

# Education for Sustainable Construction

## COST C25 International Symposium and Training School, Malta, 2010

Luís Bragança

*University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal*

Heli Koukkari

*VTT Technical Research Centre of Finland, Espoo, Finland*

Milan Veljkovic

*Luleå University of Technology, Sweden*

Ruben Paul Borg

*Faculty for the Built Environment, University of Malta, Malta*

### 1 INTRODUCTION

The COST Action C25 "Sustainability of Constructions - Integrated Approach to Life-time Structural Engineering" is a network of scientists and researchers from 28 European countries and the EU Joint Research Centre in Ispra. It was established to promote science-based developments in sustainable construction in Europe through research on life-time structural engineering. The COST Action has been active since 2006.

The Action concentrates on R&D issues that are fundamental for sustainable construction processes and technologies. These include methods to assess environmental, social and economic impacts of construction activities; methods to analyse eco-efficiency of materials, components, buildings and infrastructures; methods to integrate research approaches from various disciplines; and methods of structural design that incorporate holistic understanding of safety, eco-efficiency and sustainability.

The Action has organised three major events, an event every year, where the findings of joint efforts of the Members have been discussed and published:

- 1st Workshop in Lisbon, Portugal, on 13, 14 and 15 September 2007;
- the Midterm Seminar in Dresden, Germany, on 6-7 October 2008;
- International Workshop in Timisoara, Romania, on 23-24 October 2009.

Some of the Action results were already applied through the dissemination of the life-time engineering approach to the sustainability issues in tasks carried out by C25 members. However, a short investigation of university syllabuses, completed by an add-hoc C25 group on educational issues, has shown clearly the need for a new approach in teaching structural engineers on sustainability issues. One of the important aspects in filling this gap is the training of young research students. Three very successful Training Schools were organised by COST Action C25:

- The first Training School was "The LCA Training School" which was organised for 16 participants in Eindhoven, The Netherlands, on 13-15 February 2008. The participants were mainly Early Stage Researchers from C25 who could learn and deepen their knowledge on the use of Life Cycle Analysis theories and tools.

- The second Training School “Sustainability in structures and structural interventions: Improving the contemporary and historical urban habitat constructions within a sustainability and risk assessment framework” was held in Thessaloniki, Greece, on 17-24 May 2009. It was jointly organised by C25 and C26 and the number of Early Stage Researchers was 40, from these two COST Actions.
- The third C25 Training School “Sustainable Construction: A Life Cycle Approach in Engineering”, was organised in Malta from the 23<sup>rd</sup> July 2010, to the 1<sup>st</sup> August 2010. An Early Stage Researchers Symposium was also organised just before the Training School. The aim of the Training School was mainly to provide C25 and non-C25 Early Stage Researchers and PhD students with theories, tools and assignments to address sustainability in construction and the life-cycle approach in structural engineering.

## 2 EDUCATION FOR SUSTAINABLE DEVELOPMENT

### *2.1 Introduction*

The construction industry addresses sustainability issues, and graduates are expected to develop sustainable literacy as an essential professional skill. Murray (2007) notes that “a sustainability literate person has been defined by Forum for the Future as someone who understands the need for change to a sustainable way of doing things both individually and collectively, and has sufficient knowledge and skills to decide to act in a way that favours sustainable development”. The educator’s responsibility is to make opportunities available for students to cultivate the attributes they need (Murray, 2007). The educator needs to ensure that graduates entering the construction profession have the required level of sustainability literacy that enables them to transfer their knowledge into practice.

It has also been noted that the approach of Higher education institutions to sustainability directly affects their enrolment figures. The results of a survey of university applicants in the UK indicate that 45 per cent of applicants to built environment courses stated that an institutions’ track record on sustainable development was important or very important in their selection (Goodman, 2007). The UK set out a sustainable development strategy in 2005 explaining the need for higher education to promote sustainability literacy. Research by the Higher Education Academy found that coverage of education for sustainable development in the curriculum of higher education institutions in the UK is uneven within and across disciplines (The Higher Education Academy, 2006)

Education for sustainable development is also considered to differ from other subjects in built environment disciplines as it is a professional issue alongside being a personal dilemma. If considered correctly, education for sustainability should give the opportunity for students to learn how to use their thinking on sustainable development to impact their professional lives (McCullough et al, 2009). It is reported that education for sustainable development benefits from educators who are willing to be a part of the sustainability debate, both academically and through their lifestyles. Institutions also need to consider their role in the integration of sustainability within the curriculum.

