

Garage Physics

draft proposal 21 September 2012
by Duncan Carlsmith

Garage Physics is an unstructured open lab, a sandbox, for UW-Madison undergraduates in physics to experiment and to be creative. This proposal describes the concept and implementation details.

Garage Physics Concept:

The Garage Physics lab is an active space for both self-study and mentoring intended to support the Makerbot /synthetic biology/garage-physicist/entrepreneur generation of students joining our campus, in particular those joining the physics department and our undergraduate University Physical Society. It will offer UW-Madison undergraduates in physics a place to explore existing educational experiments in more depth, play with physics demonstrations and equipment, learn safe procedures and laboratory techniques, and ultimately explore their own creative ideas and conduct research of their own, all in an unstructured safe environment.

The lab space offers standard educational laboratory experiment setups on a rotating or request based schedule for novices. It provides for intermediate level students drawers of electrical components and wire and soldering equipment, electrical meters and oscilloscopes for electrical signal and circuit explorations, surplus equipment such as cellular phones to tear apart and reassemble, and computers and software such as Labview and FPGA program software along with interface equipment and external sensors and controls. The sandbox will serve novice and intermediate level physics students who want to play with an experiment or piece of equipment without the time constraints of a traditional laboratory course. Students might play with advanced features of an oscilloscope, program an FPGA to play a game or control an external system, or assemble a simple optical system, alone or with help from friends. Finally Garage Physics offers free workspace for more advanced students to assemble novel experiments, to explore some specific interest alone or in a collaborative way. An example might be the study of a chaotic circuit or optical technique. By hosting all levels of students, mentoring is facilitated. Other creative activities to be supported include development or extension of undergraduate educational experiments for the structured lab courses, and following up on an assigned honors project.

The Garage Physics experience complements Department of Physics structured for-credit lab courses and research/job experiences. Students using the space will learn essential safety procedures and how to manage a lab space. Importantly, they will work collaboratively and imaginatively, and think for themselves. The space will also serve as a training ground for students joining a research activity to learn skills not addressed in the for-credit laboratory courses.

Facility:

The Garage Physics lab requires minimally a space for roughly six lab tables, power and good lighting, storage cabinets, a blackboard for brain storming, and some desks.

The Sterling Hall location B651 has been identified as the candidate location. This space is presently used largely for storage and for some server testing. It contains surplus lab tables, desks, and cabinets, a sink with water, power strips along three walls, and it has a blackboard and phone jack. The use of this space for Garage Physics is endorsed by the department space assignment committee. The room identified is near the Museum development/Lecture Demo development lab and the Wonders of Physics development lab, so there may be some overlap and collaboration that is fostered by physical proximity. This assignment will be reviewed by the committee after a period of 2 years.

Equipment needs:

Lab instructional manager Brett Unks has in hand a variety of surplus equipment (oscilloscopes, computers, optical components, obsolete experiments, breadboards, FPGAs and whole experiments), enough already to

outfit the sandbox. A solicitation will be made to faculty to donate additional surplus equipment on an as-needed basis.

Student interest:

The 2012 officers of the undergraduate University Physical Society (Physics Club) enthusiastically endorse Garage Physics. An electronic survey of student interest sent to physics majors and to the class of Physics 247 in September 2012 resulted in 127 respondents of which 62 were extremely interested, 57 possibly interested, and 5 doubt they would use the space. A typical comment is "...this is the best idea in the world!!!" The report of the survey in its entirety is attached.

To incentivize students, an annual undergraduate research or laboratory development award may be offered, and contributions to the management or organization of the space and activities will be recognized by a "Distinction in the Major" award.

Staff:

Brett Unks will serve as manager of the Garage Physics space on a drop-in and as-needed basis.

Safety and security:

The Garage Physics lab is available during normal building hours. Access is restricted to students who have completed basic safety training including electrical safety. The training is administered through an on-line course hosted on the LEARN@UW system and accessible via self-registration by anyone with a Wisconsin NetID. Professor Duncan Carlsmith, Research Program Manager Aimee Lefkow, and Instructional Lab Manager Brett Unks are designated instructors in this safety class. Additional safety modules including laser safety are already available and others may be developed and required as needed. Aimee Lefkow will provide a key to the Garage Physics lab to a student who completes the required training and, in addition, a short interview with Brett Unks concerning their goals. A buddy system will additionally ensure the safety and security of students in the Garage Physics lab. Violators of the buddy system will be denied access.

Duncan Carlsmith
Professor of Physics

My Report

Last Modified: 09/18/2012

1. Please indicate your level of interest in a proposed physics "garage physics lab/sandbox," an unstructured lab space for students of physics to play with equipment, circuits, and software, to explore standard labs in more depth at their leisure, to develop novel experiments, and to be creative.

