University of the West of England, Bristol - http://www.uwe.ac.uk/ - UWE Home Page
SEEDS (Systems Engineering Estimation and Decision Support) -http://www.cems.uwe.ac.uk/amrc/seeds/ - SEEDS home page
Peter Hale - http://www.cems.uwe.ac.uk/~phale/ - Peter Hale Home Page

Semantic Web Modelling Centre of Excellence

HTML version - http://www.cems.uwe.ac.uk/amrc/seeds/semanticwebmodelling.htm
Word version - http://www.cems.uwe.ac.uk/amrc/seeds/semanticwebmodelling.doc

Introduction

The intention behind this document is to outline the concepts behind a possible proposal(s) for enabling users to program integrated applications. It is intended that tools are created to enable users to develop software in a way familiar to many, from their use of spreadsheets and web page creation tools. These tools would be available for use within a system(s) that manage software in the following areas - Knowledge Management, Decision support, and Simulation. Translations could be performed to communicate the ideas of users into information and code to solve problems of the type shown in figure 1.

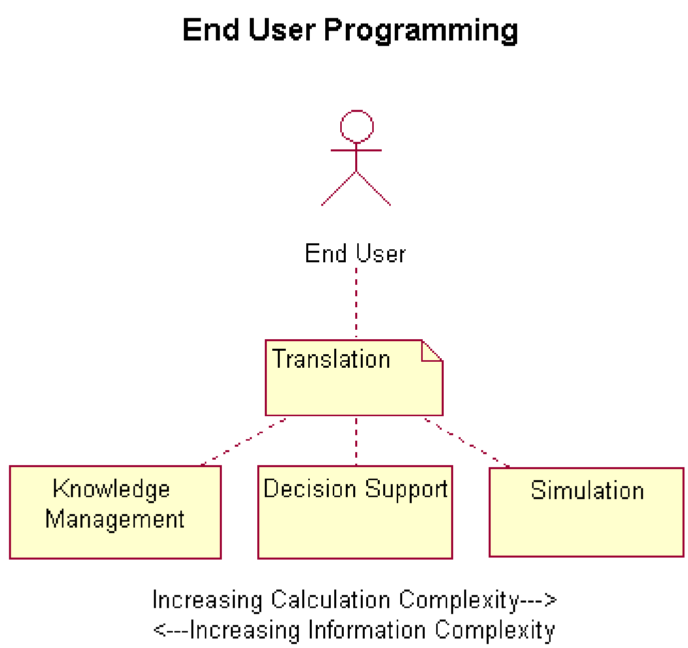

Figure 1 - End User Programming

Knowledge Management involves complex relationships between items of information, and decision support and simulation involve complex calculations. The system created could also be used to promote engineering to a sceptical public who see the profession as poorly paid and dirty. This problem is referred to later in this document. The project is likely to involve co-operation with the Institute for End User Computing http://www.ieuc.org/home.html. Other End-User Programming Consortiums are End-Users Shaping Effective Software (EUSES) http://eusesconsortium.org/ and Network of Excellence on End User Development EUD.Net http://giove.cnuce.cnr.it/eud-net.htm.

Figure 2 shows a plan for weaving Aspect-Oriented Programming http://aosd.net/ into translation that are provided for end-user-computer communication. Aspect-Oriented Programming can be used where certain tasks or properties do not fall within a natural hierarchy. These are called Cross-Cutting Concerns http://en.wikipedia.org/wiki/Cross-cutting_concern, these Cross-Cutting Concerns could be tasks the program needs to perform such as providing printing or security. This same technique could also be used for attributes that the program is to model for example if the program is to model an aircraft wings, a user with sufficient computer literacy skills can model the representation of the wing as a hierarchical diagram. The user can specify relationships between these items that make it possible to make calculations and decisions. For this model some parameters such as efficiency, weight and cost might not fit well in this hierarchical representation. So the parameters could be weaved into the program as cross-cutting concerns in a similar way to the computing parameters.

