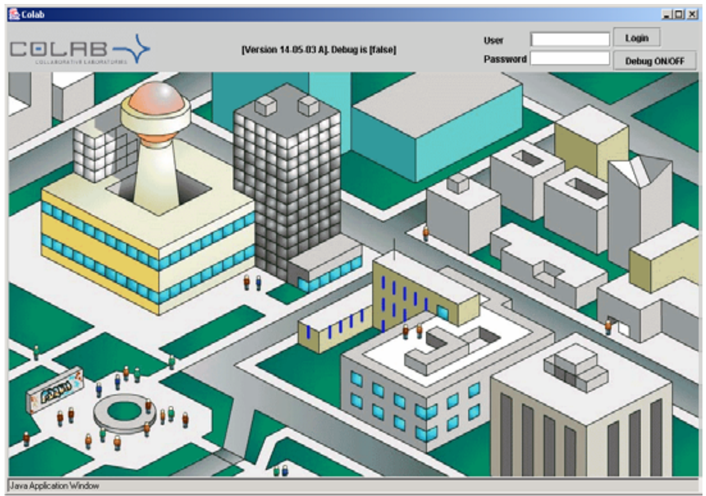
Co-Lab : Collaborative Laboratories for Europe

Co-Lab is funded by the European commission under project number IST-2000-25035.

http://www.co-lab.nl



A Project from the University of Murcia, Spain.

Co-Lab provides a new Web-based environment for collaborative inquiry learning.
In the Co-Lab shared workspace, learners perform experiments, discuss their findings, consult background literature, and construct and evaluate models.
For each of these processes, support tools are available in the environment to foster and enhance learning.
Co-Lab is particularly suitable to promote inquiry learning in the natural sciences at the upper secondary level and at first year in university.

Co-Lab provides strong support for an inquiry-based pedagogy. While inquiry learning is widely advocated, the lack of advanced resources and support has often hampered successful classroom implementation.
Co-Lab also supports student collaboration. Students from different schools, or even from different countries, can work together on scientific problems. Collaboration can take place during classroom hours, but students can also continue their Co-Lab session at home.
In addition, Co-Lab offers access to remote laboratories where students can work with equipment unavailable in school.

Curriculum materials

Co-Lab is designed for learning in the natural sciences at the upper secondary level and the first years in university. Content is available for four domains: water management, greenhouse effect, mechanics and electricity. For each of these domains, Co-Lab offers remote labs, background literature, teacher manuals and student instructions.

Water management and greenhouse effect are extensive courses that cover the richness of these interdisciplinary domains. Each course comprises several modules of different levels of complexity. Some modules are mainly physics oriented; others are more geared towards chemistry or biology. Depending on the number of modules taken, students spend 10 to 30 hours on a course. The electricity and mechanics courses are less extensive, requiring about five hours of student time.

System requirements

Co-Lab is fully JAVA-based client-server software. The client software is platform independent, and can be run from any JAVA Webstart enabled machine without further installation.
On a Microsoft Windows platform, requirements are a Pentium III at 800 MHz with 512 MB working memory and 1024 x 768 screen resolution.
The server software can be installed on a local machine in the school, or users can login to one of the Co-Lab project servers. In case of a remote server, DSL or better Internet connection is needed.

Key features

- Integrated tool suite for inquiry learning Data collection: **Remote labs** (including web cam), Simulations, and Databases. **Modelling**: Quantitative and qualitative dynamic modelling tool. **Visualisation**: Graph Tool, Table Tool. Idea writing: Graphical Whiteboard. **Collaboration**: Chat Tool, Control Tool (which allows users to keep track of who is doing what, and prevent interference between learners' actions). **Background info**: HTML Viewer. **Process support**: Process Co-ordinator and Report Tool.
- Web based Collaborate at a distance with students in different locations; connect to laboratory equipment in different institutions.
- Customisable New content can easily be added, and the layout of the environment can be fully adapted through a simple set up tool, using XML and HTML.
- Students can compare their own models and simulations with the results of a remote laboratory or with the results obtained by a simulation designed by an expert.
- Open source: The Co-Lab software and source code will be available free of charge.

Tools

Each of the four rooms, Hall, Theory, Meeting and Lab, has different tools which the students use to conduct different aspects of their inquiry. The tools guide the students throughout the learning process.