### *2.2 A Multi-Disciplinary & Holistic Approach*

The construction sector essentially requires professions from different sectors to work in a team and develop projects in collaboration together, from their inception and up to execution and completion. Wright (2003) notes that; “Sustainability is an activity of the collective, underlined with the need for co-operation and teamwork.” Education for sustainable development in the built environment requires the same multidisciplinary and holistic approach.

The education programmes need to reflect the holistic approach required in the industry, and therefore opportunities must be provided for a multi-disciplinary approach. Jucker (2002) notes that; “we need to overcome the disciplinary straight jacket of current education...because it prevents us from looking beyond one’s own narrow field of vision.” The multidisciplinary design process which has become mainstream practice underlines the fact that sustainability must be incorporated across all areas of education for the built environment, and cannot be ignored or made less of a priority by any built environment discipline (McCullough et al, 2009). Hayles et al (2008) note that sustainability has to be introduced across the board, if it is to be understood by students as a key concept in the future of the building and construction industry.

### *2.3 The Curriculum Reform*

Integrating Sustainability in teaching requires curriculum reform to become a priority in institutions. The holistic, multi-disciplinary approach is seen as better than the development of a specific course or several courses focused on sustainability. Sustainability teaching requires a multi-disciplinary approach, and therefore a coherent, integrated approach to teaching sustainable principles is required with sustainability being embedded within all parts of the curriculum. Graham notes that Sustainability education therefore encourages changing curriculum from education about sustainability, through education for sustainability, into education as sustainability (Graham, 2005). The Higher Education Academy (2006) has outlined their suggested methods for change in the following points:

- Rigorous review of curriculum;
- Develop credible teaching materials which are fully contextualised and relevant to each subject area. This will help ensure that education for sustainable development is integral to the curriculum and not a ‘bolt’ on;
- Invest in staff development; and
- Develop credible business case for higher education institutions, setting out triple bottom line benefits. Amend institutional mission and policy statements.

### *2.4 Teaching Methodology*

The teaching methods used in education for sustainability are shifting away from the traditional lecturing approach, to methods based on student experience and problems solving. These methods allow students to develop an understanding of sustainability as an academic subject and to apply it to practical situations within their lives and their subject areas. Wang noted that studies have shown that compared to passive learning, which occurs when students observe a lecture, students will learn more and will retain that learning longer if more active methods of teaching and learning are used. Active learning also helps deepen students understanding as well as to help them develop positive attitudes toward sustainability (Wang 2009). Although many methods of active learning exist, the most frequently discussed in pedagogy papers are reflective practice and ‘hands on’ projects. Hands-on practical sessions can be designed to prepare students for the work place.

Reflective practice encourages students to use their experiences to learn about sustainability. This method allows the educator to introduce sustainability as both an academic and personal issue as discussed above. Reflective practice begins with students examining their own lives and challenges them to work at becoming more sustainable (McCullough et al, 2009). This develops the process of looking at a situation, identifying the problems and implementing solutions. Franke (2005) refers to a study where students were asked what they found to be good learning experiences. Five factors that comprise good learning experiences were drawn from the students writing, and grouped as follows:

- Hands-on, practice relevant education;
- Seeing things with your own eyes;
- Teacher enthusiasm and experience (experiential learning);
- Team working; and
- Tactile, emotional experiences.

This demonstrates the value of eliciting experiential learning from both students and educators as the most appropriate approaches to sustainability education (McCullough, 2009).

### *2.5. Comparison of Teaching Methods in Sustainable Development*

McCullough et al (2009) assessed the current teaching and learning practices for sustainability in the built environment disciplines through a preliminary study. To this end a survey was sent to higher education institutions in both the UK and the rest of Europe through the COST C25 network, with specific questions concerning postgraduate education in sustainability within the built environment disciplines. Information about types of degrees, sustainability topics covered, and teaching methods was gathered. The survey also referred to online teaching resources which were intended to be used as reading material for the summer school. McCullough and Hayles reported a good response of information about teaching methods. The survey asked which teaching methods were used in their institution when teaching education for sustainable development and which they found most effective to establish whether this reflects what is being documented in the literature. A comparison has been made between teaching methods used and preferred in the UK and the rest of Europe (McCullough et al, 2009).