Once all parameters are weaved into the program it can be translated from a format most suitable to visualisation and user interaction (e.g. OWL Web Ontology Language) to users into a computer language such as Java for implementation. The program would calculate results, and these could be translated back to the user. These results would be fed back in the language used for user interaction and visualisation. The results could be visualised using stylesheets and interactive software, and where useful translated further into other kinds of representations other than trees e.g. SVG (Scalable Vector Graphics) diagrams and graphs.

Examples are at http://www.cems.uwe.ac.uk/~phale/.

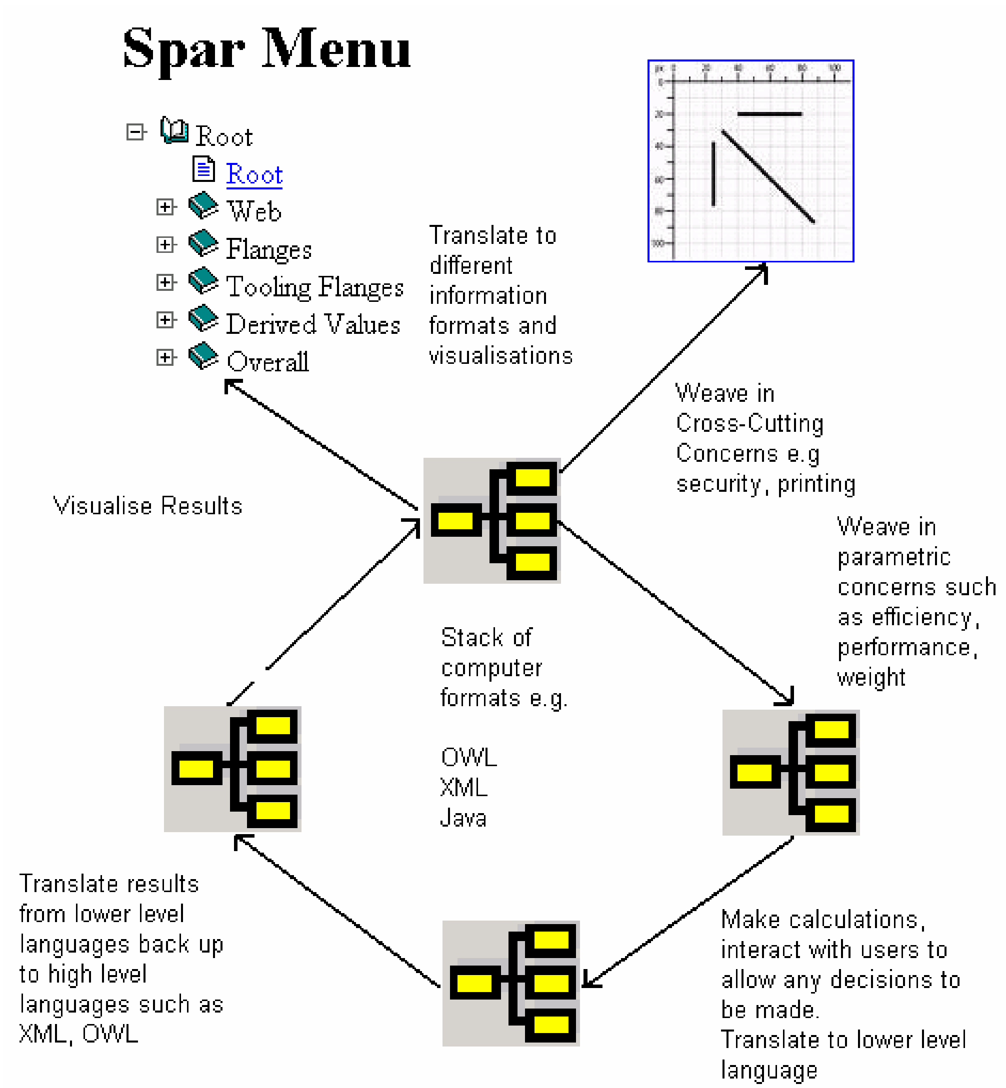

Figure 2 - Translation and Aspect-Oriented Programming

Highly interactive web pages that act like programs to provide a user interface can be used to provide an interactive user driven programming environment. These interactive web pages could be modelled on Visual Programming Languages such as Alice http://www.alice.org/.

