ICT TRAINING APPROACH FOR THE STRUCTURAL STEEL DESIGN UNDER THE EUROCODES

Miguel A. Serrano, Carlos López-Colina, Fernando L. Gayarre
Manuel L. Aenlle and Alfonso Lozano
Department of Construction, Oviedo University, Campus de Viesques, Gijón, Spain

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Abstract: Fortunately the design processes of steel buildings across Europe is eventually covered by a unified code: The Eurocode 3: "Design of steel structures". Nevertheless, although Eurocodes will soon become mandatory documents, designs will not be standardized because each country has a set of National Annexes which must be taking into account when designing in that particular country. Furthermore every country also has its own body of non-conflicting complementary information. A problem then arises when engineers need to produce designs in other European countries, either for a company based in one state or as individuals. Also, allowing engineers time out of the office for attendance at the intensive training courses which are required for earning experience on the new codes of design, frequently represents an obstacle for their employers. In an attempt to solve these problems, a strong trans-national partnership has been working on a project which aims to develop an ICT-supported, flexible training approach to allow designers to apply Eurocodes in accordance with the national regulations and practices of different member states. The resulting material shows how to design a typical building according to the different national contexts. The developed portal incorporates facilities for course presentation, forums, blogs and on-line translation.

1 INTRODUCTION

The European Codes of design for structural steel and composite buildings, designated as Eurocodes 3 and 4, EN 1993 (2005), EN 1994 (2005), will soon become mandatory documents in all European countries. Nevertheless, designs of buildings will not be standardised. Each country has a set of national annexes which provide specific mandatory factors which must be used when designing a building in that particular country.

Every country will also have some non-conflicting complementary information (NCCI), including normal practice and other legislation such as Health and Safety, which will again take into account national variations in design approaches.

In order for engineers to produce designs in their own country, they will need to be aware of both the national annexes and the NCCIs, and read these alongside the Eurocodes.

In order to be realised the vision inspired by the Eurocodes of real mobility across Europe, designers must have access to thorough information about the design processes in the country they are working in. At national level, issues have also been identified concerning the training of engineers to design according to the new Eurocodes.

Engineers are demanding training strategies that allow them to adapt as quickly and efficiently as possible to the described situation. The time out of the office to allow engineers attend the intensive training courses frequently represents a problem for their employers.

This need has encouraged the formation of an experienced trans-European partnership which has been producing appropriate and flexible training material on these subjects for more than ten years. The team has worked on four projects producing training material in a variety of formats for the new Codes relating to structural steelwork. This paper covers the work of the most recent project which has produced web-based, self-learning training courses.

2 THE INITIATIVE EUR-ING

Eur-Ing is a 2 year pilot project part-funded by the European Commission under the second phase of the Leonardo Da Vinci programme that has been running from October 2006 to October 2008. Its full

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title is 'Development of ICT supported, flexible training to enable designers to apply Eurocodes in accordance with the national regulations of different member states'.

2.1 The Aim

The main Eur-Ing project aim was to provide the necessary information for designers from any European country to produce easily a steel building design in other European countries.

The building chosen as the basis for the case study was a real steel-framed multi-storey building originally designed to UK national codes. The project partners re-designed the building according to the national annex clauses and NCCIs of their own country. We also considered the national regulations and standard practice of each one of the partner countries regarding procurement, construction and health and safety legislation. The design brief and basic building form is standard, but each partner country made detailed modifications to ensure compliance with normal practice in their country.

Professor Bijlaard, Chairman of CEN and responsible for all the structural Eurocodes on steel, presented a paper (Bijlaard, 2008) in one of the invited lecturers at the Eurosteel'08 Conference. It could be interesting to extract one of its sentences, which appears in the conclusion:

"*The introduction of the Eurocodes in the design practice needs great care. Design examples, guidelines, design tools (special software) should be developed in the various countries. Explanations of differences and the justification for these changes should be supplied to support the acceptation of the Eurocodes.*"

The above paragraph is the aim of the Eur-Ing project and it shows how this project is very valuable.

2.2 The Resources

The following resources have been produced:

- A complete building design for each country involved in the project incorporating national annex and NCCI criteria.
- A Technical Description explaining the design approach in each country. This has been translated into all the partner country languages.
- An explanation of the non-technical issues which need to be taken into account when procuring and designing a building in a particular country. This will include links to useful documents including legislative. This document has also been translated into all the partner languages.
- A comparative list of the major differences between the national annex clauses for the Eurocode 3 and Eurocode 4 in each partner country.

