



ENGINEER
NEXT

NIDays

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Reflections on “LabVIEW as a Common Language”

An Effective Tool for Resolving the Community-Building : Skill-Embedding
Tension in Taught Master’s Learning

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MSc Teaching Philosophy and Design



MSc programmes at Cardiff PHYSX

- MSc Physics
- MSc Astrophysics
- MSc Compound Semiconductor Physics
- MSc Data-Intensive Physics
- MSc Data-Intensive Astrophysics
- 2x new MSc programmes for 2018/19



What is an MSc for?

Where do our students want to go?

- Academia
- Industry
- Other (teaching, journalism, etc)

How does an MSc get them there?

- Development
- Conversion
- Other (CPD, career change, etc)

What does a “typical” MSc student look like?

- Second-class BSc, aiming for a PhD
- Little or no experience outside of university

Conflicting demands?

What do supervisors want?



Practical and research skills

What must PhD students do?



Engagement and community

A community-building : skill-embedding tension

Practical and research skills

- What the student must **do**
- Emphasis on the **individual**

Engagement and community

- What the student must **be**
- Emphasis on the **group**

Resolving the tension: student identity and ownership

1. Provide a dedicated space: **environment**
2. Unify the students' sense of purpose: **ethos**
3. Develop the skills: **core modules**



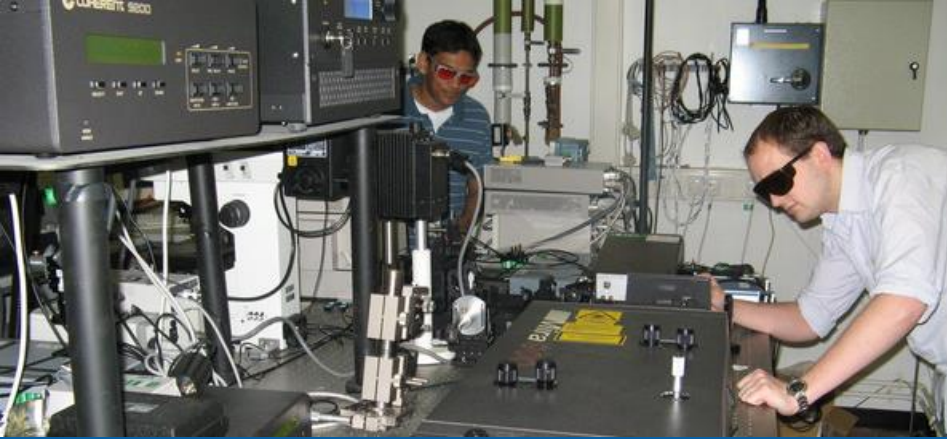
Conference / study room



Teaching laboratory

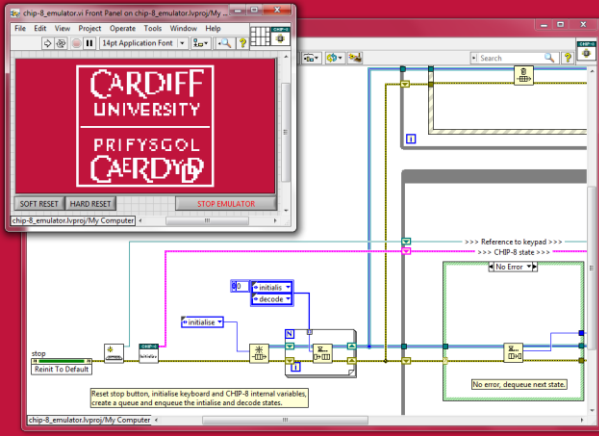
Providing the **environment**: dedicated MSc teaching facilities

- Learning in the round
- Guaranteed student access
- Student ownership of space
- Daily staff contact



The research group **ethos**: a unifying sense of purpose

- Engagement through partnership
- Student ownership of learning
- Peer support and accountability
- Collaborative learning



Developing skills: unique **core modules** (MSc Physics)

- Autumn semester: student-lead microprojects, LabVIEW core
- Spring semester: research and study skills, advanced LabVIEW elective
- Collaborative learning: **community building**
- Problem-based learning: **embedding skills**
- Student ownership of learning: **engagement through partnership**