McCullough and Hales reported that with reference to the Institutions participating in the survey, both the UK and other European institutions still have a high reliance on the more traditional approach of lecturing with 100 percent of responses in the UK using lecturing as a teaching method and 66.7 percent in the rest of Europe. The difference between the UK and the rest of Europe is in the use of other teaching methods alongside lecturing. The responses from the UK show a much wider use of other, less traditional methods.

The rest of Europe (COST C25 responses) relies heavily on critical/systematic thinking and lecturing, with 50 percent also using active learning. With only 33 percent using problem solving and 16 percent using student centered learning and reflective practice, there is little movement towards the less traditional methods explained as more effective in the literary review.

Whilst in the UK lecturing is still heavily relied upon as a teaching method, other less traditional methods are used more frequently than those documented from institutions in the COST C25 grouping. Critical/systematic thinking and problem solving are used by 80 percent whilst student centered learning; active learning and project based learning are used by 60 percent of responding institutions. Reflective practice is only used by 20 percent which is unexpected as the literary review explains that sustainability is a personal and academic issue and reflective practice is useful in developing a students' personal understanding of the subject (McCullough et al, 2009).

## 3 SUSTAINABLE CONSTRUCTION: MALTA 2010.

### *3.1 General*

The C25 Training School "Sustainable Construction: A Life Cycle Approach in Engineering", was organised in Malta from the 23rd July 2010, to the 1st August 2010. The Training School was hosted by the Department of Building and Civil Engineering, Faculty for the Built Environment of the University of Malta and offered opportunities for collaboration among the researchers. The whole event consisted of two complementary activities:

- The International Early Stage Researchers Symposium, from the 23<sup>rd</sup> of July till the 25<sup>th</sup> of July 2010;
- The International Training School, from the 26<sup>th</sup> of July till the 1<sup>st</sup> of August 2010.

The programme and the scientific content of the Malta Training School were prepared with the support of an international group of experts and were approved by the Management Committee of the COST Action C25. The group of experienced lecturers were selected to teach and supervise the group work during the school.

The Events were organised under the Chairmanship of Luis Braganca, the Chairman of COST Action C25, and Coordinated by Ruben Paul Borg, MC member of C25. The events were also supported by members of the Core Group of COST C25 including Heli Koukkari Vice-chair of C25 and Milan Veljkovic Chairman of WG2. The Scientific Committee of the Symposium and the Training School in Malta, are listed in Table 1.

Table 1. Scientific Committee and Institutions: Symposium & Training School, Malta 2010.

Scientific Committee member	Institution
Luis Braganca	University of Minho Portugal.
Heli Koukkari	VTT Building & Transport Finland.
Milan Veljkovic	Lulea University of Technology, Sweden.
Raffaele Landolfo	Univewrsita' di Napoli Federico II Italy.
Dan Dubina	Universita Politecnica Timisoara Romania.
Helena Gervasio	Universidade de Coimbra, Portugal.
Mauritz Glauman	University of Gävle, Sweden.
Viorel Ungureanu	Universita Politecnioc Timisoara, Romania.
Ruben Paul Borg	University of Malta, Malta.
Oliver Hechler	Arcerol Mittal, Luxembourg.

### 3.2 *The Early Stage Researchers Symposium*

The aim of the International Early Stage Researchers Symposium in Malta, was to give the opportunity to the participants to present their own work and to get an overview of the research work being done by the other researchers all around Europe. The Symposium was an important forum for the discussion of new ideas in the field of Sustainable Construction and brought together all those who were interested in collaborating on common projects. A book of proceedings was published before the Symposium, and included contributions from all the participants in the training School. The Proceedings cover a wide range of up-to-date issues that reflect the research areas of the participating Early Stage Researchers in the Sustainable Construction field. The issues presented include:

- Sustainable Building: design guidelines and assessment tools;
- Eco-efficiency: eco-efficient use of natural resources in construction and processes;
- Life-time Structural Engineering: life-cycle performance, design for durability, maintenance and deconstruction.

The publication also represented an important milestone in the fulfillment of the main aims of the COST Action C25, in promoting further the sustainability of construction industry and of the built environment.