#	Answer		Response	%
1	Extremely interested		62	50%
2	Possibly interested		57	46%
3	I doubt I would use this space		5	4%
	Total		124	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.54
Variance	0.33
Standard Deviation	0.58
Total Responses	124

2. I am specifically interested in (check all that apply)

#	Answer	Response	%
1	Rotating standard 200 level labs	27	22%
2	Rotating standard 300 level labs	36	30%
3	Rotating standard 400 level labs	41	34%
4	Circuits, analog and digital (operational amplifiers, chaotic circuits, computers, FPGAs)	85	70%
5	Classical optics (lens, light sources, microscopes, telescopes, interference and diffraction)	63	52%
6	3D printing	79	65%
7	Labview programming	42	35%
8	Atomic physics	72	60%
9	Biophysics	30	25%
10	Condensed matter physics	52	43%
11	Astrophysics	74	61%



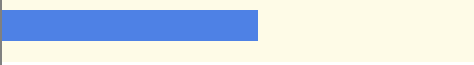

Statistic	Value
Min Value	1
Max Value	11
Total Responses	121

3. I wish to request a setup to explore the following topic that interests me

Text Response
NMR interests me.
Superconductivity
Electromagnetism
Parallel Universes
gravitational lensing
astronomy
Optical aberration, Data analysis, Computer circuits
bubbles, tesla coils
How about 1950's and 1960's particle physics laboratory? Can we set up a bubble/gas/cloud chamber?
Fluid dynamics, acoustics
Analog audio processing
Play with circuit designs
3D Printing
FPGA and microcontrollers with decent compilers, programmers and debugging.
I have an idea for a project that I want to make on a 3D printer. Can there be a mini-shop space too with bandsaws and drill press to make things.
N/A
Superconductors
Alternative methods to perform standard experiments. Improvisable science.
magic tricks
Anything quantum! In AP physics one of my independent labs was to prove the photoelectric effect which was one of the best and most meaningful physics experiments I have ever done.
Space and everything in it
astrophysics
Circuits

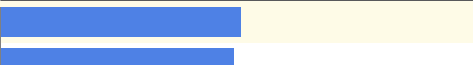
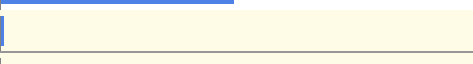
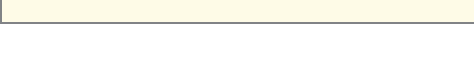
Statistic	Value
Total Responses	23

4. The hours I would hope to use the space are (check all that apply)

#	Answer		Response	%
1	Weekday morning		10	8%
2	Weekday afternoon		46	39%
3	Weekday evening		64	54%
4	Weekend daytime		49	41%

Statistic	Value
Min Value	1
Max Value	4
Total Responses	119

5. On average, the total number of hours per week I might use this space is

#	Answer		Response	%
1			62	50%
2	2-5		60	49%
3	5-10		1	1%
	Total		123	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.50
Variance	0.27
Standard Deviation	0.52
Total Responses	123

6. In terms of staffing, I would prefer

#	Answer		Response	%
1	No staff need be present, just a buddy system		97	79%
2	A TA or lab support staff should always be physically present		24	20%
3	UPS officer always present		2	2%
	Total		123	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.23
Variance	0.21
Standard Deviation	0.46
Total Responses	123

7. I have the following safety concerns:

Text Response
I might not be comfortable being there alone.
I think we should have a brief safety tutorial before we're allowed to use the space
Electrocution
depending on what equipment would be in the space just the possibility of unknowingly breaking something
If anything that could easily be dangerous if only slightly misused is present then provide an easy to follow manual for it.
I'm not sure...
Maybe a guidebook or notes could be useful.
high voltage
None
Theft
N/A
Existence of proper safety equipment
That curiosity might be curtailed for fear of safety. I would love a waiver to sign.
Must have EMT present for magic tricks involving swords or fire.
N/A
None
Physicists should be smart enough to not kill themselves, if they aren't its on them
Breaking of equipment

Statistic	Value
Total Responses	18

8. I am aware of a similar space on campus, or would like the use of the garage physics space to be coordinated with the following resource:

Text Response
Chemistry might have something like this. I'll check.
N/A
COE Student Shop
student machine shop
N/A
None

Statistic	Value
Total Responses	6

9. I just want to add that...

Text Response
This is just a test response by Carlsmith.
I LOVE SCIENCE
This is a great idea to promote intrinsic motivation to understand the keynotes of physics.
this sounds fun
Best idea ever.
I am a senior right now. I do not know how much I would use something like this in the next year, but if it were available to me earlier, I would have certainly used it.
I could see grad students wanting to prototype a research-based function, such as trying to figure out if a circuit will work for my hardware project. But, I don't see the students I taught using this; they found the labs a waste of time.
Note: The above question on hours has radio buttons, which doesn't allow checking multiple options.
...this is the best idea in the world!!!
The hours of use question is only letting me check one bubble, but I would be willing to use the lab space any time of day on week days or weekends.
I don't think you can click multiple times, but anytime besides weekday evenings would be fine.
I'd love to have a place to play with some circuit designs I thought of while taking the circuits class, but never had time in lab to do so.
The question "The hours I would hope to use the space are (check all that apply)" only lets you check one.
This sounds like a great idea!
This is an awesome idea!
Although I may not use the space much, I think it is a great idea for students.
N/A
Perhaps other programming options could be offered (text-based, not just LabVIEW)
This is such a great idea!
Wonderful Idea! I pray for wonderful execution...
THIS IS SUCH A COOL IDEA, hats off professor Duncan
I am almost done building a 3d printer that I wouldn't mind using to help create some public printers (Brett can probably guess who this is if you're interested)
VENI VEDI VICI !
This sounds like it would be a very fun and useful tool for physics students to have at their disposal.
I am not really sure what this would be for but I hope my survey responses help
N/A
This is a great idea for facilitating fun projects and curiosity in physics
This is a great idea.
Do this. It would be so awesome.
This will be beneficial for all of us that have to wait until their senior year to do actual physics

Statistic	Value
Total Responses	30