with our educational system.
- ▶ We have a 20th century industrial era (at best) educational system trying to operate in a 21st century global economy era.

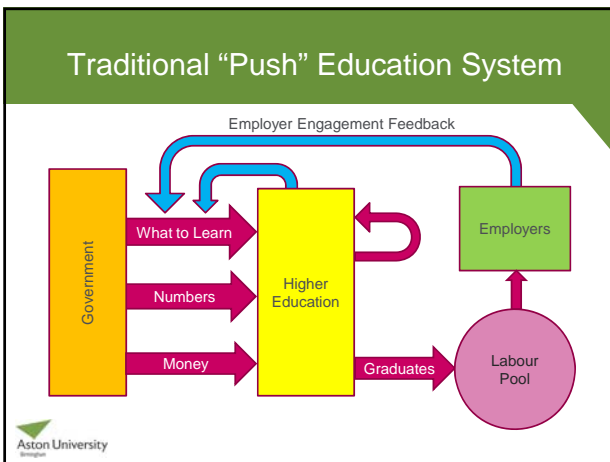
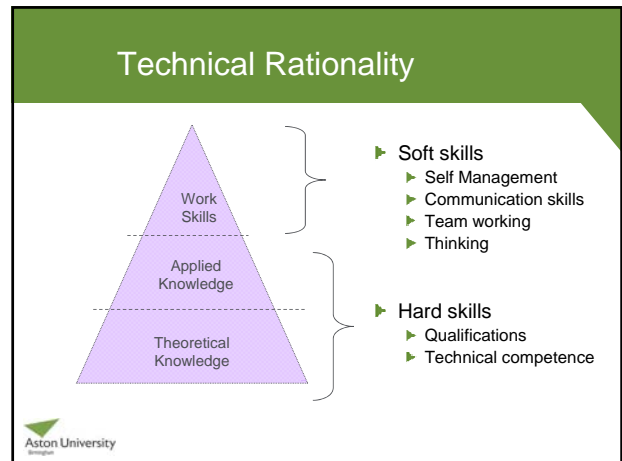
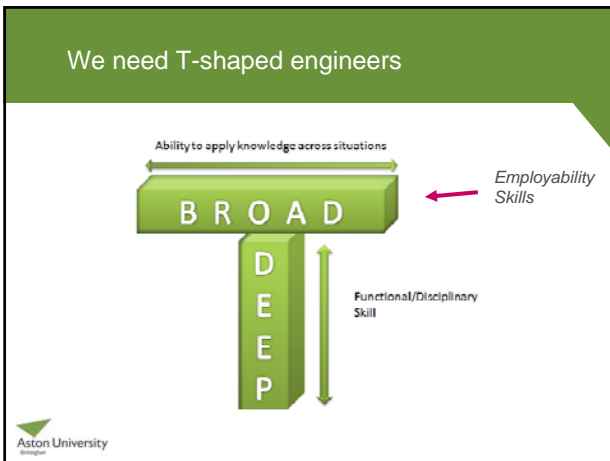


Industry Needs Engineers With:

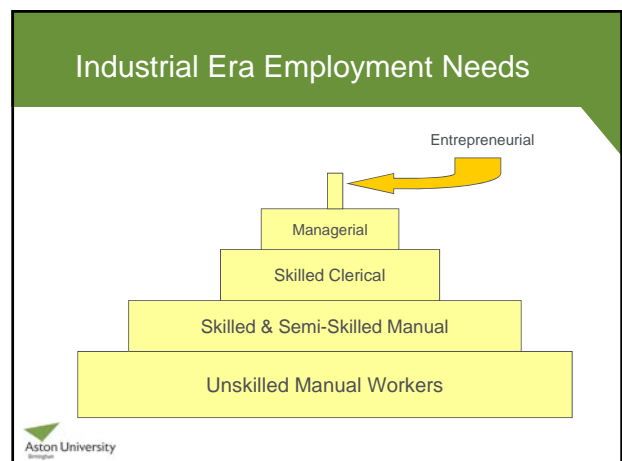
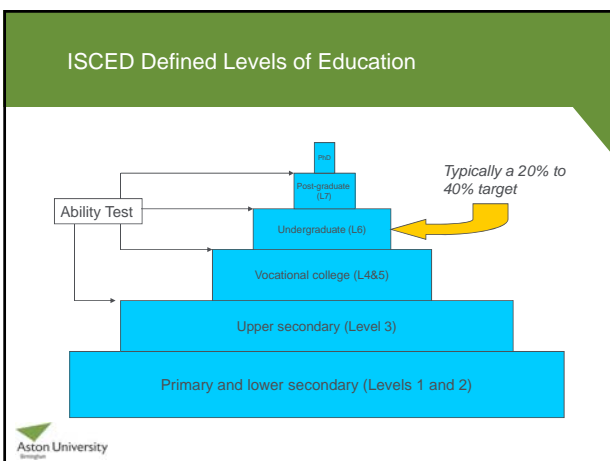


