Careers in Research

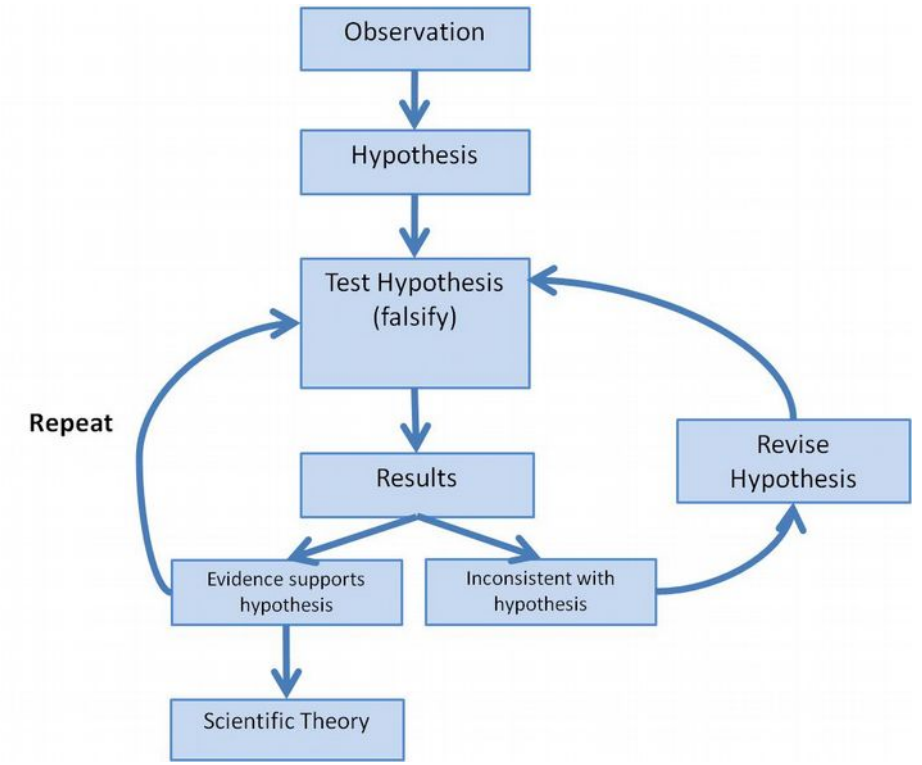
Colin Sauzé
Data Manager
National Plant Phenomics Centre
Institute of Biological, Environmental and Rural Sciences
Aberystwyth University

Overview

- Working in Science and Research
- How I got to where I am now
- Lessons from working with:
  - Biologists
  - Geographers
  - Engineers
  - Naval Architects

What is Science?

- "Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence." - The Science Council
- Most of what you've done so far is really engineering.
- Debates about whether Computer Science is really a science
  - Its in a blurred boundary between science and engineering
  - Are novel algorithms science or engineering?
  - Is applying an existing algorithm to a new domain science or engineering?



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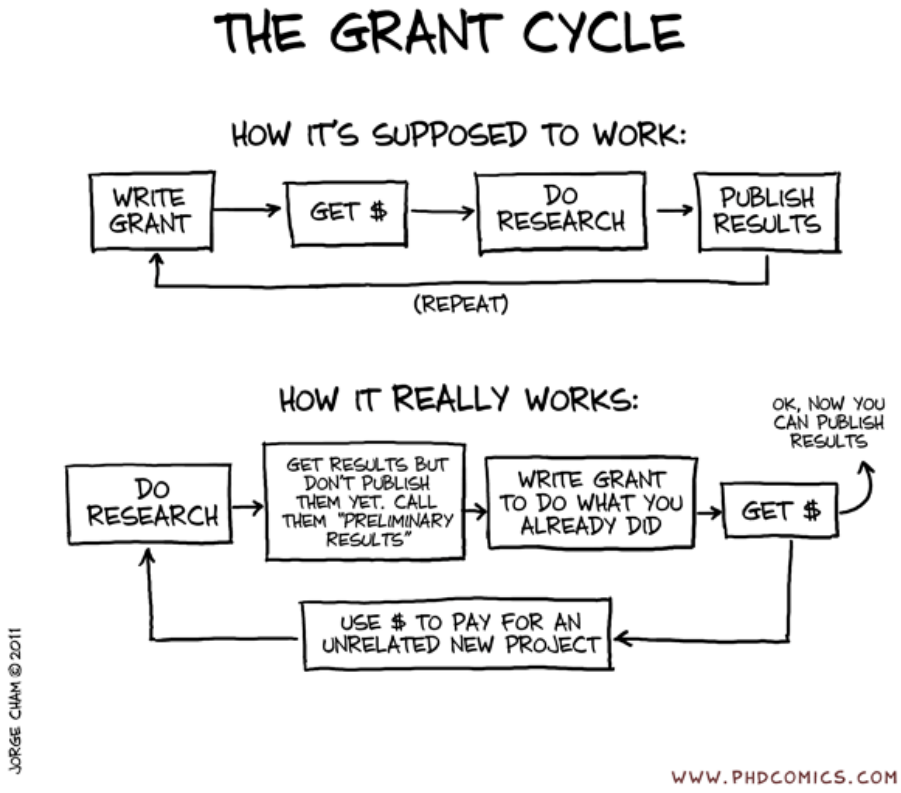
How science gets funded