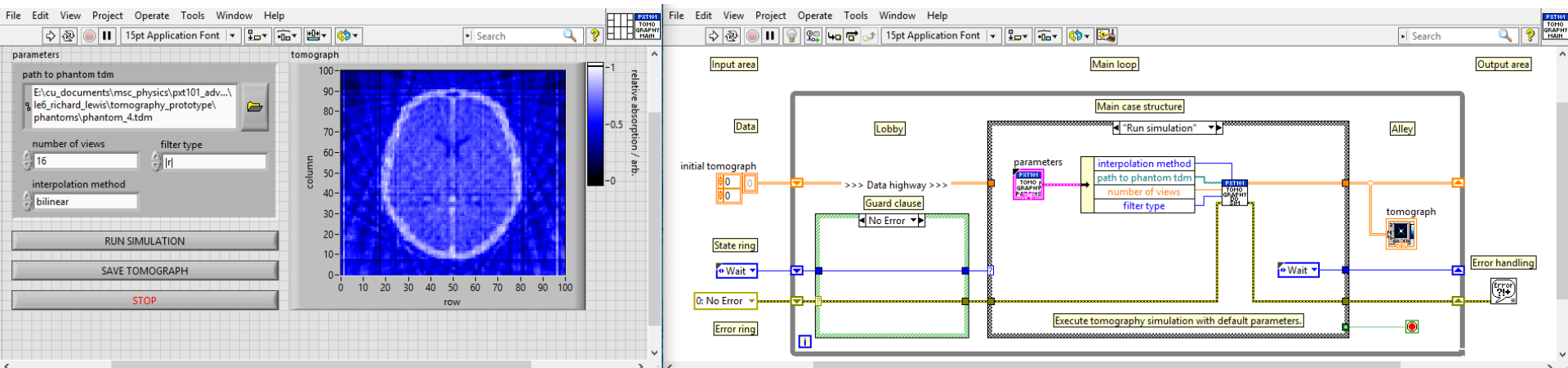
MSc student feedback

“The MSc core modules were easily the best and what I learned the most in. Having our own floor really enhanced the community feel.”

“I really enjoyed how close the cohort has become - spending so much time around each other definitely creates a support network which is helpful.”

“I enjoyed the independent work aspect and the fact that the module used a real-world approach on how physics research is conducted. It was enjoyable and the teaching was first rate.”

LabVIEW as a Common Language



Why teach LabVIEW? Why not Python or something else?

- Immediately useful with Express VIs and NI hardware
- Shallow initial learning curve: can get to GUI-driven applications easily
- Rapid development allows more time for concepts
- It's weird (in a good way): levels the field, acts as a point of reference

PXT101 “Advanced Experimental Techniques in Physics”

Introduction to LabVIEW

- Problem-based learning
- Hands-on activities weekly
- Focus on using LabVIEW practically
- Strong emphasis on good style
- Software development best practices

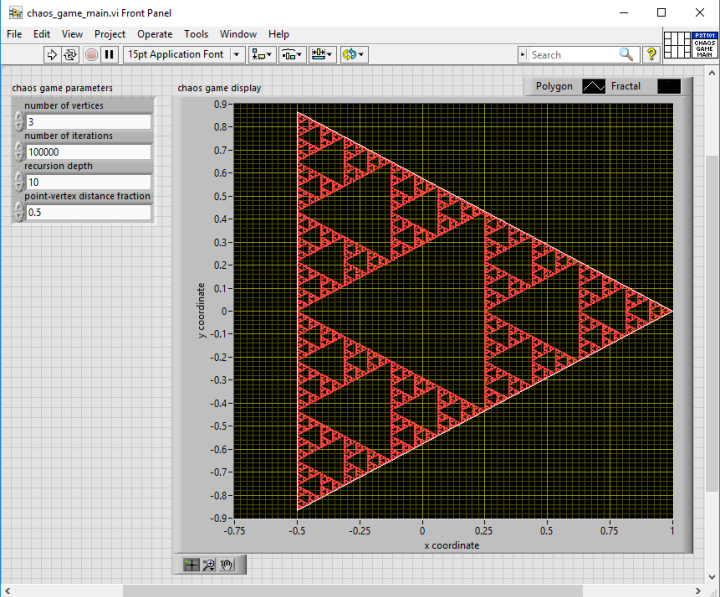
From “hello world!” to GUI-focussed queue-based state machines and laboratory automation in 10 weeks

Student-lead micro-projects

- Complete student ownership
- Objectives negotiated
- Weekly group meetings
- Weekly lab diary submissions
- Final report and presentations

Mandatory LabVIEW aspect, developed in the latter half of the semester.