Entrepreneurship & Sustainability

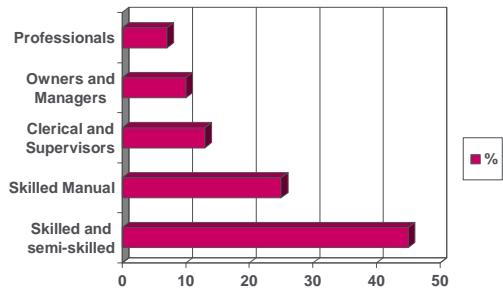




- ### Push Education
- ▶ Government decided what it thinks should be the target level of higher education participation.
 - ▶ Government and/or faculty decide upon what should be taught within programmes.
 - ▶ Where employer engagement is active this will include consideration of feedback from employer of education. This feedback may or may not be accurate.
 - ▶ Efficiency of education is the priority.
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Great Britain Employment (1951 Census)

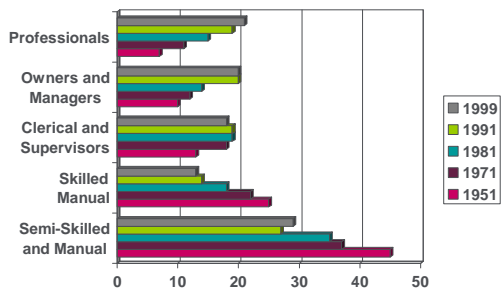


Pre-Global Changes

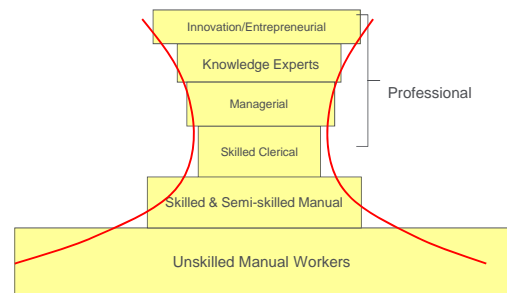
- ▶ Replacement of semi-skilled and skilled manual tasks with automation.
- ▶ Replacement of clerical tasks with computerisation.
- ▶ Relocation of manufacturing (flying geese).
- ▶ Growth of service industry.
- ▶ Growth of knowledge industry.