- A lot of funding is for universities
- Some companies do their own research
  - Often very applied, results might not get widely disseminated
  - More on this later
- A member of academic staff needs to write a grant specifying:
  - What topics their research will address
  - The methods to be used
  - How and where they will publish the results
  - What impact the research will have
  - Who will be involved
  - What staff they will hire
    - Sometimes these can be explicitly named
  - How much money they want
- Funding body will rank applications and take the top few



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Research Funding - RCUK

- Set of research councils (RCUK)
  - £3 billion budget between them
  - Each responsible for different areas
- Compsci related councils:
  - EPSRC – Engineering and Physical Sciences Research Council
  - NERC – Natural Environment Research Council
  - BBSRC – Biology and Biotechnology Research Council
  - MRC – Medical Research Council
- Open to grant applications a few times a year
- Calls for specific areas they want to encourage
- Typical success rates around 20%, but biased towards more experienced applicants
- Increasing pressure to demonstrate impact, collaborate with industry.

Other Research Funding

- EU Horizon 2020
  - EU's science budget
  - Grants need collaborators from multiple EU countries
  - Lots of very specific calls, often industry linked
  - €80 billion 2014 to 2020
  - €13 billion for European Research Council, open ended grants, less applied.
- Innovate UK
  - Supports R&D activities in companies
  - Often with help from universities, but companies must lead the project.
- Science charities: Royal Society, Royal Academy of Engineering, Nuffield Foundation, Wellcome Trust, Leverhulme Trust
- Direct from other public bodies (e.g. NHS, military, DEFRA)
- Direct from companies

Strange things about research funding

- Universities operate a Full Economic Cost model when asking for funding.
  - Includes overhead costs for service departments, building maintenance, energy etc.
  - Rates vary from university to university, but usually around the same as researchers salaries.
- Most grant money is earmarked based on the proposal.
  - Most for wages, possibly some for travel or equipment.
  - Can be difficult to spend money in ways you didn't say you would.
- A little of this money goes back to PIs (or their department's budget) in a “discretionary fund” aka slush fund.
  - They can spend it on travel, equipment or employing staff.
- Some grants are just for equipment.
  - Universities often buy equipment and then don't have the people to run it.
  - Equipment only grants are easier to get.

Publishing Research

- Researchers (everyone from PhD students to professors) can write papers detailing their research.
- Papers should be peer reviewed
  - Conference programme committee or journal reviewers
  - Reviewers usually know who author is, author doesn't know reviewers' identities
- Papers published in journals, conference proceedings, online.
  - Fee charged to anyone subscribing (e.g. university libraries).
  - Papers often behind paywalls, $30-50 to view.
  - Open access, pay a fee (usually $2000) to stop the charge