(Approximately CLAD standard)



Exercise example: *Chaos Game*

Context

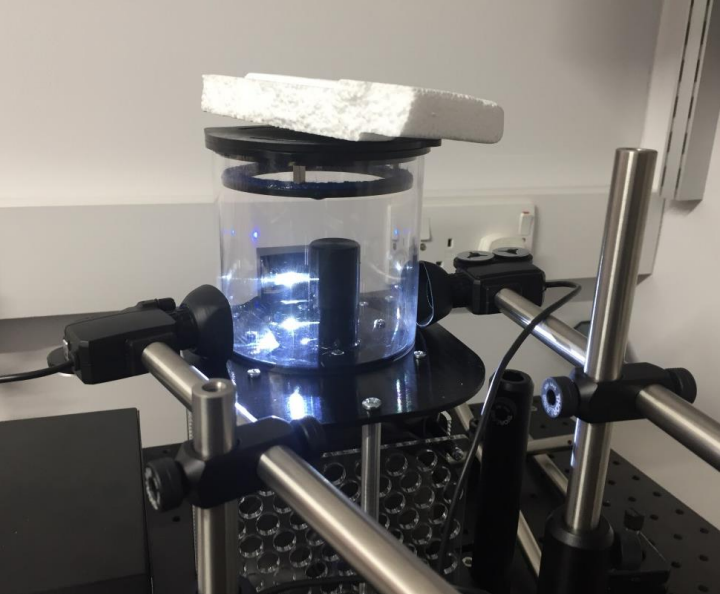
- Group assignment over weeks 5 and 6
- Course consolidation point

Aims

- Generate functional specification of application
- Assign tasks, develop as a group, bug-fix
- Deliver application on-specification and on time

Outcomes

- All groups returned working code
- One group avoided a bug in my example code!



Micro-project example: *Cloud Chambers*

Context

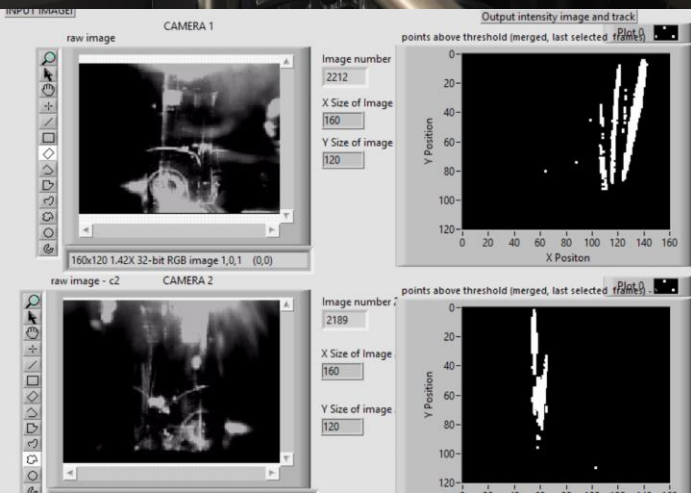
- Compact demonstration devices
- Part of £93k *Quarknet Cymru* NSA grant
- Students have zero LabVIEW at project start

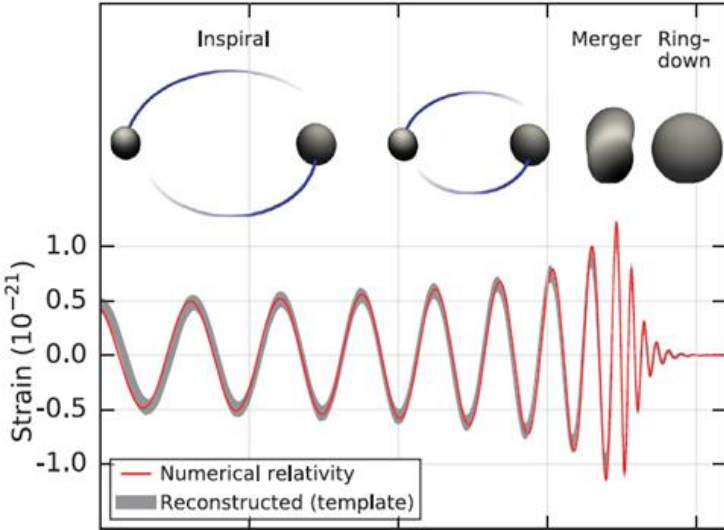
Aims

- Upgrade cloud chambers with cameras
- Maximise visibility of tracks
- Use LabVIEW to recreate tracks in 3D

Outcomes

- Automatic track extraction (2 cameras)
- Initial work on 3D track recreation (3 cameras)