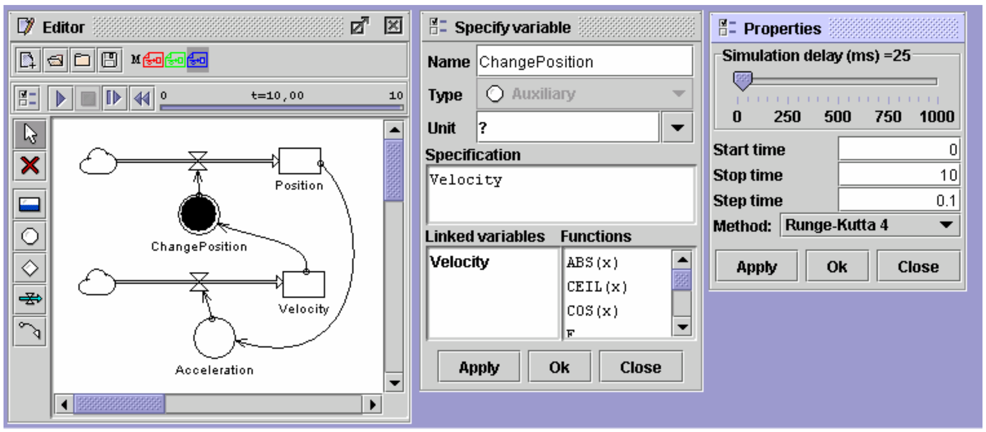
The different tools in Co-Lab are:

- Collaboration tool
- Modelling tool
- Data tools
- Process Co-ordinator tool

- Report tool
- Viewer tool

Model Editor

The current (Java) editor implementation can be used to draw quantitative and semi-qualitative models: the learner can draw a system dynamics (SD) diagram and fill in formulas or qualitative dependencies that define the specifications of values of variables



Model Simulator

- Execute Model Editor SD models
- Ordinary Differential Equations (ODE) solver
- Solve ODE systems using the numeric methods: Euler, Runge-Kutta 2, Runge-Kutta 4, and 4-5
- Use a simple and light expression parser
- "Execute" quantitative and semi-qualitative models

Development of an editor and solvers for systems of Ordinary Differential Equations

A Project from the University of Murcia, Spain

One of the goals of this project is to find common synergies for the use of software tools that support the pedagogy. Existing and well-established tools such as Modellus, Physlets, Ejs, and the OpenSourcePhysics platform address similar goals but from different perspectives and are suited for different users.

However, all tools of this sort will benefit if the underlying software is developed in such a way that the most advanced aspects of each of them can be brought together in a global ODE tool. This will cover their respective needs without duplicating the time and effort needed for each particular implementation.

A crucial task is the development a common visual editor for systems of ordinary differential equations (ODE) and of the corresponding set of solvers for these ODEs. This editor is very frequently needed in order to allow non-specialists to describe many phenomena from the physical sciences. This is of particular importance where the users of the tools are not necessarily confident mathematicians, as is often the vase among high school students. Standard solvers are then required in order to provide a numerical solution for these equations.

In occasions, however, problems arising from apparently simple models require the power of advanced, sophisticated algorithms. This is the case, for instance, when stiff differential equations are involved, or when the user needs to consider discontinuous events that affect the solution of a given set of differential equations.

For this reason, we propose devoting an amount of 10,000 Euros to fund the development of such common tools. This money will cover the cost of a programmer working for our project during the time needed to develop the necessary package in Java language.

Francisco Esquembre, from the group at the University of Murcia, will co-ordinate this task.

Physlets – Java applets for physics education

A Project developed in collaboration with Davidson College, USA.

Physlets, Java applets for physics education written at Davidson College, provide a resource for teaching that enhances student learning and interactive engagement. At the same time, Physlets are flexible enough to be adapted to a variety of pedagogical strategies and local environments. Because Physlets are based on html and open internet standards, Physlet-based curricular material is easy to translate and Physlet websites can be found throughout the world. The resulting curricular material falls into the following broad categories:

Illustrations are designed to demonstrate physical concepts. Students need to interact with the Physlet, but the answers to the questions posed in the Illustration are given or are easily determined from interacting with it. Many Illustrations provide examples of physics applications. Other Illustrations are designed to introduce and illustrate a particular concept or analytical tool. Typical uses of Illustrations would include "reading" assignments prior to class and classroom demonstrations. For example, consider the Illustration shown in Figure 1. The text of this illustration asks students to observe the position of the center of mass as they move a block. The narrative accompanying the illustration explains how to calculate the center of mass and discusses the difference between center of mass and center of gravity.