Conference vs Journal papers

- Conference papers
  - Presented at a conference by the author
  - Deadline typically a few months before conference
  - Printed (or sometimes online/CD/DVD) conference proceedings of all papers
  - Usually less scrutiny than journal papers, more willing to accept preliminary results.
  - Reviewers are a committee organised by the conference organisers, usually planning to attend or previously attended.
  - Single shot review process.
- Journal paper
  - Published in a scientific journal
  - Reviewers selected as relevant people in the field. Sometimes nominated by the authors.
  - Reviews often bounce back and forth a few times
    - Can be a very long and slow process
  - Journal editor makes final decision
  - Journals have impact factors, describe how often they are cited.
    - Nature/Science = 30
    - Average CS journal = 2 or 3

http://www.phdcomics.com/comics/archive.php?comicid=1200

Publishing and the REF

- REF = Research Excellence Framework (formerly RAE)
- Measures quality of research
- Run every 5 years. Next one in 2020.
- Mainly looks at what journals you published papers in.
  - Also considers the impact of the paper
  - Staff nominate 4 outputs (usually journal papers) to be assessed
- Assesses research quality of every member of academic staff.
- Papers are the currency of academia.
- Departments awarded money based on REF score
- Staff often hired based on REF potential
- Some universities poaching entire teams to boost REF
- Similar schemes in other countries

Typical Career Path

- PhD student
  - 3-4 years, 3 years funded, 1 year to complete after funding expires.
- Post Doctoral Research Associate (Postdoc or RA)
  - Often in 3 year chunks.
  - Sometimes less, sometimes up to 5 years.
  - A member of academic staff will be the Principal Investigator (PI)
  - Not REF returnable (without promotion), but might write papers that the PI returns.
- Post Doctoral Research Fellow (RF)
  - You are the PI
  - Employed on your own research project
  - Anything from 1-8 years
  - Harder to get, very prestigious
  - REF returnable.
- Lecturer/Senior Lecturer
  - Responsible for research and teaching
  - Can submit project proposals
  - Usually employs teams of RAs and PhD students
- Reader/Professor
  - Heads large research projects/teams
  - Might still teach
  - Expected to brings in lots of research money

What can I earn?

- PhD student (with full funding)
  - £13k+ tax free stipend, no council tax
  - No student loan repayments
  - Effectively £17-18k
  - Opportunity for additional work, often paid around £15 per hour
- UK Universities have a standardised national pay scale (HERA)
  - Graded 1-10
  - Grade 1 = £14k, Grade 10 = £50k
  - “Spine points” in each grade. Each is a 3% pay rise.
  - Generally rise by one spine point per year until you reach the top of the grade.
    - This has been stopped in other public sector areas. Might stop in universities one day.
  - Additional inflation pay rises, but often below inflation.
  - You will never get a bonus!
- Post doctoral research associate: (usually grade 7) - £32,277 to £37,394
  - Usually for at least 3 years after completing a PhD
  - Same pay grade for junior lecturers
- Research Fellow (sometimes grade 8) - £38,511 to £45,954

How I got where I am now: Undergraduate and PhD

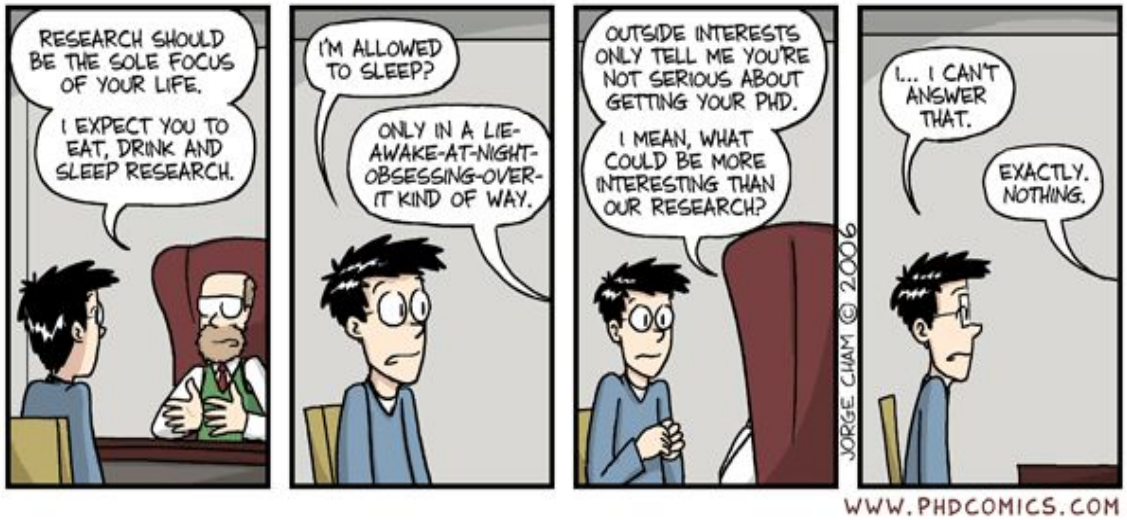
- 2000-2005: MEng Software Engineering
- August 2005-March 2006: Web Developer for University Careers Service
- Tried to register as PhD student in October 2005
- Registered part time in April 2006 under “staff regs”
- March 2006-September 2007: Computer Officer for Computational Biology Group/Robot Scientist. Working half time.
- Applied for university internal PhD funding 3 times in 2005,2006 and 2007.
- Spent much of 2006/7 applying for other funding sources.
  - 2 EPSRC and 1 EU grant.
  - All rejected.
- University PhD funding September 2007-December 2009.