The project has ended in September 2008. It is intended that all the information produced will be hosted on the project website. This will include the facility to compare procurement and design approaches and national annexes in different countries.

2.3 The Partnership

The participating partners in this project that include university departments, information and research centres, professional bodies and companies from several European countries were:

- UK - University of Sheffield
- UK - The Steel Construction Institute
- UK - Epistemics Ltd
- Germany - Fachgebiet Stahlbau TU Darmstadt
- Belgium - Centre Information Acier
- Greece - Technical Chamber of Greece
- Greece - IEKEM
- Spain - Fundación Universidad de Oviedo
- Hungary - University of Pécs
- Slovakia - Slovak University of Technology

In order to ensure that the material produced in this project is appropriate and in a suitable format for designers and companies, each partner country has an advisory (Steering) committee which provides valuable feedback at key stages of the project. The steering committees comprise large and small design companies, steel fabricators, trainers and contracting organisations.

3 THE EUR-ING WEBSITE

Originally, the material for this project was going to be uploaded on the NFATEC website. NFATEC was a previous project about an educational dissemination of Eurocodes that was carried out by many of the partners of Eur-Ing. However, experience showed that web technology significantly advanced and much more could be accomplished by using the product Drupal (http://drupal.org). To use this technology, a web server that supported database access and scripting was configured at http://n-aktive.co.uk. The n-AKTive server was seen as a portal to host the project material (Figure 1).

The capability of Drupal allowed so much

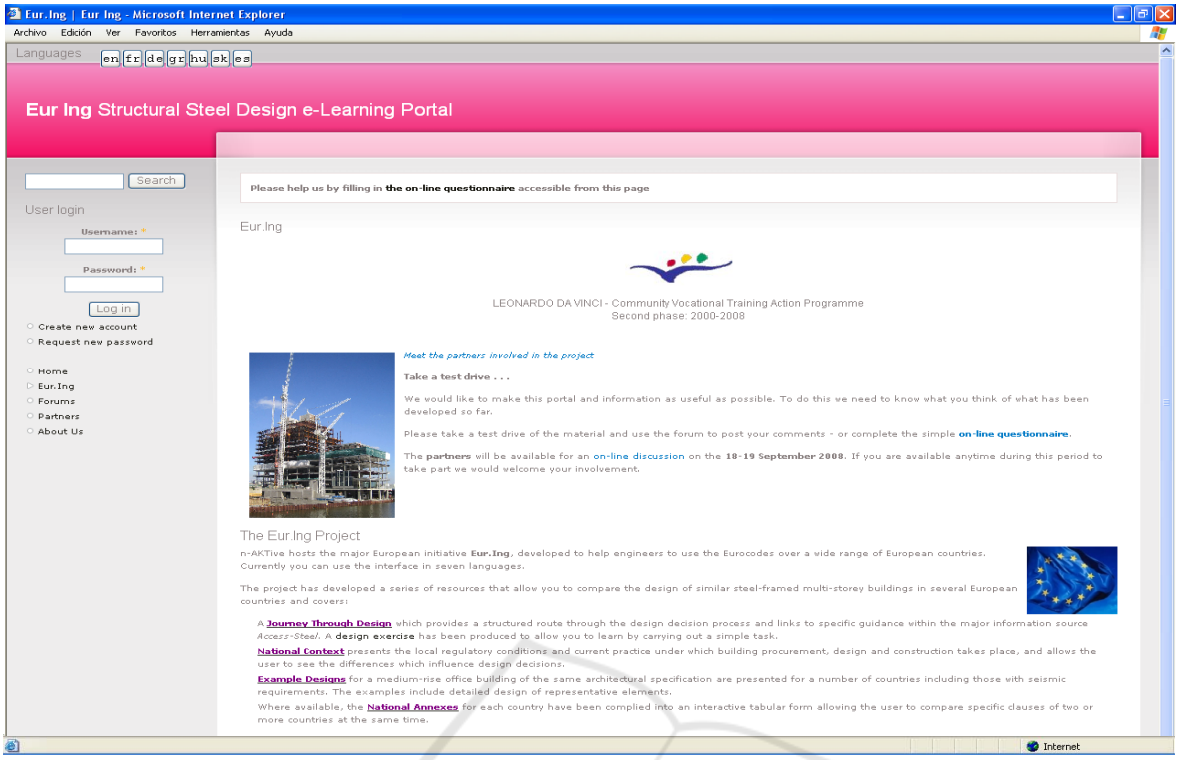

Figure 1: The n-AKTive portal. Links to Eur-Ing resources.