About Us

The Systems Engineering Estimation and Decision Support (SEEDS) team is part of the Aerospace Manufacturing Research Centre (AMRC) at the University of the West of England (UWE). Our expertise is in applying techniques for managing, categorising and visualising information to provide decision support for design and manufacturing mainly within the aerospace sector.

The SEEDS team has undertaken a number of projects in recent years with key regional aerospace companies. These projects developed systems to facilitate management of design and cost related knowledge within those organisations, with the aim of using this knowledge to reduce the costs of manufacturing products. These projects have used a combination of proprietary software solutions and bespoke software developed by our team. Our experience has been that open standards in software and information representation are most effective in enabling software integration. The SEEDS team used this approach to investigate innovative ways of creating decision support models, and for searching and visualising their results.

What we are Proposing to Achieve

The SEEDS team have identified a number of new areas for research. These fall within a broad approach the SEEDS team calls User Driven Model Development. This research unites approaches of object orientation, the semantic web, relational databases, and event driven programming. [Frankel et al, 2004] explain the opportunities for and importance of this kind of research. Tim Berners-Lee defined the semantic web as 'a web of data that can be processed directly or indirectly by machines' http://www.w3.org/People/Berners-Lee/Weaving/Overview.html. The research proposed would examine ways of structuring information, and enabling processing and searching of the information to provide a modelling capability. The proposal would also investigate increasing user involvement in software, and investigate the possibility of providing templates to enable non-programmers to develop modelling software for the purposes that interest them. The advantages of increasing user involvement in software development are explained by [Olsson]. To assist in this project, it is essential that new ways of enabling collaboration between all those involved in software creation and use are investigated. For this purpose the SEEDS team promotes the idea of a Semantic Web Modelling Virtual Centre of Excellence.

Collaboration

The Semantic Web modelling virtual centre of excellence would be a project to encourage collaborators who have different research interests or are in different faculties. Also, this would open up collaboration to the general public and industry. The collaboration would consist both of research meetings and forums, and virtual collaboration through the web. This collaboration would involve translations of the ideas of collaborators into a user interface designed to capture these ideas. The structure created via the user interface would then be converted into code by recursive translations of the ideas through a layered architecture into computer code. This form of collaboration would be modelled on the 'open source' method of co-operation where source code and explanations are added to a web site and comments and improvements would be encouraged. Some examples of this form of co-operation are the Wikipedia collaborative online encyclopaedia http://en.wikipedia.org/wiki/Main_Page, the Mozilla Firefox browser development http://www.mozilla.org/ and the Semantic Web Environmental directory (SWED) http://www.swed.org.uk/swed/about/.

Our research has shown an open standards web driven method of collaboration to be effective in making it possible for organisations and individuals to become involved in projects who otherwise could not. [Aziz et al.] examine how open standards software can assist in an organisation's collaborative product development. The intention is to further the research of others into the approach of web based collaboration, and use semantic web software and techniques to achieve this. This approach is outlined in [Ciancarini et al.]; [Huang and Mak]; [Kim et al.]; [Li]; [Morris et al.]; [Nidamarthi et al.]; [Reed et al.]; [Zhang et al.]. The above research reinforced our view that this is a robust approach.

The intention is to create an online community that can provide free software for modelling and education. The advantages of open source collaboration are that as well as allowing researchers to co-operate and work together on research where they share an interest; it will also allow the untapped potential to be developed of those who do not have an official research position. This could include students, people employed outside the academic environment, retired people and amateurs' who have useful expertise. Astronomy, for example, has harnessed skills of this very diverse range of people to make new discoveries. The expertise provided by anyone involved could be in providing feedback on usefulness, or ease of use of software, as well as actual involvement in software development. This means feedback would be sought from users of software even if they were not software experts. Anyone interested in participating could subscribe to an email list, which would ensure they were kept informed of developments, meetings, and forums, both for web based and real world participation. Researchers would benefit the community by providing modelling and education tools online and on CDs.