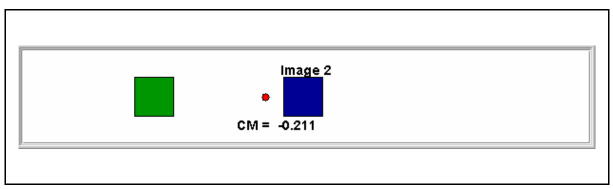


Fig. 1: Demonstrating the position of the center of mass between two blocks of unequal mass.

Explorations are more tutorial in nature. They provide some hints or suggest problem-solving strategies to students in working problems or understanding concepts. Some explorations ask students to make a prediction and then check their predictions, explaining any differences between predictions and observations. Other explorations ask students to change parameters and observe the effect, asking students to develop, for themselves, certain physics relationships (equations). Typical uses of Explorations would be in group problem solving and homework or pre-laboratory assignments. Explorations are also often useful as Just In Time Teaching exercises. Consider the Exploration shown in Figure 2. This exploration asks students to apply what they learned about center of mass in order to explain how to build a mobile. In the first part (Figure 2(a)), students must use the position of the center of mass (must be located somewhere below the support string) to determine the mass of the unknown block (green block). Students will continue to use conditions for static equilibrium to determine the masses of the orange and red blocks (Figure 2(b)). As they work through this exploration, they can verify their calculations because the position of the center of mass must remain beneath the support string from the ceiling.

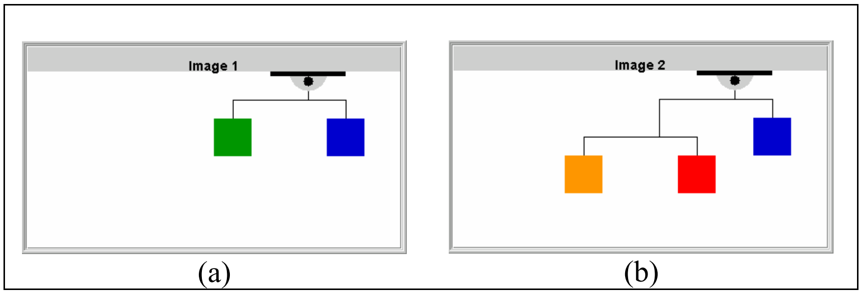
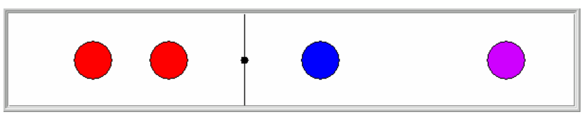


Fig. 2: Applying the concept of the center of mass to understanding how to balance a mobile.

Problems are the kinds of things you might assign for homework. They require the students to demonstrate their understanding without as much guidance as is given in the explorations. They are on many different levels (high school physics to calculus-based university physics). Some problems ask conceptual questions, while others require detailed calculations. Typical uses for the problems would be for homework assignments, in-class concept questions, and group problem solving sessions. Consider the Problem shown in Figure 1.3. Here students can use what they have learned by seeing how the position of the center of mass changes as a mass gets moved.



Problem 13.2: Four spheres are shown in the image. A blue sphere is half as massive as a red one and a purple sphere is twice as massive as a red one. Where should the purple one be placed in order for the center of gravity to be at the location of the black dot **(position is given in meters)**?

Fig. 3: Center of mass calculation.

Internet-based Science Experiments

A Project from the University of Oxford, England. The Universities of Murcia and Madrid also plan work in this area.

Central to this EU project is the assumption that students understand science better (and probably enjoy it more) when they actually do the science, rather than just learn it from a book.

This assumption reflects that most distinctive characteristic of science - that it is experimental. There seem to be clear advantages in teaching science experimentally, but it is not necessarily easy to do this. There are many reasons why, perhaps most notably the cost of scientific equipment. It can be more expensive to buy even a modest piece of equipment for a science class than to purchase an entire set of textbooks for a geography or a language course. As a result, the kinds of science experiments that children can carry out for themselves at school may be determined as much by what the school can afford as by what is academically desirable.

