Engineering Education Provision Across Europe

G. Barrow†, R. Heinemann and S. Hinduja

The University of Manchester

School of Mechanical, Aerospace and Civil Engineering

A few facts about I*PROMS

- FP6 NoE “Innovative Production Machines and Systems” (2005-09)
- 30 core members from 14 European countries
  - 21 academic partners (Cardiff, Naples, Fraunhofer IPK, …)
  - 9 companies (Fiat, Schneider, Robosoft, Fidia, …)
- Four clusters:

  a) Advanced Production Machines
  → Innovative machines and efficient manufacturing processes.

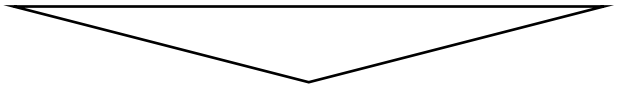
  b) Innovative Design Technology
  → Tools and techniques to bring design closer to manufacturing.

  c) Production Automation and Control
  → Control issues associated with the 'Autonomous Factory‘.

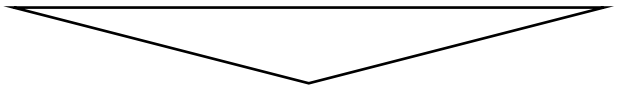
  d) Production Organisation and Management
  → Sustainable management strategies.

Motivation for Manufacturing Engineering Provision Survey

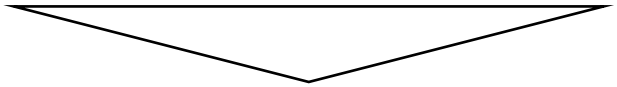
What are the knowledge/skills required for manufacturing engineering graduates?



What would the “ideal” syllabus for a manufacturing engineering course look like?



Do European universities already provide this knowledge?



How homogenous is this provision?

Participating Institutes

- University of Cardiff
- University of Newcastle
- University of Manchester
- University of Warwick

} United Kingdom

- Dublin City University (Ireland)
- University of Clausthal
- University of Hannover

} Germany

- ENIT - Ecole Nationale d'Ingénieur de Tarbes (France)
- University of Naples (Italy)
- University of Sakarya (Turkey)
- University of Patras (Greece)

Phase I

Was concerned with:

1. Identification of manufacturing-related modules.
2. Determination of amount of manufacturing-related content.
3. Appraisal of recent graduates by their employers (industry) regarding the manufacturing engineering provision they had received.

<u>Main findings:</u>

- ❑ Industry is only moderately satisfied with knowledge/skills level.
- ❑ Inhomogeneous manufacturing engineering provision.

- ➢ More detailed breakdown of education provision necessary.
- ➢ In how far does a particular module contribute to a specific knowledge/skill?

Phase II

- Question: How much time/effort is spent on gaining a particular knowledge/skill?
  - Time/effort = lectures + tutorials + labs + homework + self-study
- If possible, each module was evaluated by academic in charge.
- For each module, data was weighted by number of credits and expressed as percentage of total degree programme.
  - **Minimum provision:** Only compulsory modules are considered.
  - **Maximum provision:** All optional modules the students can take are considered.
- Assessment was carried out for
  a) General/Mechanical Engineering courses
  b) Industrial/Manufacturing Engineering courses