The modelling centre would bring together experts in engineering, systems modelling, computing, and Human Computer Interaction. This could also hold regular seminars on the subject of World Wide Web Consortium (W3C) http://www.w3.org/ standards languages and other topics related to the development and use of the models to bring these experts together. In any location there are likely to be several researchers examining a different part of a related overall subject, and this is the case for the Bristol area and web based systems. The SEEDS teams could co-ordinate researchers, in computing and engineering in a project to link together research on information management and visualisation for modelling and decision support. Users of such a system could be engineering organisations such as Airbus and Rolls-Royce, and others in many fields. The work of researchers in this project could be used in courses at universities, colleges, and schools and be provided to libraries at universities, science and technology attractions such as At-Bristol http://www.at-bristol.org.uk/, and in the community. Examples of this sort of functionality is the University of the West of England and University of Bath Research Observatory - collaboration online teaching and learning resources http://www.uwe.ac.uk/ro/ and http://www.bath.ac.uk/ro/, and the work of the UWE Graphic Science team http://www.uwe.ac.uk/fas/graphicscience/. Bristol University also created a semantic web directory that is a good example of using semantic web techniques to enable collaboration and SWED (Semantic Web Environmental Directory) - http://www.swed.org.uk/swed/index.html. We are examining possible collaboration with the Institute for End User Computing http://www.ieuc.org/home.html.

Web Deliverables

The SEEDS team has created a web site to trial new semantic web technologies for modelling and decision support, and to allow access and comment from organisations and the public http://www.cems.uwe.ac.uk/amrc/seeds/. Examples of semantic web costing, searching, and decision support techniques will be available for business, government, and the public to see on the web. An example page for this has been created at http://www.cems.uwe.ac.uk/amrc/seeds/models.htm. The software produced will be freely available and could be used within universities and in outside industry. The models will be particularly aimed towards modelling of systems, which are fairly complex, but capable of being modelled using web based software. Such modelling would be useful for, but not limited to the following applications :- decision support for design and manufacture of products, simulation of manufacturing processes or business processes, economic forecasting, scientific modelling, medicine, business decision making, construction, and cost benefit analysis. It could also be used for modelling of systems for educational use. The models would illustrate and explain processes. Such modelling would be useful to universities as an illustration of concepts to students, and for some, as a chance to participate in the development of modelling systems. There would also be scope for business to develop the technologies further using their own information and models, and they could be stored on a secure Intranet at the University of the West of England, or be added to the organisations' own Intranet.

How are we proposing to achieve it

This proposal would include research on automatically producing software for the semantic web site from visual representations of the problem. The web site would also promote our research activities and allow the SEEDS team to publish information quickly and easily as an additional mode of communication as well as journals and conferences. This is interlinked with other collaboration arrangements current and planned with universities including Southampton, Bath, Cranfield, and Reading. This partnership also includes Rolls-Royce, Airbus, and Vanguard software.

The SEEDS team has begun to put examples of modelling systems on the web and encourage and enable feedback on their usefulness and usability. The core of this would be automated generation of models written using World Wide Web Consortium (W3C) standards based languages and the visualisation of information represented in such W3C standard ways. A local semantic web company Koala Publishing is also working with us to provide model building and cataloguing http://www.koalapub.co.uk/.

[Huhns] and [Paternò] both explain that alternatives to the current approach to software development are required. This should allow translation from a model-based representation of software to the actual software. This could involve automatically producing software for a semantic web site from visual representations of the problem. The core of this modelling infrastructure would be automated generation of models written using World Wide Web Consortium (W3C) standards based languages and the visualisation of information represented in such W3C standard ways.