PhD and related work

- Biologically Inspired Power Management in Sailing Robots
- Built several sailing robots
- In 2005 there were less than 5 in the world!
- Watched (and influenced???) this field as it developed during my PhD
- Ran a transatlantic race
  - We were first to enter in 2010
  - Nobody has succeeded yet.
- Lots of public engagement projects
- Travelled to conferences in Bristol, Guildford, France, Portugal, Austria, Canada and Plymouth.
- Felt like I needed undergraduate degrees in compsci, naval architecture, engineering,biology, maths and electronics.

Typical day as a PhD student

- No such thing as typical!
- Mixture of:
  - Meetings with research group and supervisor
  - Teaching/Demonstrating
  - Building/Fixing robots in the lab
  - Coding at my desk
  - Public Engagement Activities and Open Day Demos
  - Field Work
  - Writing Papers
  - Going to Conferences
- Hours can be highly variable
- Very different from being an undergraduate.
- Much closer to being a member of staff.
  - You get a desk in a shared office
  - Access to the coffee room
  - Keys to the building
- Things with hard deadlines tend to come first
  - Can push actually doing PhD work to the bottom of the list
- Phdcomics.com is scarily accurate.



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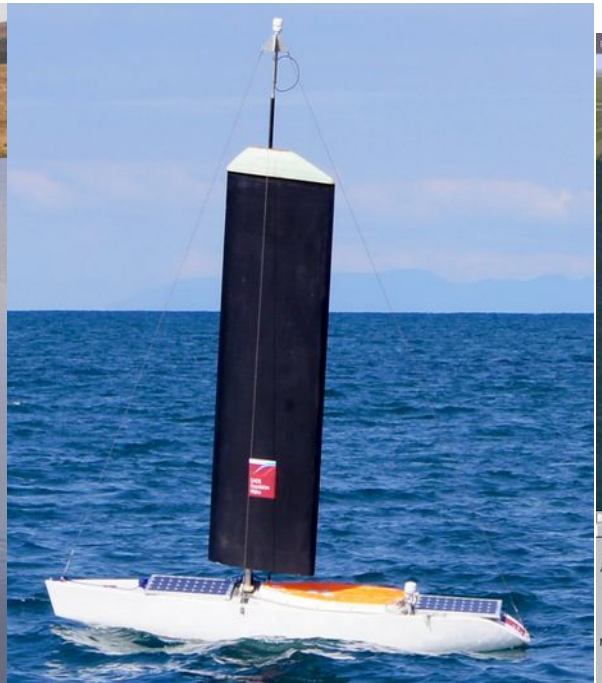
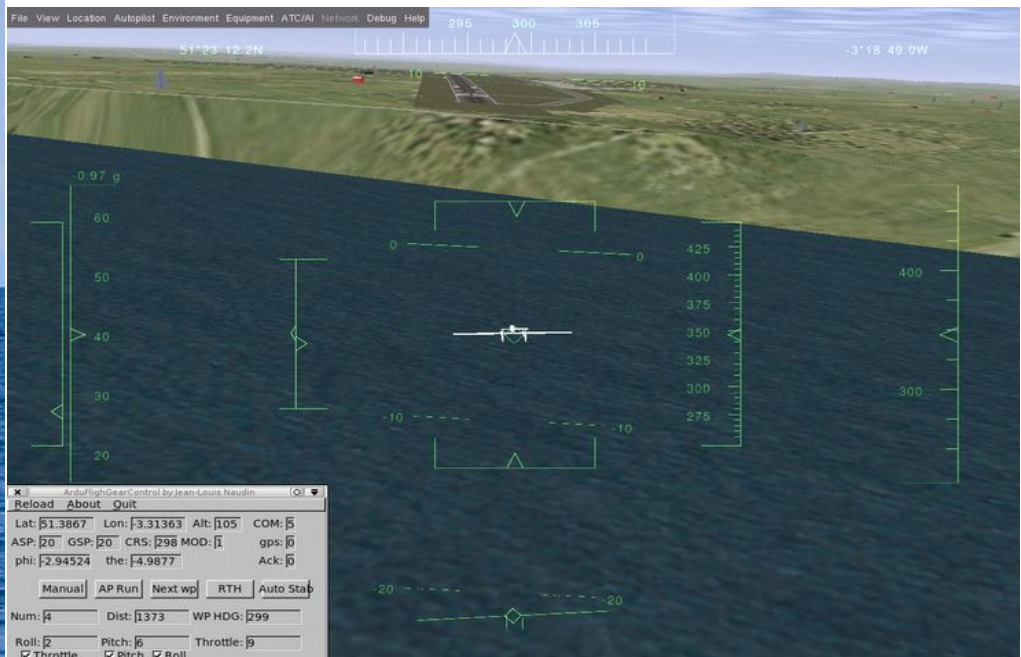
How I got where I am now: Early Post Doctoral Jobs

and the curse of short term contracts

- Jan 2010 – June 2010: Finishing/Writing up PhD. No Funding. Living on savings and demonstrator work.
  - Had saved £1000 from (almost) every PhD stipend payment.
  - Spent a lot of it in this time.
- June 2010 – September 2010: 3 month software engineer job with Amanda.
- September 2010-September 2011: 1 year post doc funded by EADS Foundation Wales
  - EADS Foundation Wales = Collaboration between Welsh Government and EADS
    - each funding 50%.
    - EADS gets first refusal on any IP generated
  - Originally supposed to be a 3 year project
  - Reduced to 1 year with “good chance” of additional funding
  - First non-EADS project the foundation funded.
  - Second project they ever funded.
  - Rules made up as they went along.