Table 2. Paper titles and authors: Symposium. (Braganca et al, 2010a)

<b>Paper Title</b>	<b>Author/s</b>
Sustainability of Constructions: Integrated Approach to Life-time Structural Engineering	<i>Bragança L., Koukkari H., Blok R., Gervásio H., Veljkovic M., Plewako Z., Landolfo R., Ungureanu V.</i>
<b>Chapter 1: Sustainable Construction</b>	
The Role of Environmental Assessment of Buildings	<i>Haapio A.</i>
Building Sustainability Assessment: System SBToolPT	<i>Mateus R., Bragança L.</i>
Green Building Design Guideline	<i>Kahraman İ.</i>
<b>Chapter 2: Eco-efficiency</b>	
Structural, economic and environmental performance of fibre reinforced wood profiles vs. Solutions made of steel and concrete	<i>Manthey C. &amp; Guenther E., Heiduschke A. &amp; Haller P., Heistermann T. &amp; Veljkovic M., Hájek P</i>
Comparative Life-Cycle Impact Assessment of Short RC Columns and Composite Columns	<i>Lukic I</i>
Life Cycle Inventory of Stainless Steel: Review of Challenges, Methods and Applications	<i>Rossi B.</i>
The potential use of Waste Tyre Fibres in Concrete.	<i>Borg R.P., Farrugia C.</i>
Sustainable Planning of Renewal of Buildings in Public Ownership	<i>Kusar M., Selih J.</i>
Perceptions of Sustainable Housing Design: Current Strategies for Zero Carbon	<i>McCullough J.E.</i>
Sustainable design in the neighbourhood scale: Analysis of planning issues and case studies.	<i>Tsirigoti D.</i>
Energy Saving in Lithuanian Building Sector	<i>NorvaišieneR.</i>
Examination of Photovoltaic (PV) Component Use in Architecture from the Viewpoint of Energy Efficiency	<i>Altin M.</i>
An acoustical and visual evaluation approach for the proscenium type of drama theatres.	<i>Yilmaz Karaman O.</i>
<b>Chapter 3: Life-time Structural Engineering</b>	
Structural Flexibility: Inventory and Qualification of Parameters	<i>Koopman E.F., Blok R., Moonen S.P.G.</i>
A Literature Review of Life Cycle Assessment for Bridge Infrastructure	<i>Du G.L.</i>
Inflation Adjusted LCCA of a Comparative Study of an Integral Abutment Bridge and a Concrete Bridge with Expansion Joints	<i>Iqbal N., Gervasio H., Eriksen J., Veljkovic M., Simoes da SilvaL</i>
Embodied energy in the 'Flexiarch' relative to other types of short span bridges.	<i>Cregg D., Long A. &amp; Magee B.</i>
Refurbishment of Multi-dwelling Building Based on the LCC Principles.	<i>Mirtič M.</i>
Multi-criteria Decision Making Methods in Refurbishment, Deconstruction and Demolition of Existing Structures	<i>Portioli F., Cascini L. Ungureanu V.</i>
The Use of Timber Tenon Joints with Pegs: Sustainable Solution for Improving Deconstruction	<i>Marmo R</i>
Sustainable Conservation of Heritage at Risk: Strategies for Proactive Preservation and Maintenance	<i>Robinson L.</i>