Ontology systems such as Protégé http://protégé.stanford.edu/, Jena http://jena.sourceforge.net/, Metatomix m3t4 http://www.metatomix.com/news/060307.html, and Kaon http://kaon.semanticweb.org/ either individually or in combination will be used to create an ontology in order to organise models. Systems that act as a development environment to enable semantic web programming, hide some of the details of developing in ontology tools. This can make it possible to provide an end user programming environment. The software we create could make use of semantic web decision support applications that are being provided by other organisations such as General Electric's ACUITy enterprise modelling tool [Aragones et al] http://jena.hpl.hp.com/juc2006/proceedings/crapo/paper.pdf, and http://www.topbraidcomposer.com/, which provides an environment based on Protégé, Jena, Java Eclipse, and Pellet http://www.mindswap.org/2003/pellet/. This would enable collaboration by making the use of visual menu and search tools possible for finding and sharing models. This is similar to the way RDF/XML (Resource Description Framework using Extensible Markup Language) syntax is used to enable the searching and sharing of web pages. So far, Protégé and Jena have been investigated for this model sharing purpose. The use of RDF/XML allows XQuery and SPARQL (SPARQL Protocol And RDF Query Language) http://jena.sourceforge.net/ARQ/ to be used for searching. The ability of Jena and Protege to save in relational database format also makes it possible to use SQL (Structured Query Language). Using these standards, it is possible to represent information in Jena, Protégé, or other ontology systems. All this flexibility is useful when different organisations are not all using the same systems. An important reason for creating an open standards central ontology is that it can be accessed by many different applications. The open standard OWL (Web Ontology Language) is explained by [Bechhofer and Carroll]. Research of others in this field have been investigated

[Corcho]; [Corcho and Gómez-Pérez] and [Noy]. The ontology needs to be simple and lightweight in order to be widely re-usable by different organisations, in different sectors. Issues involved in visualisation of lightweight ontologies are examined by [Fluit et al.]. OpenCyc http://www.opencyc.org/ should be investigated, as it looks useful for creating and sharing ontologies. OpenCyc http://www.opencyc.org/ also looks worth investigating because of its usefulness in building and sharing large ontologies, this would be necessary for any engineering application, and for enabling the building of end user programming environments.

This ontology would then be read into a decision support system which outputs results in web formats. This would also allow information that is relevant to different faculties or organisations to be shared. To enable creation of web pages by people who are not experts in this task, open source content management tools such as Rainbow Portal www.rainbowportal.net or the Zope Community Content Management Framework (CMF) http://www.zope.org/, which is currently used at UWE could be considered.

AJAX (Asynchronous JavaScript And XML) is an overall name for techniques to create highly interactive web pages. Ajax techniques for creation of highly interactive web pages may assist assist computer literate end-users in programming tasks on the web http://ajaxpatterns.org/wiki/index.php?title=Whats_Ajax%3f, with the use of web development environments such as Ruby on rails http://www.rubyonrails.org/, and Writely http://www2.writely.com/info/WritelyOverflowWelcome.htm and similar web based office technology such as the Google Spreadsheet. This type of Rich Internet Application technology research is very useful for providing an environment for end-user programming. XML (eXtensible Markup Language) is a programming language, not just a language for representing information as illustrated by its use in Ajax and rich internet applications, and many products including Adobe Flex2 http://www.adobe.com/products/flex/flexbuilder/. This technology is generally called web 2.0 because of the intention to provide much greater interactivity than previously found in web pages.

Aspect Oriented Programming [Elrad et al., 2001] could be used to capture and translate user requirements. Aspect Oriented Programming can also be used where software functions can not be neatly attached to particular objects or nodes in a hierarchy. These are known as Cross-Cutting Concerns as they may affect several nodes. A diagrammatic representation of the cross-cutting concerns can then be translated into a computer language representation such as AspectJ for Java [Kiczales et al, 2001] and AspectXML for XML http://www.oreillynet.com/xml/blog/2005/09/part_3_assets_atom_feeds_and_a.html. This allows for specification of a program as a model and translation to different languages beginning with Java, and XML. This also makes use of XML as a programming language not just an information format. Collaborations involving Aspect Oriented Programming can be found at http://aosd.net/ and http://www.aspectxml.org/. We will also make use of our expertise in the Alloy http://alloy.mit.edu/ modelling language [Wallace, 2003], in order to build and test an End-User Programming environment.

The approach our team intends to use is to enable a type of very high level meta-programming. Meta-programming and structured language is explained by Dmitriev http://www.onboard.jetbrains.com/is1/articles/04/10/lop/ and [Mens et al]. This is intended to mitigate the problems of cost and time over-run, and failure to achieve objectives that are the common malaise of software development projects. The creation of a web based visual representation of the information will allow people to examine and agree on information structures. It is envisaged that SEEDS develop a translation system to create software from diagrams that represent the problem. Figure 2 illustrates our approach to provision of a system to enable users to create and/or use their own models.