Post doctoral Work



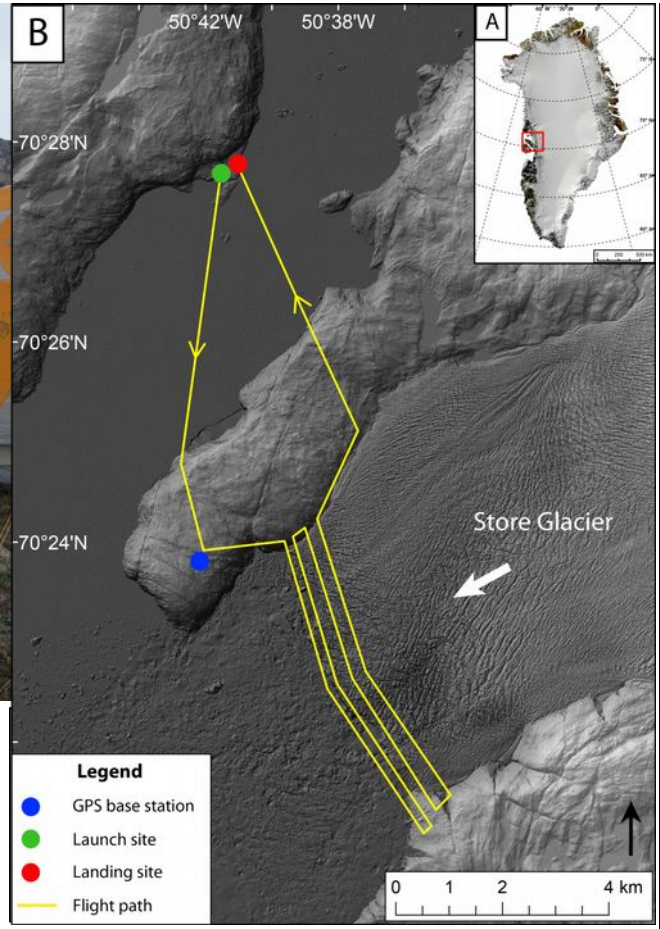


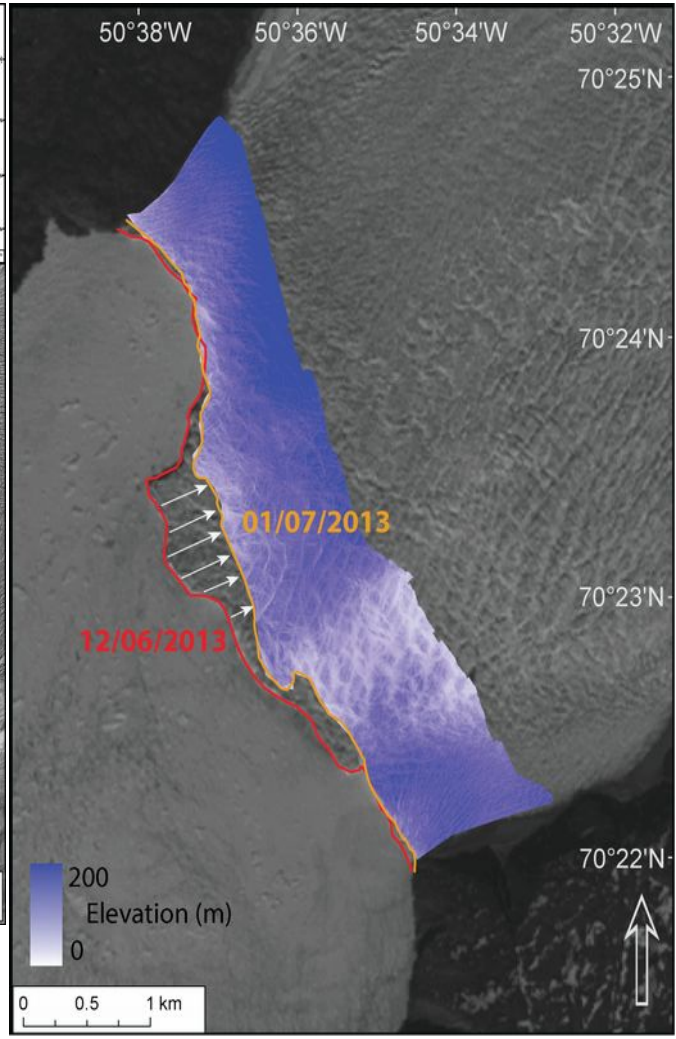
Post Doctoral Jobs – 2011-14

and the continued curse of short term contracts

- September 2011-November 2011
  - EADS Foundation Wales indicate they will extend funding
  - But slow to do so
  - Managed to find temporary job in research office developing a repository for scientific papers.
- November 2011-November 2013: Second/third phase of EADS project
- Paid half time from slush fund November 2013-March 2014
  - Also did some lecturing/demonstrating in November. Zero hours contract, but with lots of hours.
  - Overall reduction in pay.
  - Demonstrating pay often takes 2 months to arrive.
- December 2013 – March 2014 Half time employed by Chris Price/Neal Snooke on ASTUTE project to work on UAVs with geography.

UAV's in Greenland





Post Doctoral Jobs – Since 2014

no more short term contracts??

- March 2014 – June 2015: Academic Liaison Officer with Software Alliance Wales.
  - Teaching courses to industry
  - Finding industrial dissertation projects
  - Bought out to do some teaching.
- June 2015 – Present: Data Manager with National Plant Phenomics Centre, IBERS
  - Mixture of:
    - System Administration
    - Software Engineer
    - Hardware Engineer
    - Research Scientist

The National Plant Phenomics Centre

- Phenomics = Physical Characteristics of Plants
- Large facility for running 600 plants on conveyors.
- Automated watering and weighing.
- Daily (RGB/IR/NIR) imaging and 3D laser scanning.

