Why do Physics?
Where does it really lead?

John O’Byrne, Alberto Mendez
School of Physics, University of Sydney
and
‘Physics Graduates in the Workforce’ Working Party
and representatives in 21 universities
A survey

• In the first half of 2008, a survey was distributed to a wide range of Physics graduates across Australia.
• The survey is the product of the Working Party on 'Physics Graduates in the Workforce', part of a project funded by the Carrick Institute for Learning and Teaching in Higher Education (now the Australian Learning and Teaching Council).
• The survey sought to reach graduates from all Australian universities with physics or physics-related courses, both undergraduate and postgraduate - and their employers. Over 140 graduate replies have been received so far - forming a relatively big sample.

• Graduate and employer interviews are to come.

• It is a major component of an effort to provide a realistic answer to the questions

  *Why do Physics?  Where does it really lead?*

  based on the experience and perspective of real physics graduates in the workforce.
• **Stated goal** … we aim to identify graduate destinations and employer expectations and explore the diverse employment opportunities available to Australian Physics graduates to determine the suitability of current course content, structures and learning activities.

• The practical outcomes will be web-based information including:
  – Who employs physics graduates?
  – Comments on *work* experience/satisfaction by Graduates and Employers,
  – Comments on *course* experience/satisfaction by Graduates and Employers,
  – Individual Graduate profiles.
• It’s not the first such survey, but it is:
  – Big - national, across many universities
  – All graduate levels - single degree, higher degree, double and combined degrees,…
  – Physics only, not all of Science [unlike McInnes et al. 2000, Rodrigues et al. 2007]

• Note: We ran a previous AUTC Physics project (2004-5) that included a small set of interviews of 3-year graduates and employers [see Mendez et al. 2008 and http://www.physics.usyd.edu.au/super/AUTC/].
Why do you need to know this?

• To help us!

• **Action #1 - for you to help**

  Do you know anyone who did Physics at university (yourself, friends, past students, and especially employers) who you can ask to fill in this survey? Go to

• So we can help you!

• **Action #2 - for you to tell us**
  – What career information do school students *want* - salaries, profiles of working graduates, visits to universities,…?
  – What career information do school students *need* to encourage them to consider Physics?
  – Does what you/we provide matter anyway?

• Why? Because career advice in science for students is generally poor, both at school and university.
• **Action #3 - for you to consider**
  – Can you use this to convey the relevance of physics, even to students who will never do physics at university?
  – What does the survey tell us about recruiting high school physics teachers?
  – Is there any other relevance to you?

• **Action #4 - for us**
  – Deliver the results!
Context - School

- In most developed countries there is a well-documented fall in student numbers in enabling sciences and maths at school and university level, creating a looming shortage in technically-trained people.

- What to do at the school level?

- Change curriculum - e.g.
  - new HSC Physics syllabus - popular or not?
  - introduction of one-term science units in year 10 - seen as successful [Butler 2008]

- Some suggest that any new curriculum or teaching practice is never all that new – so the problem will never really be solved by such changes.
• Is the problem really employment, salary conditions, status,...?
  • e.g. gradsonline [http://www.gradsonline.com.au/] information on median salaries for Bachelor (under 25)
    – Dentistry $68,000
    – Optometry $51,240
    – Medicine $51,000
    – Engineering $46,000
    – Earth Science $45,000
    – Physical Sciences $40,000

• Rodrigues (2007) survey implies that “high school students had little idea of the range of workplace possibilities opened up by a science degree” and “career advice prior to beginning university was completely inadequate.”
• It was also “clear that the type of course that would attract most students was one leading to flexible and multiple employment pathways” – a very Gen Y characteristic! Does this describe physics?

• Macquarie University (2006) study suggests that the three most important elements in choosing a career are:
  – A job that will benefit the community,
  – A chance to interact with many people,
  – A job with plenty of variety and challenge.
• We could claim that science provides these, but do the students see it that way?
• Rodrigues notes that people interviewed did not undertake a science degree with a specific purpose or career in mind. Several simply fell into science and several changed their minds on exposure to alternatives at university.

