Hard and Soft 2009
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OneX – Making On-line Experiments accessible for teachers and students

In many disciplines at school and university students conduct experiment to learn key fact hands-on. Teachers expend considerable effort to make these experiments doable and meaningful. Our contest task is to use the power of the ordinary PC with a specially designed interface, to enhance the experiment experience for students, to make designing and setting up experiment easier for the teacher, and to show off our work in a spectacular way to the public.

There are four interlinked parts to the task:

1. An inexpensive microcontroller based interface for real world analogue and digital signals, linked to a PC via USB; the OneX box.
2. A web browser based environment for carrying out experiments, and for teachers to design and set up experiments. This environment should suitable for students and teachers from any discipline and require minimum computer literacy skills; the OneX environment.
3. Two, or three, demonstration experiments from different disciplines. One, described below is compulsory, one must be interesting and attractive (spectacular) for the general public. The third is optional, your opportunity to show special skills; OneX experiments.
4. Full on-line documentation for OneX.

To achieve high marks teams must pay balanced attention to all four parts of the task.

The Jury will assess your efforts by three means: first, we will visit you in your lab on Wednesday to look at work in progress and again on Friday morning (or possibly late Thursday afternoon) to see you finished (or nearly finished) work, second, your contribution to the public exhibition of your work early on Friday afternoon and finally, your submitted on-line “documents” that supports your design and experiments.

Here follows a more detailed description of the elements of the task:

The **OneX box** should provide sufficient programmable analogue and digital input and output signals to link to a wide range of experiments and should connect to the PC via USB. It may be used in conjunction with other PC peripherals such as web cams, scanners et cetera.
A key requirement is that the OneX box should be inexpensive; to encourage this you will be supplied with a PIC from the PIC 18F2455 family which costs only about €5. (You are allowed to use other devices if you wish, but your solution must still be inexpensive.)
A second key requirement is that the OneX box should be as idiot proof as possible, you must pay attention to protecting its input/output circuitry from damage and to providing easy to use and easily identifiable connections to the experiments.

The **web** browser **environment** to activate the OneX box must isolate the user from all programming, and preferably provide an attractive graphical interface. A teacher

should be able to set up a new experiment and enter the experimental and analysis procedure that the students must follow easily, and it must be capable of allowing the teacher the option of local or remote experiments, or experiments that the students set-up for themselves. The system must also archive experiments for re-use, enable students to submit their work for assessment, and allow the teacher to give feedback and keep a grade-book. (Note that you are free to base your work on any open source tools that may useful.)

To demonstrate the capability of your system you will develop two or three **sample experiments** from different disciplines. One must be the temperature measurement and control experiment outlined below and one must attract the interest of the general public preferably in a spectacular way, the third is optional and is included to enable you to demonstrate special or original features of your design.

The compulsory demonstration, from our own field of electronic engineering and computer science, is focussed on **temperature measurement and control** through a set of linked experiments. It is easiest to describe the requirements by discussing the apparatus rather than the experiments. First, design and construct an oven where the heating is provided by a number of resistors driven by a controlled current source, include a temperature sensing element so you can build a feedback loop to control the temperature, the rate of heating and the temperature set point must be programmable. Second, in the oven there should be at least two electronic temperature sensing elements (such as: thermistor, diode, integrated circuit sensor, platinum resistance sensor) Set up additional circuitry (such as: Weatstone Bridge, instrumentation amplifier, current source) and design experiments to show how the sensors are used measure temperature and may be calibrated. You may include experiments that discover or illustrate the sensor principle of operation or physical law under which they operate. Finally, design an experiment to explore the basics of PID control using the oven temperature as the controlled variable.

The **second experiment**, drawn form a different field of study, requires you to design apparatus or conduct an experiment that will attract the general public. You can think of it as a marketing exercise for your design, or maybe it's the kind of display that could be used when your university or faculty has an open day to attract new students. The main feature here is "spectacle" it has to have some look or feature that will draw an audience. Some examples: Do plants respond to noise/music?: Weather station: Monitoring athletes: a Chemical reactor: Face recognition …….

As an **option**, in order to demonstrate special or unique features of your hardware or software design, or to demonstrate the skills of your team you may include a **third experiment** or set linked experiments of your choice. But remember, it must be from yet another field of study.

Documentation. You will have access to a web server on which to host your software, experiments, user manuals and any other information you think relevant, as a minimum you should include; the web environment, enough design and software information for others to be able to replicate your work, a teacher's manual, a student manual, and the experiment scripts. Details of access to the environment will be given to you later.
Finally, remember this is a contest, there can be only one winning team!

Good Luck,

Timothy Hall, President of the Jury.