Lessons from working with Other Disciplines

- Computer Science is often a tool to solve somebody else's problem
- We may encounter some novel challenges in doing so. This is where the actual Comptuer Science research component comes from.
  - Should avoid just doing engineering for them.
- You know how to fix their computer, but that's not why you are there.
- Scientists often spend lots of money on expensive software/hardware.
  - Often without a complete plan or the skills to use it.
  - Needs extra software to integrate it
- Each discipline has its own way of doing things.
- Everyone assumes everyone else knows something about their area.
  - Often causes confusion when they don't.
  - Some real examples later
- People who truly understand multiple disciplines are rare.
  - Having degrees in other areas is useful.
- Good software engineering principles and collaboration tools are a good idea.

Working with biologists

- Comic sans is an acceptable font
- Manual processes are OK
- Calibration of sensors and confirming values is really important
  - But sample sizes are small
- A lot of measurements are done by eye
  - They don't always know what they want to measure
- Some of them can (sort of) code, but
  - Its often in MatLab, R or even Visual Basic.
  - Recent trends towards Python.
- Impact factors in biology journals are very high
  - Impact factor of 5 considered low
  - 5 is almost unachievable in Computer Science

Communicating your requirements

How do you measure the height of this wheat plant?

- Height of tallest stalk?
- Height of tallest tiller (productive bit)
- Computer vision algorithms for plant height at NPPC differed from manual measurements
  - Turned out they were measuring different things

Working with Naval Architects

- Computers are magic black boxes
- A few software packages do most of their calculations
- Field is split between the experimentalists and theorists
- A lot of understanding is just instinct in their heads.
- They have very good attention to detail when building things.
  - The tiniest bump makes a performance difference
- Like to produce big tables of parameters

Working with Engineers

- They really can't code!
  - But often need to
- They think Lab View is really good
  - (I call it Scratch for Engineers)
  - It costs £3,000 per copy
  - It plays nicely with National Instrument's very expensive hardware
  - We can achieve the same with an Arduino and free software. They pay because they don't have the coding skills.
- Their maths is better than most Comp Sci's
  - Some of them like to find uses for it.
  - Some of them overuse it.
- People who can code and understand engineering are very valuable to companies like EADS
- My childhood obsession with planes and flight simulators paid off!

Working with EADS

- Very technology dependent company
- Worked with “Innovation Works”, an internal R&D group.
  - Works closely with universities.
  - But doesn't hire many PhDs
  - Much smaller than equivalent units at other companies (e.g. Lockheed Skunkworks, HP Labs)
- Research from Innovation Works has to be passed onto to a “business unit”
  - They want demos that they can use to sell to business units.
  - Very focused on having things that make nice demos
- TRLs – Technology Readiness Levels
  - 1 = basic idea, 9 = working product
  - University Levels 1-5
  - Innovation Works 3-6
  - Business Unit 7-9

Working with geographers

- They put things in extreme environments and break them
- Have lots of fun and expensive toys
  - Looking for next toy to use
- They are very good at data management and manipulation
  - Less keen on disseminating their data, code etc.
- Often accused of “just colouring in”. But these days they use computers, laser scanners and UAVs to do it for them!
- Some of them can code. Often in Python.
- Interesting attitude to risk
  - http://www.bbc.co.uk/programmes/p0107v5j
  - http://www.bbc.co.uk/programmes/p0107vlt

How do other disciplines view compsci?

- “Are you from Information Services?”
  - “Can you fix my computer/printer?”
- The people who magically join everything together and make it work.
  - And get more out of hardware
  - Scientific equipment vendors don't understand integration
  - Wish for more open source solutions from academics
  - Selling £100k hardware, you can afford free software
- The people who can program properly

Recommendations if you want to work with scientists

- Learn scientific languages and tools: R, Matlab/Octave, Python/Matplotlib and Labview.
- Learn some statistics
- Learn something about other sciences
  - Popular science programmes, books, websites etc can offer a gentle introduction
  - Undergraduate text books for more in-depth knowledge
  - Suitable GCSEs and A-Level may help
- Do a PhD