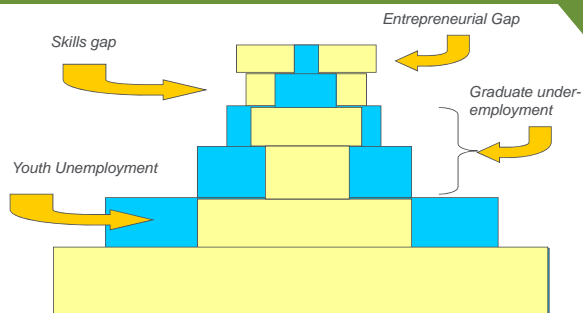
Great Britain Employment Statistics



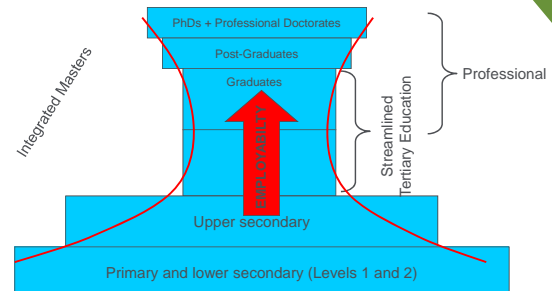
Global Era Employment Needs



Education to Work Mismatch




Innovation Stage Education Model

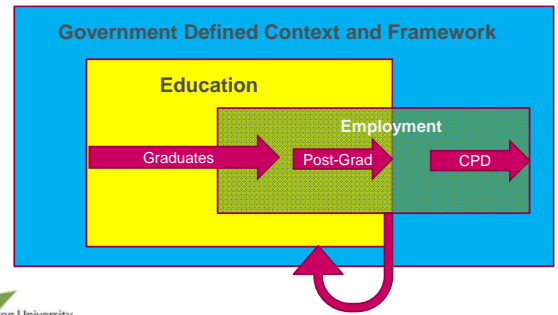



Pull Education

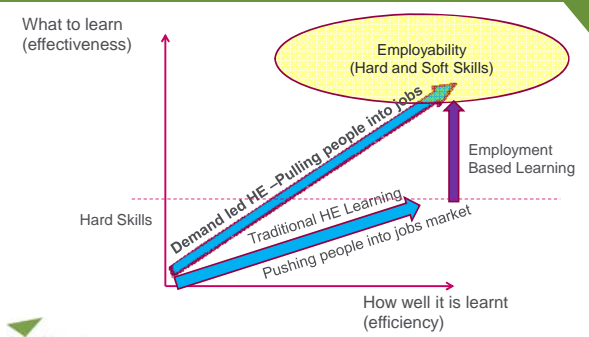

- ▶ Education programmes tailored to individual requirements.
- ▶ Mass customisation.
- ▶ Concurrent development of hard and soft skills.
- ▶ Chunking of programmes down into shorter blocks to reduce lead times.
- ▶ The effectiveness of education is the priority.



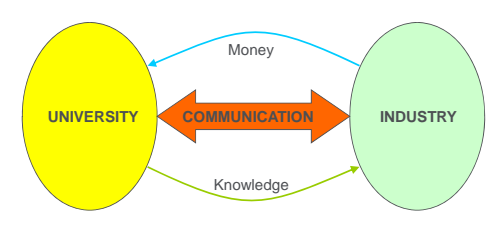

"Pull" Education

"Voice of The Customer"

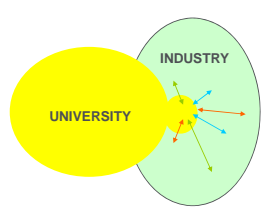




Traditional Industrial Collaboration Model

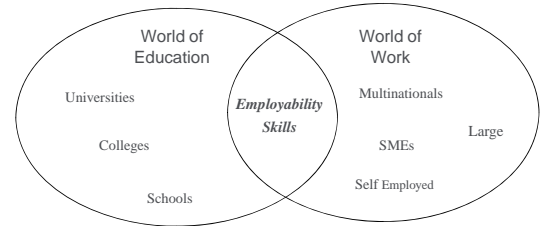




Professional Engineering Model

Taking the learning out of the classroom and into the workplace.


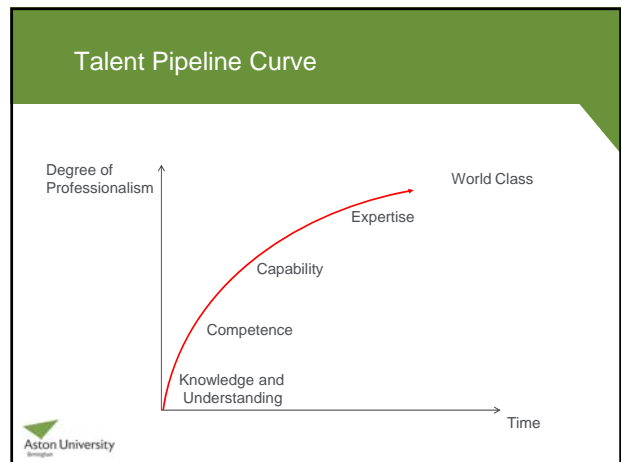
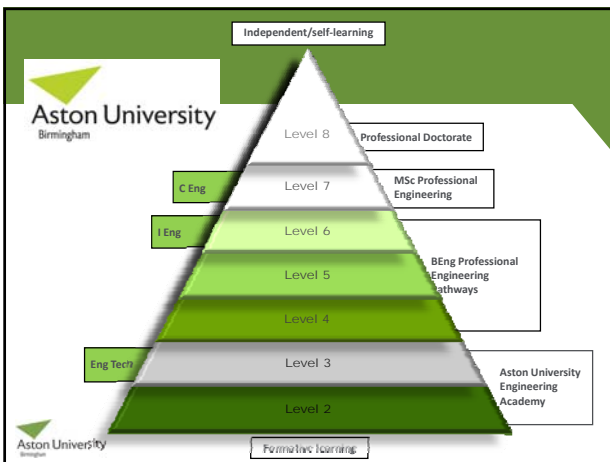
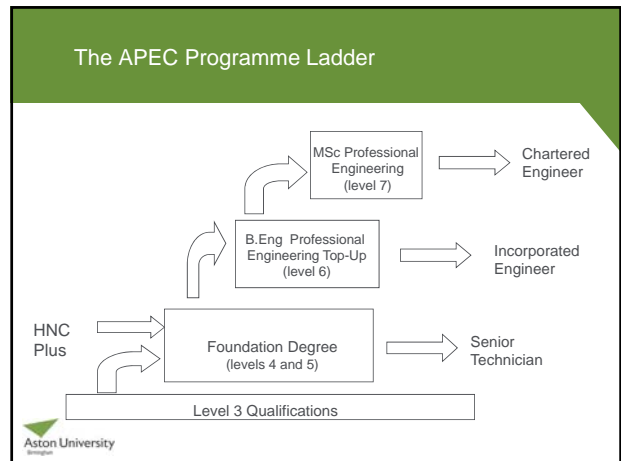