The aim of this project, lead by Hugh Cartwright in the Chemistry Department at Oxford University, is to place real experiments onto the Internet for use by students in schools across Europe. These experiments, which will involve interaction by students with real equipment, (and so will be neither simulations nor recordings of "stored" experiments), will be freely available to schools participating in the project.

The chemistry department at Oxford has experience in such experiments going back several years. However, previous experiments developed within the department have been intended only for internal use; the proposed new experiments, developed as part of our contribution to HSci, will be specifically designed to meet the needs of those learning science at school and first year university levels.

There are several important advantages to Internet-based experiments. They can

* Expand the range of practical work that students can perform by providing access to equipment not available in the student's own institution, so extending the practical curriculum;

* Provide access to hands-on experiments for students undertaking remote learning courses, and others who are unable to attend normal laboratory courses (including those for whom practical work presents difficulties because of disability);

* Spread the cost of the provision of experiments over a number of participating institutions, thus enhancing the cost-effectiveness of science spending;

* Allow students to engage in genuinely collaborative experiments;

* Encourage those who are comfortable with the Internet, but are reluctant scientists, to try scientific experiments in non-threatening environments, thus encouraging broader participation and interest in science;

* Promote efficient use of equipment by ensuring that remote experiments are used by the largest number of students possible;

- Permit the safe completion of experiments in remote, exotic or dangerous environments (such as inside volcanic craters or in other harsh environments).