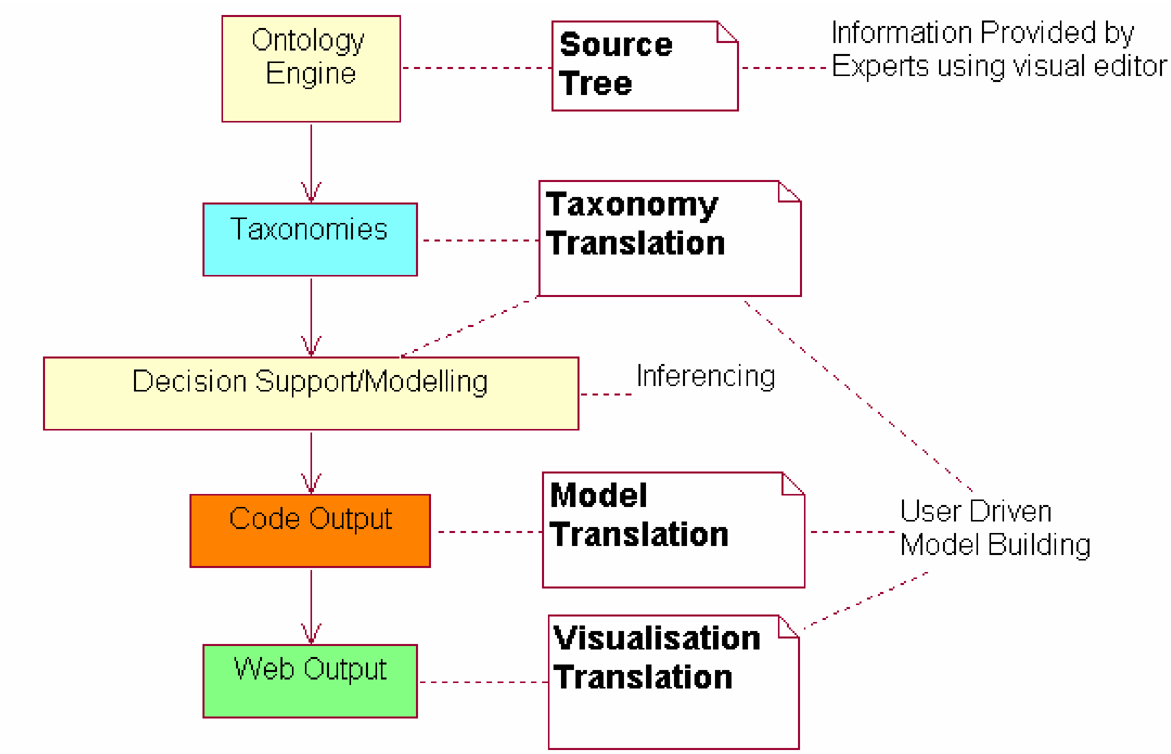

Figure 2 - Translation Process

The SEEDS teams' approach involves creation of an elaborator or translator that converts the diagrammatic representation of the problem into software, in various computer languages or a meta-programming syntax. The software created falls into two categories, although there is no strict separation as much of the software is multi-purpose. The first category is structuring, sorting, and searching of information Jena http://jena.sourceforge.net/, Protege http://protege.stanford.edu/, Exist XQuery http://exist.sourceforge.net/, and Orbeon Xforms http://www.orbeon.com/. This kind of software can be both the taxonomy/ontology editor and the output format. The other category of software would be used for modelling, visualising, and inferencing. The models are output from the taxonomy to this software, this could include DecisionPro http://www.vanguardsw.com/decisionpro/, Cost Estimator [Koonce et al.] [Wujek et al.], metaL http://www.meta-language.net/ and Simkin http://www.simkin.co.uk/Links.shtml. The elaborator needs to follow a structured taxonomy to establish how related concepts represented visually can be represented in equivalent code. The visualisation can be either as a colour coded tree or an interactive SVG (Scalable Vector Graphics) diagram of a component to be modelled http://www.cems.uwe.ac.uk/~phale/InteractiveSVGExamples.htm and http://www.koalapub.co.uk/svg.htm.