additional functionality that was simply adopted and used. The product could:

- Facilitate the translation of the material.
- Provide a good Community of Practice with the associated Forums, Blogs, Comments and Tagging.
- Support structuring of material in a simple Taxonomy to allow structured classification and searching.
- Allow online editing of material by approved users.
- Allow collaborative working on content such as e-Books.
- Allow customised design of forms.
- Support RSS, or Really Simple Syndication. This is a method of sharing and broadcasting content such as news from a website. Using XML, items such as news articles can be automatically downloaded into a News Reader or published onto another website.
- Allow users to interact with one another and to see what other users found useful. This is a bit like "users that purchased this item also purchased this other item" on sites like Amazon.
- Be able to be extended by adding new modules to add new functionality.
- Control the addition of content by users who had not been validated to reduce the amount of "spam" or unwanted advertising on the site (a common practice with a whole industry growing up to pollute websites).
- Allow users to configure their own view of the site – a workbench if you like.
- Be able to delegate activities to allow more than one person to perform administration actions such as "Moderating the Forums" as the site grew.
- Have a Calendar to keep users informed of events.
- Deliver sufficient statistics to allow the owners of the site to make informed decisions about the content.
- Conform to standards to ensure that its content could be shared using emerging technology (RSS feeds, Blog readers, Widgets and many more).
- Allow Semantic tagging to cut across the barriers of language.
- Allow easy addition of new languages.
- Allow the individual partners to extend the content if they thought it appropriate.
- Allow the site to be easily moved if it became necessary in the future.

- Be scalable to handle many thousands of pages with many thousands of users (proved by the products themselves where the sites are implemented in their own product and have tens of thousands of users with hundreds of thousands of pages).

The project has developed a series of resources that allow the user to compare the design of similar steel-framed multi-storey buildings as the one chosen as the Eur-Ing study. This covers:

- National Context, that presents the local regulatory conditions and current practice under which building procurement, design and construction takes place and allows the user to see the differences which influence design decisions.
- Example Designs for "The Bioincubator", a medium-rise office building. These designs have the same architectural specification and are presented for a number of countries including those with seismic requirements. The examples include detailed design of principal elements.
- The National Annexes (where available) for each country, that have been complied in an interactive tabular form. It allows the user to compare specific clauses taken from the Eurocodes 3 and 4 with those from one, two or more countries at the same time.
- A Journey Through Design which provides a structured description of a route through the design decision process and links to specific guidance within the major information source Access-Steel (Access-Steel, 2006).

n-AKTive provides access to e-Learning materials developed by leading industrial and academic experts within the EU. It also provides a forum for discussion and collaboration with regard to multiple EU-sponsored initiatives such as Eur-Ing, (Gonzalez et al., 2008), (Iványi et al., 2008), (Serrano et al., 2008), the SSEDTA project, (Ssedta, 2002) and the NFATEC project, (Nfatec, 2004), (Serrano et al., 2005).

It is to be noted that the material developed for SSEDTA and NFATEC, two previous projects related to the learning of Eurocodes, have been

transferred on the n-AKTive web site in order to provide the necessary basic information to the users.

Although it was a project within the European scope, at least initially, and the content of the

web is mainly aimed to people that need to work with the European codes, to date the authenticated users come from beyond the European borders. There were registrants from 38 countries all around the world. Obviously the main effort in dissemination was done among the partner's countries and most of registrations are from these states. But it is worth noting that an important rate near to 20% has its origin in other European countries (Portugal, Italy, France and Netherlands just to mention the highest rates). Also there were an important number of registrants from Asia 5% (India, Singapore and South Korea are the more representative), from America 4% (Brazil, Canada and Mexico mainly), and even from Oceania 2% and some people from South Africa. Figure 2 shows the percentage of registrations in the web site depending on the origin.