Employability





"APEC" Programmes


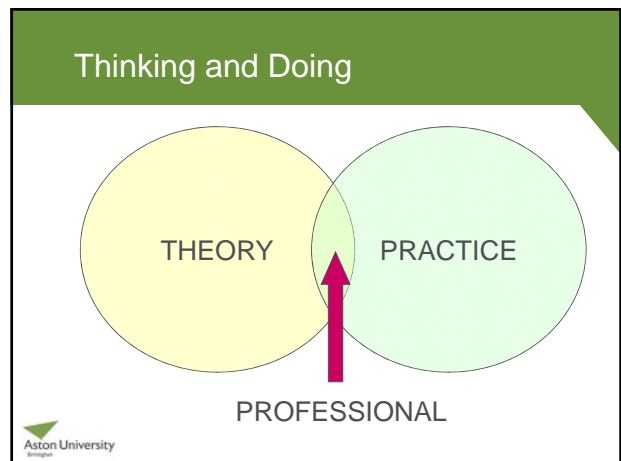
- ▶ MSc Professional Engineering
 - ▶ Leading to Chartered Engineer status
 - ▶ Multi-disciplinary work based learning
 - ▶ 2 to 4 year part-time
 - ▶ Run in collaboration with partner universities.
- ▶ BEng Professional Engineering
 - ▶ Leading to Incorporated Engineer status
 - ▶ Multi-disciplinary blended learning
 - ▶ 2 year part-time top up
- ▶ Foundation Degrees
 - ▶ Leading to Engineering Technician status
 - ▶ Discipline specific block taught with self study
 - ▶ 2 year full time

What is an "engineer"?




- ▶ A pessimist feels that the glass is half empty, whilst an optimist feels it is half full.
- ▶ An engineer thinks the glass is twice as big as it needs to be.

An Engineer Thinks and Does.

- ▶ An engineer thinks about the physical infrastructure that supports mankind and then finds ways to improve it.
- ▶ Usually scientifically or logical, but sometimes creatively.




Theory with Practice

to inform

	Theory	Practice
Theory	Theoretical Conceptualisation	Application
Practice	Model Building	Benchmarking

Using




Theory with Practice

to inform

	Theory	Practice
Theory	Theoretical Conceptualisation	Application
Practice	Model Building	Benchmarking


Using

Professional




Conformity to QAA-M level & UK-SPEC (or PEI equivalent)


QAA M-Level Descriptors Knowledge •Systematic & Comprehensive Understanding •Originality in application •Conceptual & Critical Evaluation Skills •Operational •Cognitive •Transferable	Learning Contract Work-Based Goals 180 Credits	UK-SPEC •Engineering Knowledge •Problem Solving •Leadership •Interpersonal Skills •Professional Standards
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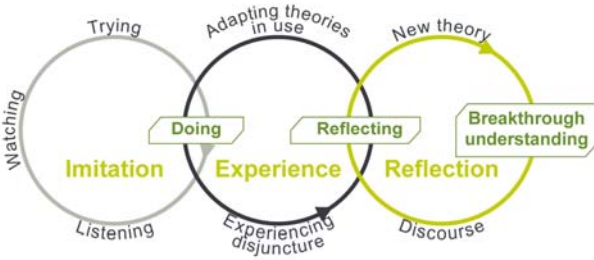

Experiential Learning Cycle



- ▶ Based on Kolb (1975)
- ▶ Single loop learning
- ▶ Giving continuous improvement
- ▶ Basic theory of all work based learning