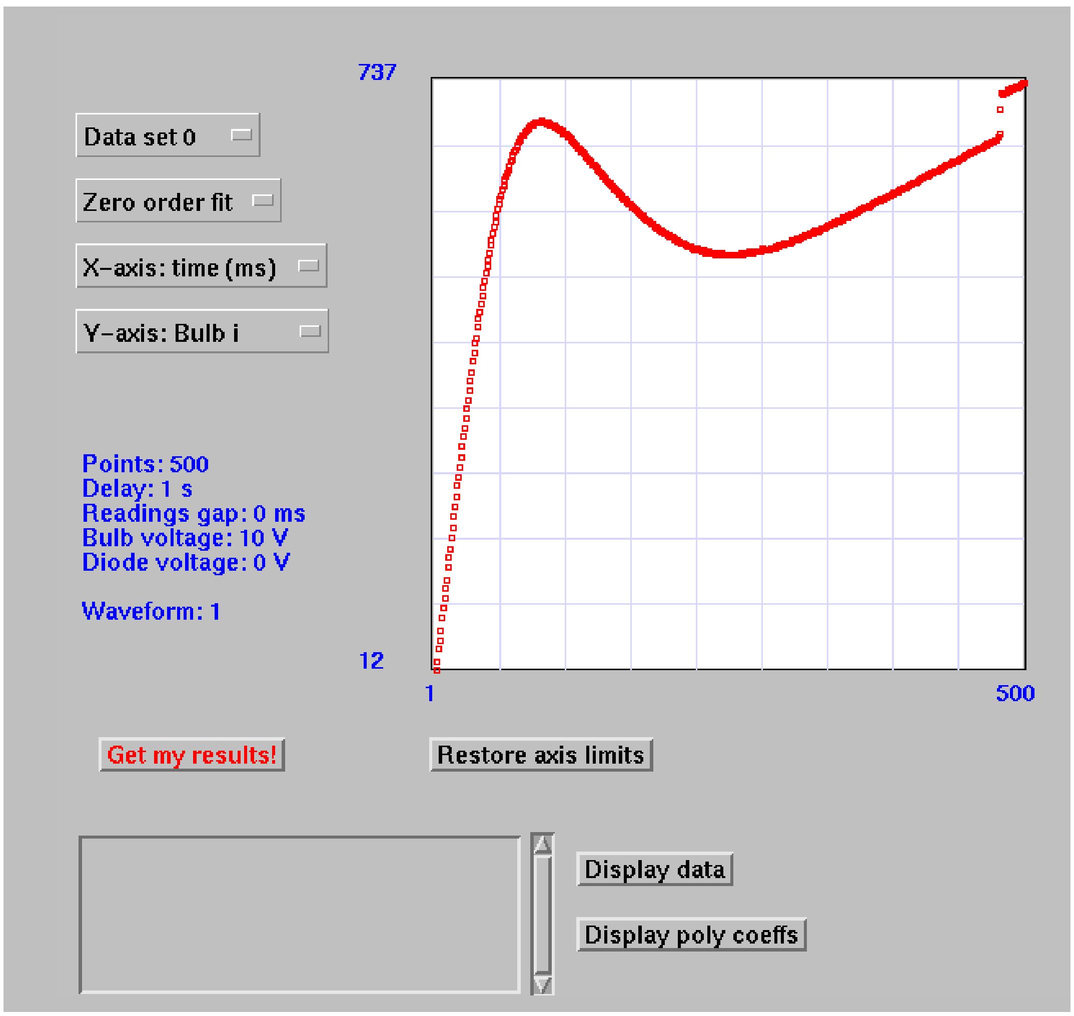


Fig 1. Data gathered during an Internet-based experiment. The figure shows the current through a small tungsten-filament bulb as a function of time, as the voltage is ramped up from zero.

During the course of the project equipment will be purchased and interfaced so that it is readily accessible through the web using conventional web browsers. A number of experiments will be devised, including some that are predefined to allow students to carry out set tasks, and others that are "open-ended", permitting users to design their own experiments. We intend to develop extensive support material for teachers, including background information on the equipment available and how it can be used, and also suggestions for experiments, how they can be incorporated into the science curriculum, and comments on how Internet-based equipment can be used to advantage in lessons.

We expect to institute a dual system of control: a queuing system and the ability for users to take complete control of equipment in real time. This dual system will help to maximise the number of students able to run experiments, and also provide direct and immediate control over the equipment where this is educationally desirable. While an Internet-based experiment might occupy a complete lesson, or longer, we anticipate that most experiments will actually take of the order of a minute or less to run. We are also devising strategies that will allow many experiments to be run simultaneously. Typical experiments with our present Internet-based experiment take between 0.1 and five seconds, so that we can accommodate several hundred users per hour. We therefore expect to be able to meet the needs of many schools.

Software will be developed in a modular form and made freely available. One of our aims is to prepare software which is sufficiently generic that science teachers at schools and Colleges can, if they wish, place their own school scientific equipment on the Internet and thus share experiments across Europe without the need for highly specialised computer training.

Anticipated timetable: Prototype experiments 4-6 months; completion of main experiments: 6-12 months; testing with schools: 6-18 months; preparation of curricula material: 12-18 months; general release of experiments (to schools beyond the Hsci project) 18-24 months.

Chemistry on the web

A project from the University of Oxford, England

The Chemistry department at Oxford University has developed one of the most extensive and heavily used chemistry web sites of any University in the world (www.chem.ox.ac.uk). The site attracts roughly 3 million hits per month, with users accessing data on research, chemistry courses, admissions and other aspects of chemistry at Oxford.