During the 3 day period of the last trial web course, our site was linked to from more than one hundred other sites (some of them linked to general

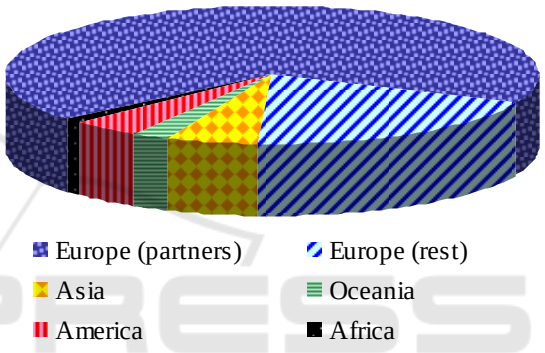

Figure 2: Origin of registrations in n-AKTive web site.

search engines but most of them really focussed in the topic of steel structures as:

- http://www.eurocodes.co.uk
- http://www.infosteel.be.
- http://www.access-steel.com
- http://eurocodes.jrc.ec.europa.eu
- http://portal.tee.gr/portal/

4 WEB-BASED COURSE: JTD

The Journey Through Design (now referred to as JTD) is a resource designed to provide links to information on relevant aspects of the design of a steel structure to Eurocode 3 and 4. Its structured format is intended to help the selection of the appropriate information through a sequential method.

The initial idea behind producing this resource follows this scenario:

A graduate or student in civil engineering is presented with a design brief outlining a problem

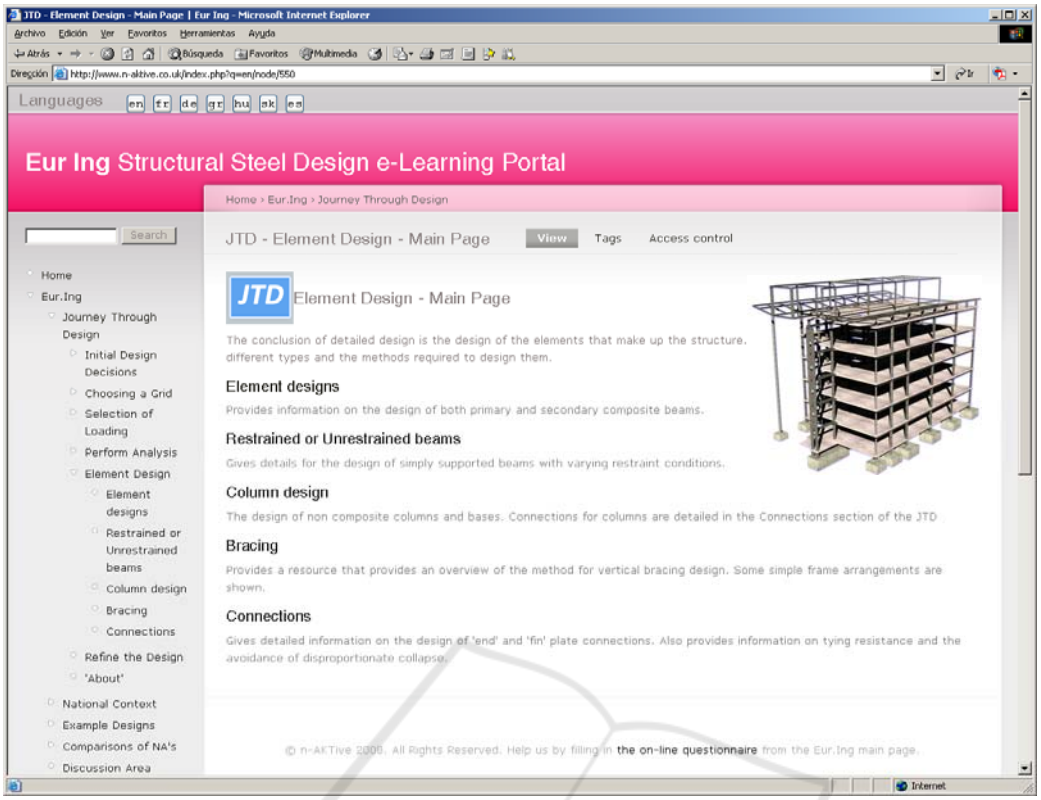

Figure 3: The n-AKTive portal. The Journey Trough Design tool.

that he is unsure how to solve. The graduate would ask a more senior member of his team for initial ideas on how to work out the problem and the response would be to look in a text book or at a website.

This resource is to be designed to eliminate or reduce the need to consult another colleague by providing a central hub containing a collection of links to selected information in a user friendly layout.

Figure 3 shows: The Journey Trough Design tool included in the n-AKTive portal.

4.1 JTD Resources

The resources in the JTD (with few exceptions) have not been produced by the makers of the JTD. Whilst every effort has been made to make sure that the information is correct, the resources linked to should be used as learning tools only. More information is specified on the producers' of resources website. A list is provided below.

- Access-steel.co.uk
- Communities.gov.uk
- Energysavingtrust.org.uk

The resources provided are PDF documents.