• Common motivations for doing science:
  – Familiarity from high school
  – Personal interest
  – Parental perceptions
  – Social expectations
    • Relative worth of science (relative to, say, Arts)
    • Gender issues (‘boys do science’ or some girls are now pushed towards science)

• Responses to our survey feature many of these same comments.
Context - Uni

- University physics student numbers are relatively healthy, even growing at top levels, even if some departments are not:
12 June 2008

Sydney data - 3rd, 4th year

Senior Student numbers

<table>
<thead>
<tr>
<th>Year</th>
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<th>Male</th>
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<tr>
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<td>25</td>
<td>9</td>
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Honours Student numbers

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<td>2007</td>
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<td>5</td>
</tr>
<tr>
<td>2008</td>
<td>26</td>
<td>5</td>
</tr>
</tbody>
</table>

Some more up-to-date data
Sydney data - postgrad

Postgrad research students

Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
F    | 11  | 11  | 12  | 16  | 20  | 16  | 22  | 26  | 20  
M    | 50  | 45  | 40  | 57  | 65  | 67  | 79  | 76  | 74  

Postgraduate coursework students

Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
F    | 2   | 4   | 0   | 0   | 0   | 9   | 8   | 13  | 7   
M    | 2   | 0   | 0   | 0   | 4   | 10  | 8   | 11  | 12  

12 June 2008
• It is commonly known that most students majoring in physics continue with further studies, but the AUTC survey illustrated this because of the difficulty of finding 3-year only graduates - e.g. Sydney in 2002 had 2 out of 66 students!
• As far back as 1980, nationally only ~20% third year physics students sought employment. ~46% went onto honours or higher degrees and ~30% went onto further undergraduate or diploma studies.
• This trend seems even stronger now with the growth in double/combined degrees.
• In stark comparison, in 2007, only ~20% of Bachelor graduates from all degrees went on with full-time study.
Rodrigues notes that career advice at university is often very poor - "throughout their training there was little exposure to the relevance of the science and the probable or possible use of this in real work scenarios." - even in applied science streams.

Job information at the University of Sydney
Survey results so far

• Preliminary data only - more to come!
Decade of first degree

<table>
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<tr>
<th>Decade</th>
<th>Responses</th>
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<td>80s</td>
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<tr>
<td>90s</td>
<td>51</td>
</tr>
<tr>
<td>00s</td>
<td>39</td>
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</tbody>
</table>
Undergrad Physics degree
Postgrad degrees

Physics Postgraduate Degrees

- Physics PhD: 59
- doing PhD: 7
- MSc: 5

Non-Physics Postgraduate Degrees

- no Physics PhD: 18
- other PhD: 7
- other postgrad degree: 50
- no PhD: 50
First job after graduation - where?

- Australia: 109
- Europe: 12
- North America: 7
- Asia: 4
- Africa: 1
- Pacific: 2
- Antarctica: 1

Total: 191
First job

- Post Doctoral / Academia: 34 responses
- Private Sector (Science & Engineering): 32 responses
- Public Sector (Science & Engineering): 24 responses
- High School Teaching: 10 responses
- IT / Computing: 9 responses
- Medicine / Medical Physics: 8 responses
- Patents / Law: 4 responses
- Financial Maths: 5 responses
- Defence Force: 4 responses

Responses
Current / most relevant job

- Post Doctoral / Academia: 30 responses
- Private Sector (Science & Engineering): 30 responses
- Public Sector (Science & Engineering): 20 responses
- IT / Computing: 11 responses
- Medicine / Medical Physics: 7 responses
- High School Teaching: 5 responses
- Defence Force: 5 responses
- Patents / Law: 4 responses
- Financial Maths: 4 responses
Comments

• There is a clear bias in the sampling because people who respond are more likely to be Honours or higher degree students with a closer association with Physics. This is especially true since the sample is, at present, heavily weighted with University of Sydney graduates.

• Not surprisingly, previous data suggests that the employment profile is different for different institutions - for example
  – the University of Sydney and
  – the University of Technology, Sydney (UTS).

• … and different for those with/without PhDs.
Sydney v. UTS

Sydney

UTS

- Instrumentation, electronic, 17%
- Medical, 14%
- University, 14%
- CSIRO, ANSTO, etc., 11%
- Other non-science, 8%
- Energy, 6%
- Telecom, 6%
- Defence ind., 5%
- School, 5%
- Optics, 3%
- Other science, 3%
First job - PhDs or not

- Tertiary: 5 no PhDs, 29 PhDs
- Private Sector (Science & Engineering): 23 no PhDs, 9 PhDs
- Public Sector (Science & Engineering): 12 no PhDs, 12 PhDs
- High School Teaching: 7 no PhDs, 3 PhDs
- IT / Computing: 5 no PhDs, 4 PhDs
- Medicine / Medical Physics: 5 no PhDs, 3 PhDs
- Patents / Law: 3 no PhDs, 1 PhD
- Financial Maths: 2 no PhDs, 3 PhDs
- Defence Force: 2 no PhDs, 2 PhDs
Who employs non-PhD graduates?

- The diversity of occupations and employers in the following Table of *non-PhD graduates* (any discipline) is impressive.