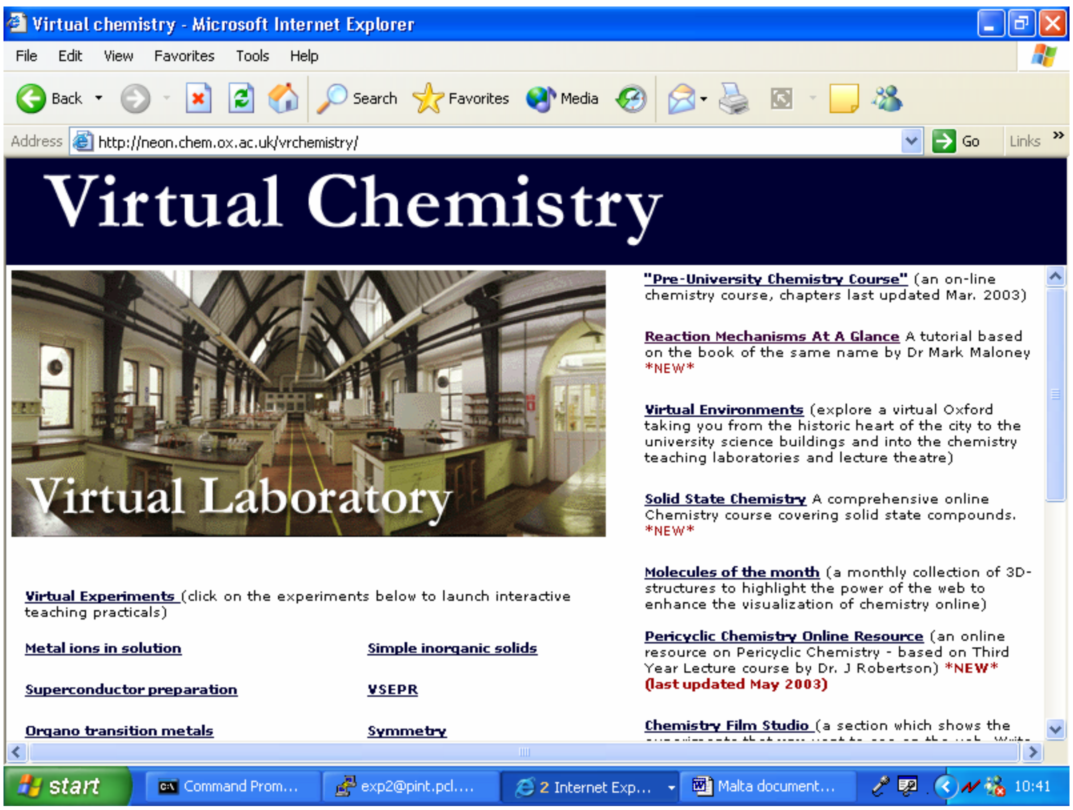


Fig 1. Home page for the Virtual Chemistry Laboratory at Oxford University.

A major feature of the site is the depth and quantity of teaching material available. The award-winning “Virtual Chemistry Laboratory” provides access to a range of teaching and educational material, and includes information of interest to users from upper primary level to University students.

The chemistry web site was not designed initially as a source of information for schools, but has developed to such an extent that it now represents a significant resource. We intend to make this resource easier to navigate for both teachers and students and to promote its widespread use within Europe. The professional design of this site, and the authority of its content are such that it offers the potential to be a major resource for science teaching in schools.

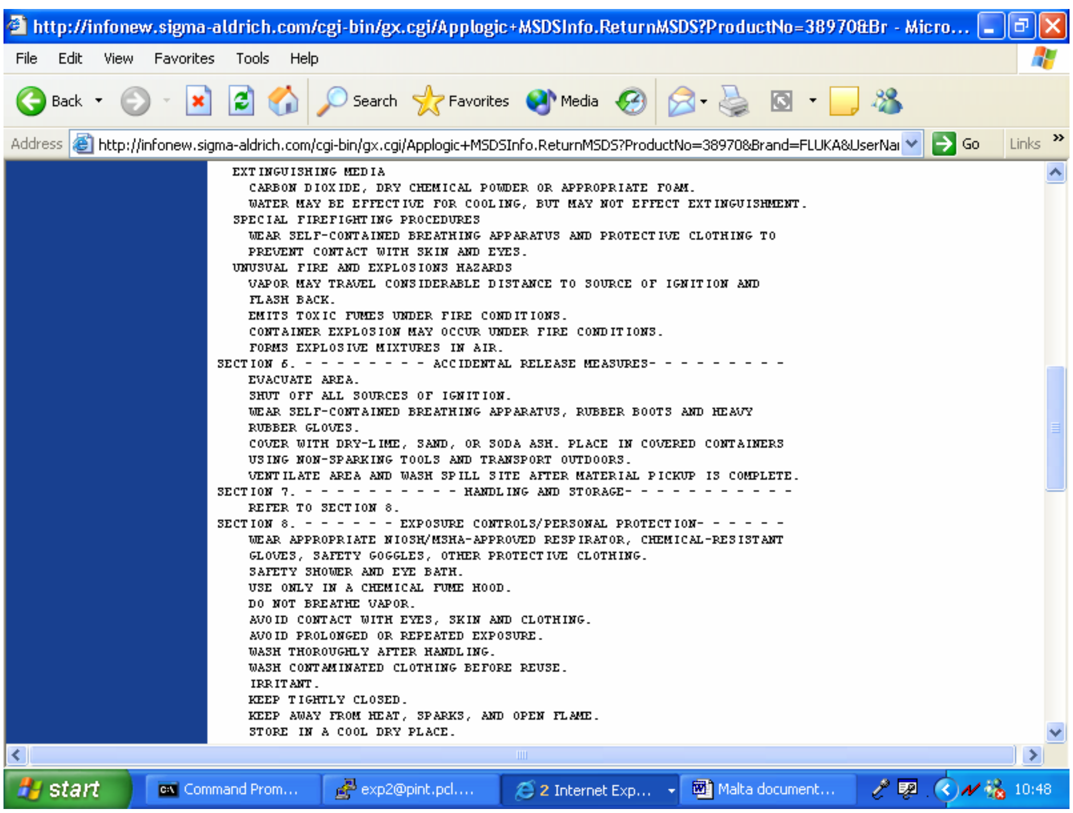
Anticipated timetable: 6-8 months.