Micro-project example: *LEGO-LIGO*

Context

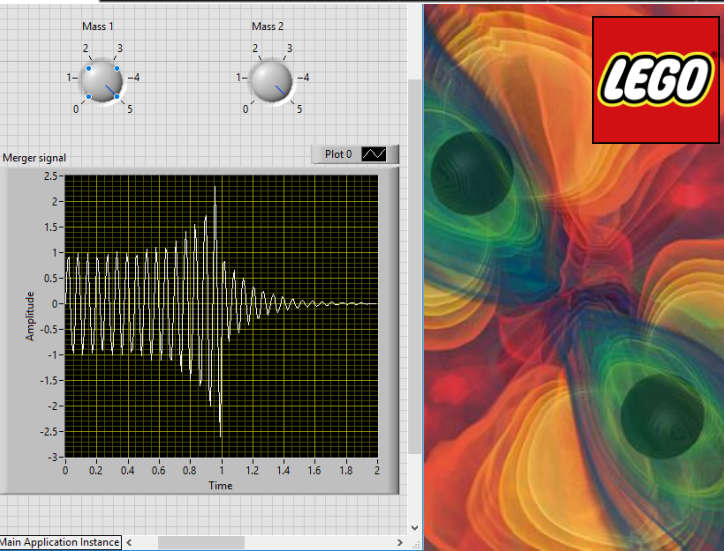
- £3.8k STFC Public Engagement Small Award
- Recreate LIGO in LEGO for outreach(!)

Aims

- Create mechatronic LEGO diorama of LIGO
- Demonstrate proof-of-principle

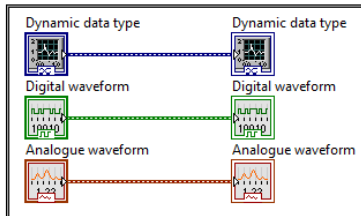
Outcomes

- Diorama essentials constructed
- Working mechatronics and GUI
- “Toy” waveforms used for proof-of-concept



Waveforms and time stamp data types
(Waveforms are clusters, time stamp is numeric)

Waveforms
DDT waveforms can be coerced to use the operations intended for digital and analogue waveform data types, as well as using their own signal manipulation operations.

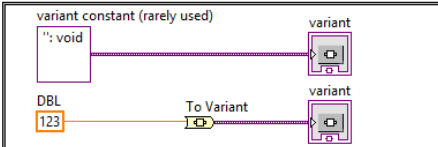


Time stamp
The default value is zero seconds since 12:00 a.m., Friday, January 1, 1904, Universal Time [01-01-1904 00:00:00].

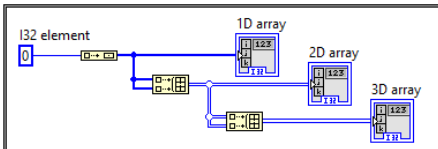


Variant data type, array and queue data structures
(Wire thicknesses and colours vary)

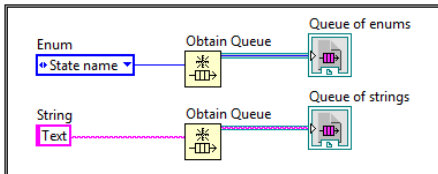
Variant
A data type that contains metadata identifying the data type and value.



Array
Wire colour matches that of the element data type. Thickness increases with number of dimensions.



Queue
You can enqueue anything but all elements of a queue must have the same data type. Wire colour will change to reflect the element data type.



LabVIEW as a common language?

Promotes collaborative learning

- Bug-fixing in group meetings promotes sharing of hints, tips and best practice
- Graphical nature more intuitive; easier to grasp the gist of **well-written** code

Rapidly accessible, solves real problems

- From about week 5, students can be told “code it in LabVIEW and find out”

Weird in a good way :)

- Requires a certain type of lateral thinking
- Students often sketch G code on the board, even when discussing other languages!

MSc student feedback

“The way the LabVIEW language was explained definitely improved the total progress I made”

“Excellent quality teaching supported by good module resources. Good hands-on programming experience.”

“The coding aspects of the MSc have been insanely useful for my new job.”

“[LabVIEW] has proved extremely useful throughout my MSc course”



Summary

- Unique approach to MSc teaching
- Embeds skills and builds a PGT community
- Bridges culture between UG and PGR
- Does not compromise quality or thoroughness

Read the NI EIA award-winning case study:
<http://sine.ni.com/cs/app/doc/p/id/cs-17230>

Get in contact:

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Top-level MSc design: building towards independence

- Core: community, skills, LabVIEW
- Electives: research-lead teaching
- Direct scaffolding of core modules to summer research project
- Degree of instructor-lead material **tapers off** throughout core modules