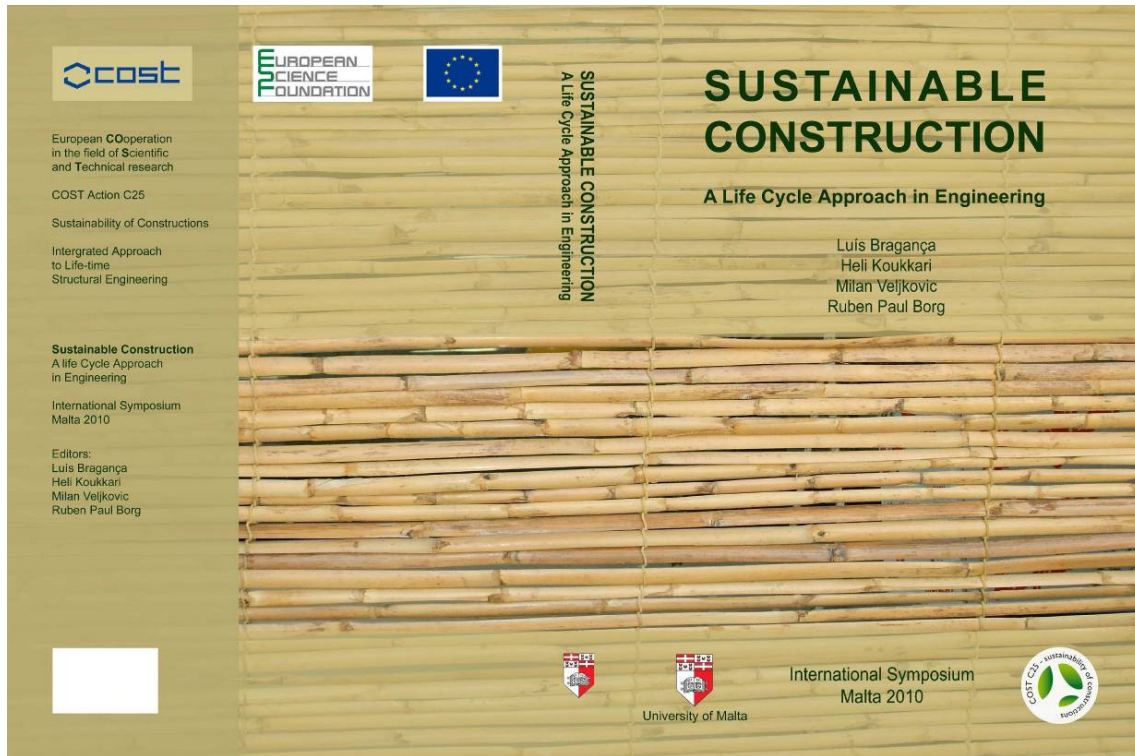


Figure 1. International Symposium: Sustainable Construction, Malta 2010. (Braganca et al, 2010a)

### 3.3 The Training School

The Training School in Malta, had two main objectives:

- First objective; the Training School was a project oriented school. This means that students were expected to work in a group to solve assignments prepared to illustrate various aspects of design for sustainable construction. The work performed was evaluated and then disseminated to the participants as the school outcome.
- Second objective; The Training School also served as an important forum to exchange of experiences and knowledge, and for the development of new ideas in the emerging field of Life Cycle Analysis in construction.

A book of Lecture Notes was published before the Training School, and included most of the presentations of the Malta Training School lectures. It was intended to assist the participating Early Stage Researchers in following the lectures. It also serves as an inspiration for the development of new ideas in the field of the life-cycle approach in structural engineering and construction. The lectures covered a number of emerging topics where new knowledge has already been achieved but also where further research is still needed, such as in the following areas:

- Sustainable Construction and the Integrated Life Cycle Approach;
- Criteria for Sustainable Building, Infrastructure and Bridges;
- Eco-Efficiency & Sustainable Construction;
- Life Cycle Analysis Methodologies and Tools;
- Life Cycle Inventory Analysis of Structures;
- Environment Product Declarations;

- Durability Assessment of Materials and Structures;
- Life-Time Structural Engineering;
- Sustainable Technologies and Maintenance of Structures;
- Design for Deconstruction, Demolition and Recycling;
- Life Cycle Design Methodologies.

The publication of the lecture notes is considered as an important achievement for the promotion of sustainable construction, which is one of the main aims of COST C25.

Table 3. Training School Lectures. (Braganca et al, 2010b)

<b>Lecture Title</b>	<b>Lecturer/s</b>
Sustainability of Constructions: Integrated Approach to Life-time Structural Engineering	<i>Braganca L</i>
Sustainable Construction and the Integrated Life Cycle Approach	<i>Koukkari H.</i>
Environmental Assessment of Buildings & Building Material.	<i>Glauman M.</i>
Eco-efficient Structures	<i>Koukkari H.</i>
Eco-efficiency & Sustainable Construction: A Case study of a Residential Modular Building designed for 2 climate regions	<i>Veljkovic M., Koukkari H</i>
Sustainable Rehabilitation Strategy: Xrobb il-Għaġin Sustainable Development Centre & Nature Park	<i>Borg R.P.</i>
Intelligent use of Energy & Renewable Energy Sources (RES)	<i>Spiteri Staines C.</i>
Sustainable Constructions: Life Cycle Inventory Analysis	<i>Veljkovic M., Rossi B.</i>
Durability Design of Metal Structures	<i>Landolfo R.</i>
Sustainable Technologies for Maintenance of Structures	<i>Dubina D., Ungureanu V.</i>
Sustainable Technologies for Maintenance of Structures: Case Studies	<i>Dubina D., Ungureanu V.</i>
Design for Deconstruction, Demolition and Recycling	<i>Hechler O.</i>
Multi-criteria Decision Making Methods in Refurbishment, Deconstruction and Demolition of Existing Structures	<i>Portioli F.</i>
Life Cycle Design Methodologies	<i>Vesikari E.</i>
Life Cycle Management of Structures	<i>Vesikari E.</i>