- There is a somewhat similar list, which first appeared in *Physics Today*, at [http://www.haverford.edu/physics-astro/Careers.html](http://www.haverford.edu/physics-astro/Careers.html)
<table>
<thead>
<tr>
<th><strong>High School Science teacher</strong></th>
<th>Dept of Education</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>science teacher</strong></td>
<td>NSW Dept of Education</td>
</tr>
<tr>
<td><strong>Secondary Maths/Physics teacher</strong></td>
<td>Department of Education - Tasmania</td>
</tr>
<tr>
<td><strong>Laboratory Technician</strong></td>
<td>Private School</td>
</tr>
<tr>
<td><strong>High School Science Teacher</strong></td>
<td>Private School</td>
</tr>
<tr>
<td><strong>high school teacher</strong></td>
<td>NSW Dept Education</td>
</tr>
<tr>
<td><strong>Public Sector (Science &amp; Engineering)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Health Physicist</strong></td>
<td>Australian Radiation Services</td>
</tr>
<tr>
<td><strong>Geophysicist</strong></td>
<td>Bureau of Mineral Resources</td>
</tr>
<tr>
<td><strong>Experimental Officer</strong></td>
<td>CSIRO Division of Textile Physics (later</td>
</tr>
<tr>
<td><strong>IT Support Tech</strong></td>
<td>ANSTO</td>
</tr>
<tr>
<td><strong>Experimental Physicist</strong></td>
<td>ANSTO</td>
</tr>
<tr>
<td><strong>Reactor Engineer</strong></td>
<td>ANSTO</td>
</tr>
<tr>
<td><strong>TO2 Observer</strong></td>
<td>Australian Bureau of Meteorology</td>
</tr>
<tr>
<td><strong>Electrical Locomotives Coordinator</strong></td>
<td>QR</td>
</tr>
<tr>
<td><strong>Experimental scientist</strong></td>
<td>DSTO</td>
</tr>
<tr>
<td><strong>Electronics Technical Officer</strong></td>
<td>Gold Coast City Council</td>
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<tr>
<td><strong>Graduate</strong></td>
<td>ANSTO</td>
</tr>
<tr>
<td><strong>Laboratory scientist</strong></td>
<td>CSIRO Minerals</td>
</tr>
<tr>
<td><strong>Private Sector (Science &amp; Engineering)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CCP Supervisor</strong></td>
<td>BHP Queensland</td>
</tr>
<tr>
<td><strong>Health Physics Technician</strong></td>
<td>CH2M Hill Pty Ltd</td>
</tr>
<tr>
<td><strong>Project Engineer</strong></td>
<td>Rheem Australia</td>
</tr>
<tr>
<td><strong>Planning and Scheduling Engineer</strong></td>
<td>Dravo</td>
</tr>
<tr>
<td><strong>Operation Engineer</strong></td>
<td>Comalco Aluminium</td>
</tr>
<tr>
<td><strong>Geophysicist</strong></td>
<td>Austirex International Ltd</td>
</tr>
<tr>
<td><strong>Assistant Physicist</strong></td>
<td>CIG, later BOC</td>
</tr>
<tr>
<td><strong>Technical Instructor</strong></td>
<td>Honeywell Australia Ltd</td>
</tr>
<tr>
<td><strong>Tradesperson Instruments</strong></td>
<td>Sugar Mill</td>
</tr>
<tr>
<td><strong>Graduate Engineer</strong></td>
<td>Delairco ML Engineering</td>
</tr>
<tr>
<td><strong>Maker and designer of solar cells</strong></td>
<td>Dyesol</td>
</tr>
<tr>
<td><strong>Production Support Engineer</strong></td>
<td>Phonak &amp; Unitron Pty Ltd</td>
</tr>
<tr>
<td><strong>Satellite Operator</strong></td>
<td>Aussat</td>
</tr>
<tr>
<td><strong>Environmental Engineer</strong></td>
<td>Mt Newman Mining (now BHP Billiton -</td>
</tr>
<tr>
<td><strong>Technical Officer</strong></td>
<td>GHD</td>
</tr>
<tr>
<td><strong>IT</strong></td>
<td>Keays Software</td>
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<tr>
<td><strong>Project Engineer</strong></td>
<td>Esso Australia Ltd</td>
</tr>
<tr>
<td><strong>Senior Systems Supervisor</strong></td>
<td>Queensland Alumina Limited</td>
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<tr>
<td><strong>Avionics LAME</strong></td>
<td>Jayrow Helicopters</td>
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<tr>
<td><strong>Technical Sales Representative</strong></td>
<td>Courtaulds Packaging</td>
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<tr>
<td><strong>Project Officer</strong></td>
<td>Direct Edge Corporate Development</td>
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<tr>
<td><strong>Wireline Logging Engineer</strong></td>
<td>Schlumberger</td>
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<tr>
<td><strong>Electrical &amp; ESD Engineer</strong></td>
<td>EMF Griffiths</td>
</tr>
<tr>
<td><strong>Tertiary</strong></td>
<td>Central Queensland University</td>
</tr>
<tr>
<td><strong>Research Officer</strong></td>
<td>UniSA Mawson Lakes Campus</td>
</tr>
<tr>
<td><strong>Planetarium Operator</strong></td>
<td>UNSW</td>
</tr>
<tr>
<td><strong>Research assistant</strong></td>
<td>Pre-cataloguer</td>
</tr>
<tr>
<td><strong>Pre-cataloguer</strong></td>
<td>Queensland University Library</td>
</tr>
<tr>
<td><strong>TO1</strong></td>
<td>RMIT</td>
</tr>
</tbody>
</table>
• Other studies have indicated that 50% of a sample of employed science graduates are in positions outside their discipline base. Our sample is likely to under-represent these.