Safe Hands-on Science at School

A project from the University of Oxford, England

"Doing" rather than "observing" science is educationally desirable, but brings with it risks. An experiment that is played as a video over the net, or merely described in a textbook presents no risk to the students who learn about it. An experiment performed within a school laboratory, using chemicals, electricity and other possible hazards may present genuine risks, which must be recognized and avoided by the teacher.

In this connection, ready access to high quality data on safety is essential. The web provides an excellent medium through which such data might be found and downloaded, but few suitable sources exist. Data on a very wide variety of chemicals is available through chemicals suppliers' web sites, but this data is generally in the "Standard 16-point MSDS" format, which is largely unintelligible to teachers and - especially - students. Similarly, information on the type of gloves necessary to protect against chemicals, the problems of peroxide formation in chemicals, the dangers of carcinogens and so on is hard to find, hard to understand or both.



EXTINGUISHING MEDIA
CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.
WATER MAY BE EFFECTIVE FOR COOLING, BUT MAY NOT EFFECT EXTINGUISHMENT.
SPECIAL FIREFIGHTING PROCEDURES
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO
PREVENT CONTACT WITH SKIN AND EYES.
UNUSUAL FIRE AND EXPLOSIONS HAZARDS
VAPOR MAY TRAVEL CONSIDERABLE DISTANCE TO SOURCE OF IGNITION AND
FLASH BACK.
EMITS TOXIC FUMES UNDER FIRE CONDITIONS.
CONTAINER EXPLOSION MAY OCCUR UNDER FIRE CONDITIONS.
FORMS EXPLOSIVE MIXTURES IN AIR.
SECTION 6. - - - - - - - - - ACCIDENTAL RELEASE MEASURES- - - - - - - - -
EVACUATE AREA.
SHUT OFF ALL SOURCES OF IGNITION.
WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY
RUBBER GLOVES.
COVER WITH DRY-LIME, SAND, OR SODA ASH. PLACE IN COVERED CONTAINERS
USING NON-SPARKING TOOLS AND TRANSPORT OUTDOORS.
VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.
SECTION 7. - - - - - - - - - - - HANDLING AND STORAGE- - - - - - - - - - -
REFER TO SECTION 8.
SECTION 8. - - - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - - -
WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.
SAFETY SHOWER AND EYE BATH.
USE ONLY IN A CHEMICAL FUME HOOD.
DO NOT BREATHE VAPOR.
AVOID CONTACT WITH EYES, SKIN AND CLOTHING.
AVOID PROLONGED OR REPEATED EXPOSURE.
WASH THOROUGHLY AFTER HANDLING.
WASH CONTAMINATED CLOTHING BEFORE REUSE.
IRRITANT.
KEEP TIGHTLY CLOSED.
KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME.
STORE IN A COOL DRY PLACE.

Fig 1. A screen shot of part of a typical 16-point MSDS data sheet.

Few web sites exist to provide safety information to schools. Those that do are generally commercial sites, for which cost may be a significant disincentive. Furthermore, access by students to such sites is generally by password, and schools may, quite naturally, be reluctant to issue the relevant passwords to all students.

The chemistry department at Oxford University maintains a large safety web site (ptcl.chem.ox.ac.uk/MSDS) containing in excess of 10,000 pages of safety information. This site is heavily used (typically around 350,000 accesses per week) by users from commercial, educational and other sites. The Oxford site, an initiative of the Physical and Theoretical Chemistry Laboratory, is intended to provide safety information in a readily-digested form.