The research undertaken aims to adapt or create software systems to provide the visual editor for the source tree, and allow model builders to create a model by editing this. By doing so the model builders would create a generic model for a particular modelling subject. DecisionPro can be used to convert the taxonomy into a decision support and modelling system. Vanguard has made their server available for collaborative model development http://wiki.vanguardsw.com/. UK universities are already linking together to use DecisionPro on a network for aerospace and construction industry modelling. The model users could then use this decision support and modelling system to create their models. These models would be a more specific subset of the generic model, and could be applied for their own analysis. Our team would also provide a translation mechanism to convert information or models into other representations (primarily web based), and to visualise this information. Researchers would also create individual learning objects for education.

Why it is important and novel

This project involves the public, rather than just explains results. This is important as the DTI http://www.dti.gov.uk/ost/ostbusiness/puset/history.htm state in reference to the House of Lords Select Committee on Science and Technology report science and society http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3804.htm - a17 -

'In recent years there has been a growing recognition in government and the scientific community of the need to move away from the old model of the 'public understanding of science' to one which involves public engagement in science and proper dialogue between scientists and the public. This was set out clearly in the House of Lords Select Committee on Science and Technology report'.

In this report it states -

'Attitudes to engineering
2.39 Some from the engineering community consider that there is a distinct and damaging public attitude to engineering. According to the Engineering Council[20](p 285), the general public—quite wrongly—thinks that engineering "is poorly paid, dirty and offers little prospect for advancement", fails to appreciate that engineering creates wealth, and associates engineering with bringing about disaster rather than averting it or putting things right.
2.40 The Engineering Council has told us about some of its initiatives to correct these impressions, particularly those aimed at schoolchildren (p 286).'

So it is important to correct this wrong impression. Our project would give people more access to software for modelling and education, and allow them to develop their own software. It would allow those who previously had to rely on generic software to create their own specific software for their own purpose. Although we have examined many open source collaborations already, they are not involved in our field of modelling, and do not provide facilities for non-programmers to create their own software. So this is an area of research we should pursue. Users who have in mind what they want computers to do could instruct computers visually, provided a reliable visualisation can be defined to represent their requirements properly. The SEEDS team also intends to adapt the techniques used for searching and visualising information to use for searching, editing, linking, and construction of models, not just depiction of results.

The research would provide software for modelling and education that is cost free, and is also freely licensed. This would save large numbers of users both software costs and administration costs. Many organisations and users would get access to information and software, which they would not otherwise have. This project could also link with excellent work already undertaken in communicating science and technology by the UWE Graphic Science team http://www.uwe.ac.uk/fas/graphicscience/. Hewlett Packard http://www.hpl.hp.com/semweb/sw-technology.htm are also involved in semantic web information sharing projects, and hold regular talks to promote the public understanding of science and technology. Koala publishing's regular semantic web events with UWE participation, involving semantic web organisations, and clients mainly in aerospace also improve the understanding of these technologies.

Why we are the best people to do it

The SEEDS team have completed large projects and have a great deal of experience in creation of software for costing and decision support modelling with large aerospace companies. We recently completed the DATUM (Design Analysis Tool for Unit cost Modelling) project with Southampton University http://argos.e-science.soton.ac.uk/wiki/doku.php?id=project:project_description, and Rolls-Royce aerospace. For this project the team created sophisticated decision support models and web output. The SEEDS team has created a rigorous semantic library, which will provide the structure for future modelling. SEEDS has considerable expertise both in software modelling and manufacturing engineering, along with experience of visualising complex information, in cost maps and interactive diagrams. This can be seen from our web site at http://www.cems.uwe.ac.uk/amrc/seeds/. The team has been involved with research in new open standard languages for representing information such as XML since near the beginning of development of these languages, and also has links with the UWE project to create a CEMS (Computing, Engineering and Mathematical Sciences) Faculty Information System, using XML and XQuery. There is a great deal of expertise that we can call on within the CEMS Faculty, who have been innovative in providing open standards based learning and modelling software, and ontology representation systems. We have extensive contacts with aerospace companies and semantic web software suppliers.

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