Clicking a link will take you to the relevant page in the document. Due to the nature of different operating systems or configurations, the page number has been provided as well. Each resource has a primary link that refers to the first page of the document. Where pages have been specially selected (and highlighted within the JTD) the link refers the user to the respective page within the resource. It should be noted that each link opens up a new document.

Depending on the user preferences, the resources in the JTD tool and the documents linked are also available in several partner languages. Access Steel web page recognizes which country you are accessing it from and displays the appropriate language version of the page.

4.2 Design Exercise

A design exercise has been produced to allow the user learn by carrying out a simple task. It is a simple design brief purposed to try out the Eur-Ing material, that consists on a multi-storey administration building similar to the Bio-Incubator. It is planned to be developed using the JTD tool. To this purpose, the work is divided into six tasks to be followed by the user.

- Initial design decisions: aspects such as floor to floor heights and local regulations.
- Choosing a grid: this section provides information such as what form the building will take, the selection of building elements and how they are constructed.
- Selection of loading: this section includes information on loading types.
- Perform analysis: it introduces ideas such as 'Simple' construction.
- Element design: the design of the individual elements themselves. Figure 3 shows an example of the JTD tool interface.
- Refine design: design is an iterative process and it is important to ensure that any changes made during the design stages still satisfy the original design requirements.

5 CONCLUSIONS

The main outcome in the Eur-Ing project was the production of a innovative multi-national approach to the design of real steel buildings. Typical worked examples available in this field are country-specific and do not describe how national annexes and local applications and regulations affect the design process in different countries, resulting usually in different solutions.

The web site produced for this purpose has showed to be really useful for practitioners in industry and other target groups identified in the project, who have been demanding more efficient ways to learn and familiarize themselves to the European codes of practice.

By means of a trans-national methodology of working, it has been discovered that, not only differences in codes and annexes but also variations in design and construction practice, planning procedures, procurement routes and other factors contribute to diverse national design approaches.

The availability of such innovative reference and learning material in seven European languages will facilitate the mobility of designers and the ability of organisations to operate under the regulations and traditions of other countries by increasing confidence.

After several on-line pilot courses held to date, feedback from attendants assures that the developed product agrees with the project's objectives.

The partnership is intending to get funding from the steel industry to maintain the existing web and to extend the project to some more European countries producing more language versions.

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REFERENCES

Access steel website, 2006. Eurocodes make easy. *http://www.access-steel.com/*

Bijlaard, F.S.K., 2008. Eurocode 3. Present status and further developments. *Proceedings Eurosteel'08*, Graz. Austria.

CEN/TC250 N518, 2003. Nationally determined parameters and National Annexes for EN Eurocodes.

Drupal official website, *http://drupal.org/*.

EN 1993: 2005. Eurocode 3: "Design of steel structures". Part 1-1: "General rules and rules for buildings". Part 1-2: "Structural fire design". Part 1-8: "Design of joints".

EN 1994: 2005. Eurocode 4: "Design of composite structures". Part 1-1: "General rules and rules for buildings". Part 1-2: "Structural fire design".

González, F., Lange, J., 2008. Harmonization of Design Rules in Europe. *Proceedings Composite Construction VI*. Tabernash, Colorado, USA.

Iványi M., Iványi P. 2008. Devolpment of ICT supported, flexible training to enable construction designers to apply Eurocodes. The goal of Leonardo da Vinci Project. *Proceedings of ICEE 2008 International Conference on Engineering Education*. Pécs, Hungary

n-AKTive, 2008. Structural Steel Design e-Learning web page. *http://www.n-aktive.co.uk/*.

Nfatec project. 2004. Web-based training for Engineers in the Eurocodes for Structural Steel Design. *http://www.nfatec.com/*.

Serrano, M.A., Burgess, I.W. and Armstrong, S.E. 2005. An efficient training approach on Eurocodes for engineers in construction. *Proceedings Eurosteel'05*, Maastricht. The Netherlands.

Serrano, M.A., Burgess, I.W., and Armstrong, S.E. 2005. The NFATEC Project: An efficient training approach on Eurocodes for engineers in construction. *Civil Engineering journal of the Korean Society of Civil Engineering* Vol.53, Nº 10.

Serrano, M.A. et al. 2008. The Eur-Ing Project-A Case Study for Structural Steelwork Design under the Eurocodes. *Proceedings Eurosteel'08*, Graz. Austria

Ssedta project. 2002. Structural Steelwork Eurocodes, Development of a Trans-National Approach, *http://www.ssedta.com/*.