Knowledge/skills and Subject Groups

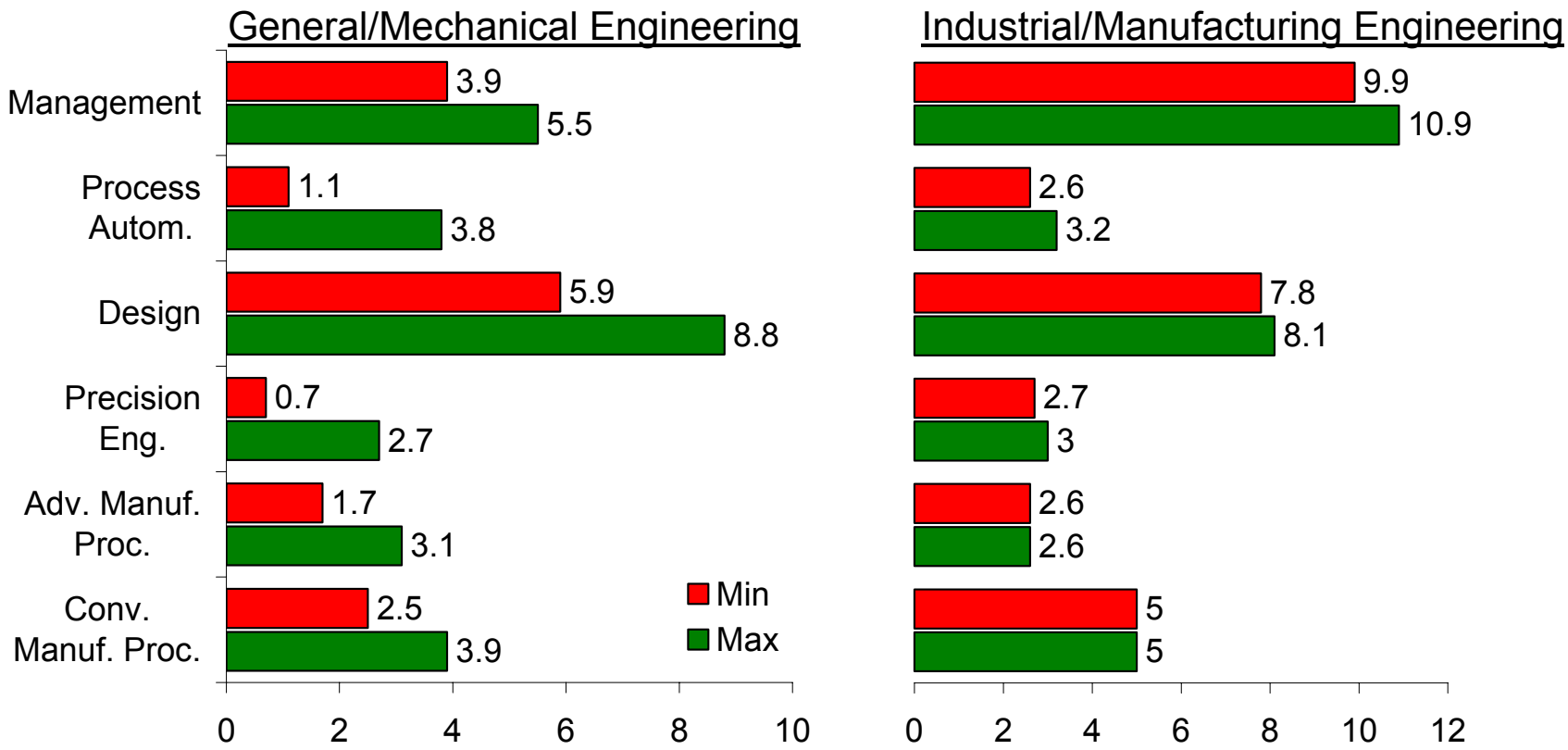
Knowledge/skills were grouped into Subject Groups:

- Conventional Manufacturing Processes: conventional machining; forming; casting and moulding; joining and assembly.
- Advanced Manufacturing Processes: non-traditional machining; rapid prototyping; reverse engineering; CAM/CNC.
- Precision Engineering: micro/nano technology; metrology; inspection.
- Design: drawing interpretation; design; FEM; rapid prototyping; life cycle engineering.
- Process Automation: robotics; automation; instrumentation.
- Management: lean manufacturing; production organisation; project management.
- Other: knowledge/skills not directly relevant to I*PROMS core-competencies.

Main observations

- Significant variation in knowledge/skill provision between the different courses assessed.
- In general, industrial/manufacturing engineering courses offer a higher manufacturing engineering provision than general/mechanical engineering courses.
  - Especially in the case of minimum (compulsory) provision.
- In general, substantial reduction in knowledge/skills provision from ‘maximum’ (all options) to ‘minimum’ (compulsory) provision.
- For some courses, the project – if manufacturing-related – can represent a substantial knowledge/skill provision.

Main observations (cont'd)



- In general, Design and Management …
  - … represent a larger-than-average knowledge/skill provision.
  - … exhibit smaller reduction from "max" to "min" provision.

Education Provision and Research

- Why do some institutes offer a higher manufacturing engineering education provision than others?
- Institutes were asked to quantify the ‘level of research’ they undertake in the subject groups considered.
- Scores were given for different levels of research:
  - “5” for high level
  - “3” for medium level
  - “1” for low level
  - “0” if no research was undertaken

Main observations

- Strong variation in ‘level of research’.
- In general, an above average ‘level of research’ score coincides with relatively high knowledge/skills provision in most subject groups.
  - Link between research activity and knowledge/skills provision is strongest for optional modules.
  - Compulsory element of degree programmes is, in general, not dominated by research interests.
- Little correlation between ‘level of research’ and knowledge/skills provision in Design and Management.

Conclusions

- Considerable training in certain knowledge/skills was detected, which is not apparent from module titles.
- Variation of both maximum and minimum amount of manufacturing engineering provision between universities creates stumbling block for student mobility (→ Bologna process).
- Design and Management are seen as ‘key’ subject areas, as small reduction from maximum to minimum amounts of manufacturing education provision indicates.
- Apart from these ‘key’ subject groups, correlation between amount of knowledge/skills provision and ‘level of research’ was observed.
- Research interests appear to influence optional rather than compulsory programme content.

Potential shortcomings

- Some modules with manufacturing engineering content might have been missed out (because not identified in Phase I).
- Amount of knowledge/skills provision was assessed based on information provided, which was interpreted on a subjective basis.
- Inconsistent interpretation of ‘level of research’.
- Patras did not quantify ‘level of research’.
- Contribution of projects towards manufacturing engineering provision difficult to estimate → varying topics each year.
- Degree programmes vary in length (Naples: 3 years, Hannover: 5 years)

In memory of Dr. George Barrow.

Thank you very much for your attention.