Triple Loop Learning

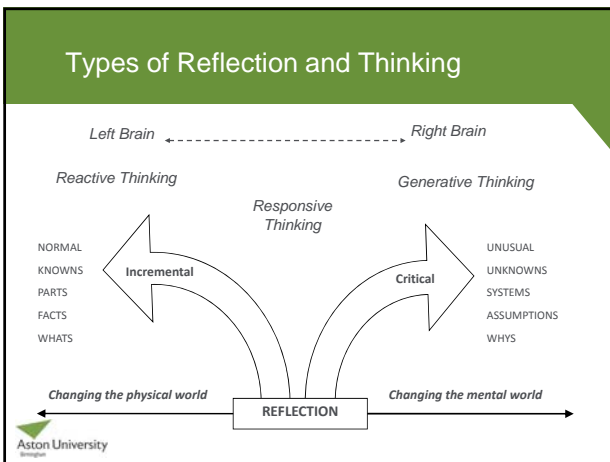
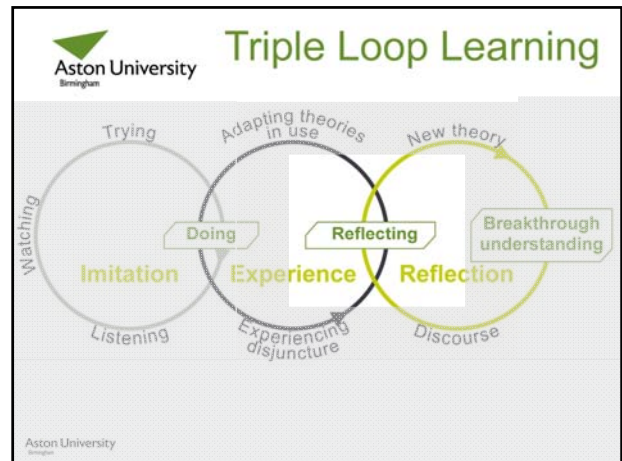



Confucius




- ▶ *“I hear and I forget. I see and I remember. I do and I understand.”*
- ▶ *“By three methods we may learn wisdom: First, by reflection, which is noblest; Second, by imitation, which is easiest; and third by experience, which is the bitterest.”*

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Mentoring (Critical) Dialogue



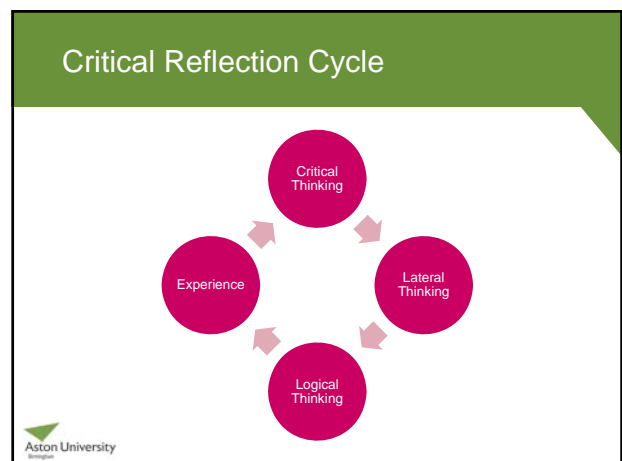
- ▶ Regular meetings with Professional Supervisors who engage them in critical dialogue.
- ▶ Using structured mentoring to maximise personal excellence.
- ▶ They “coach” the art of critical reflection.

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Critical Reflection

- ▶ Multi-perspective, probably involving moral and ethical consideration.
- ▶ Systematic reframing of complex problems.
- ▶ Tacit to explicit knowledge generation.
- ▶ Thinking about thinking; learning about learning.
- ▶ Challenging of assumptions and “*taken-for-granted*s”.

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5 Factors for Successful Learning

- ▶ Wanting to learn
- ▶ Ownership of learning
- ▶ Learning by doing
- ▶ Learning through feedback
- ▶ Making sense of learning



UK Engineer Example

- ▶ Howard; coal mine engineer.
- ▶ Five projects:
 - ▶ Redesign of colliery compressed air system
 - ▶ Testing of new type of hard wearing steel plates
 - ▶ Introduce planned maintenance system
 - ▶ Evaluate potential for using coal gas by-product for electricity production
 - ▶ Investigation into technologies for cleaning up waste water



International Pilot Programmes

- ▶ Company Need
 - ▶ Large quantity of high quality engineering skills development in various global locations
- ▶ University Solution
 - ▶ MSc work based learning programmes
 - ▶ Trialled in Angola and Indonesia
 - ▶ Participants doing real projects which challenge and develop at the same time giving immediate bottom line benefits.
 - ▶ Better motivated workforce
 - ▶ More loyal workforce
 - ▶ Now following on with a trial BEng programme



Where we have partnerships already



Why a Global Perspective?

- ▶ In today's world we are more separated by our beliefs than we are by distance.
- ▶ I believe:
 - ▶ Better education for all is a world wide imperative.
 - ▶ Human intellect is the ultimate renewable resource.
 - ▶ Strong international partnerships between universities are the best way to ensure the development of that resource.