• Over 70% of responses to our survey recommend a major in Physics as useful training for a career in their field.
• Of those who didn’t, over 70% “recommend a smaller component of Physics” in a students training.
• While a positive response is not too surprising from this sample, it is nonetheless a strong endorsement of physics training from those who have survived the experience.

• But what was good about the training? What ‘graduate attributes’ were developed? More importantly, attributes weren’t?
Graduate Attributes developed in Undergraduate Physics Degrees

- Problem solving: 3.50
- Laboratory skills: 2.95
- Computational skills: 2.68
- Experimental design: 2.59
- Research methodology: 2.50
- Information retrieval: 2.46
- Written communication: 2.22
- Teamwork: 1.94
- Project planning: 1.83
- Oral communication: 1.39
- Ethical and social issues: 0.82
Graduate Attributes needed

Graduate Attributes needing more attention in Undergraduate Physics Degrees

- Oral communication: 46.5%
- Project planning: 35.4%
- Written communication: 33.1%
- Experimental design: 29.1%
- Ethical and social issues: 26.0%
- Teamwork: 21.3%
- Research methodology: 20.5%
- Information retrieval: 17.3%
- Computational skills: 15.7%
- Laboratory skills: 12.6%
- Problem solving: 5.5%
• Undergraduate data only presented here, although postgraduate data is also available.

• Rodrigues (2007) quotes focus groups of ‘science graduates undertaking research’ that found significant emphasis on skills such as communication - in contrast to the emphasis on knowledge and technical (e.g. laboratory) skills they experienced in their courses.

• Our data is showing the same and is also consistent with feedback from employers in our AUTC interviews of physics graduates.
What now?

• Using survey data and subsequent interviews, plus a similar survey of employers, the Working party will
  – Prepare a summary of the actual work experience of the sample of physics graduates,
  – Prepare individual graduate profiles.
  – Construct a perspective on current physics training with suggestions on where changes in emphasis might be required.
Some references


• Butler, M. (2008), Has the time come to re-imagine science education?, *Australian Physics*, 45, no.1, 18-20.

• Macquarie University (2006), *Macquarie university science, engineering and technology study*.

• Mendez et al. (2008), Australian Physics bachelors and honours graduates in industry: Where are they? How well prepared are they?, *Australian Physics*, 45, no.1, 21-24.


• Rodrigues et al. (2007), The usefulness of a science degree: the “lost voices” of science trained professionals, *International Journal of Science Education*, 29, no.11, 1411-1433.
Some links

• Current surveys

• University of Sydney Physics jobs pages
  • http://www.physics.usyd.edu.au/about/grad_jobs.shtml

• University of Sydney Physics graduate profiles

• University of Sydney Science faculty career page
  • http://www.careers.usyd.edu.au/students/careeropt/degree_science.shtml

• University of Sydney Science faculty graduate profiles
• Australian Institute of Physics (AIP) SA Branch career pages
  – What can you do with a physics degree
  – Job trends to 2003 by John Prescott
• Australian Multimedia for Physics Students (AMPS) site
  • http://www.hscphysics.edu.au/home
  – See the video clips
    • Academic Freedom
    • Becoming a Physicist
    • Physicist Dress Code
    • Physics Researcher
    • Radiographer
    • http://www.hscphysics.edu.au/resources
• Graduate Careers Australia
  – career profiles
  – Physics profile
    • http://www.graduatecareers.com.au/content/view/full/3201
  – and follow link to Careers in Physics booklet

• Graduate Careers Australia - gradsonline - Salaries etc.
  • http://www.gradsonline.edu.au/