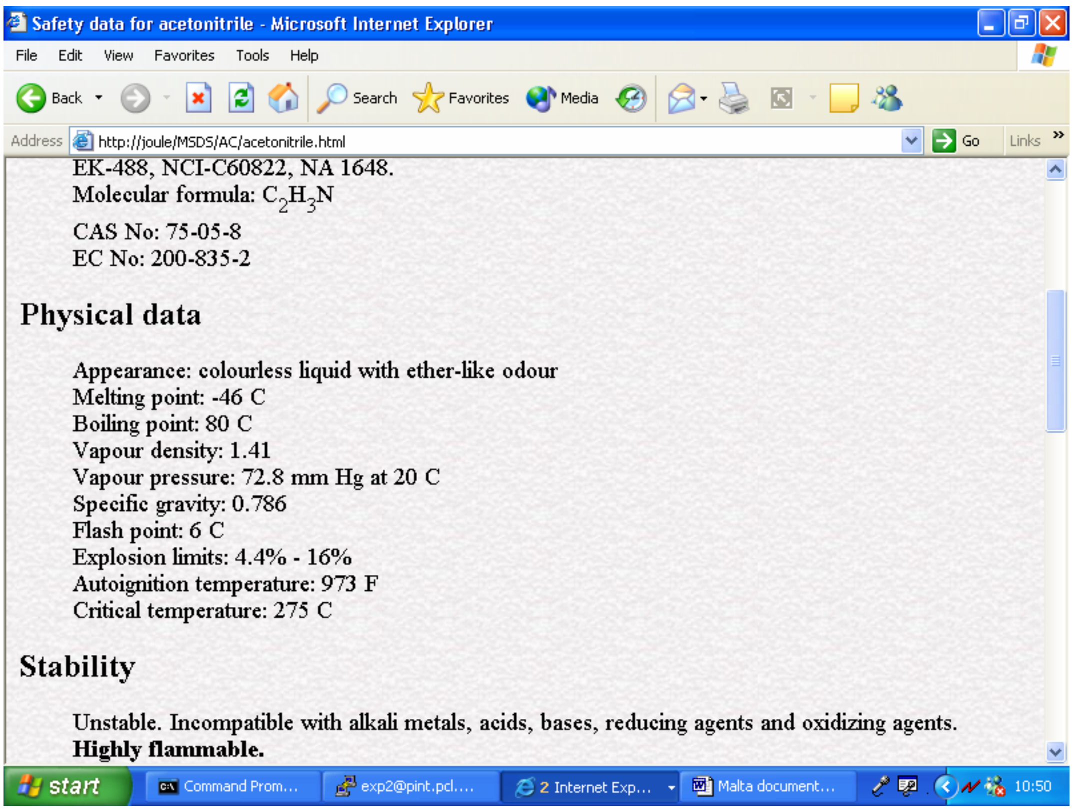


Fig 2. A screen shot of typical data from the Oxford Chemistry safety web site.

Although the Oxford site is constructed to be easy to navigate and simple to use, it was not designed with schools in mind. The need remains for a simple, free-to-access site that contains the data that schools need on chemical safety, prepared with the needs and levels of understanding in schools taken into account. Using the expertise gained in construction of the Oxford site, we intend to prepare a safety site containing data of use and relevance for schools, using formats that will be appropriate for teachers and students.

Anticipated Timetable: Initial phase (construction of site templates, identification of principles types of data to be posted, planning) 3-5 months; formatting and posting of data 6-12 months; further extension of site, publicity: 12-36 months.

Hands-on Physics in Slovakia

A project from the University of Bratislava, Slovakia (Marian / Zuzana: Is this right?)

(Marian / Zuzana – I have tried to rewrite what was sent to me by Jose Miguel. Could you check this please and let me know if you want to add / change / delete anything? Thanks. Hugh)

We intend to analyze the use of hands-on experiments during physics lessons in Slovak secondary schools. We will study how key activities based on active learning with hands-on experiments can be used to enhance the teaching of physics at the secondary school level.

As part of the project we intend to prepare a handbook of hands-on experiments that incorporate active learning with didactical help for science teachers. This material will be published as web pages or pdf files. In order to disseminate this material as widely as possible, relevant portions of it will be translated into English.

The Slovak group has eight years experience with life-long education for teachers. In the framework of the Comenius project we propose to offer a three day course oriented towards active learning with hands on experiments for teachers. This will include lectures and workshops covering the project results in field of hands-on experiments, and include results from other parts of the project.

In addition, the group expects to be able to translate some of the project materials for subsequent use by Slovak teachers.

The Slovak group will participate in the Comenius project as part of the CoLoS Association. The group has excellent contacts with the Faculty of Mathematics, Physics and Informatics in Bratislava, the State pedagogical institute in Bratislava, the Center for education and with some of the best gymnasiums in Slovakia.