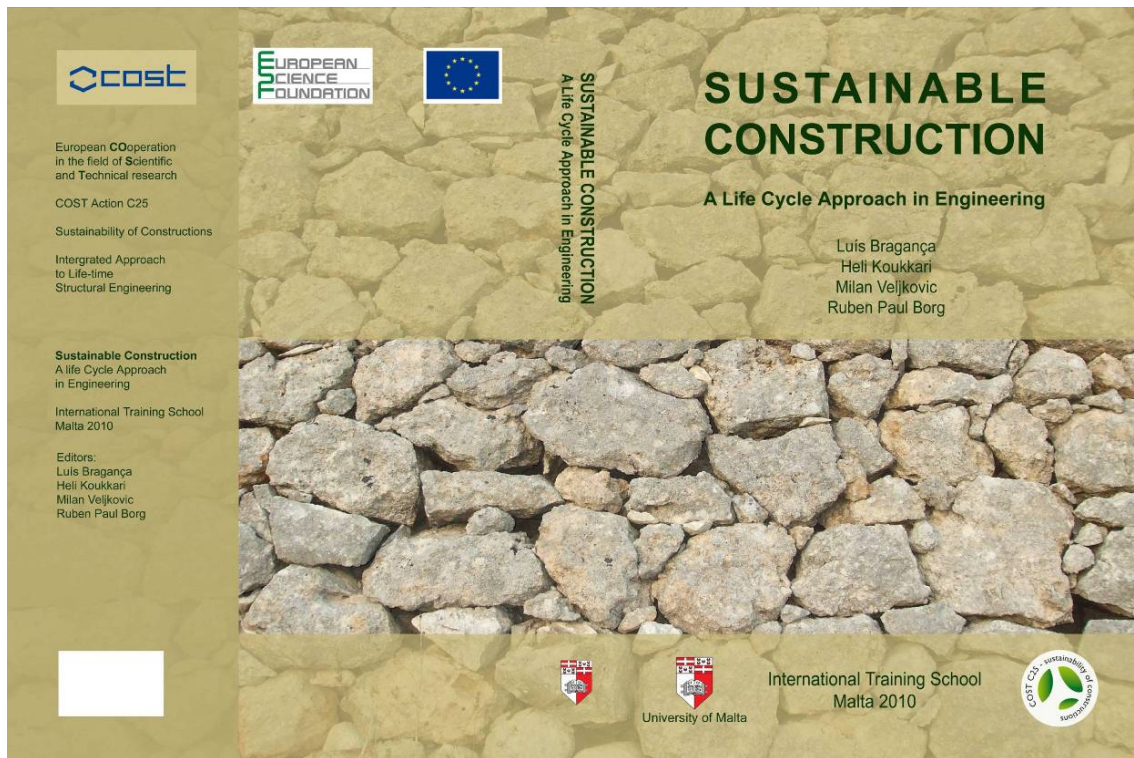


Figure 2. International Training School: Sustainable Construction, Malta 2010. (Braganca et al, 2010b)

#### 4. ASSESSMENT OF THE SYMPOSIUM AND TRAINING SCHOOL: MALTA 2010.

##### 4.1 General

Important considerations were taken for the effective organization of the Symposium and training School. The success of the International Symposium and Training School, was considered to depend on a number of important considerations, related to education aspects for Sustainable Development. In this regard the organization of the two events, was based on criteria intended to ensure the smooth and effective progress of the events, in relation to effective methodologies.

##### 4.2 Symposium and Training School Organisation: An Overview.

The events were held in Valletta, in the Aula Magna of the Valletta Campus of the University of Malta. The conference opening ceremony was hosted by the Pro-Rector of the University of Malta, and introductory speeches were made by the local host Ruben Paul Borg of the University of Malta and MC member of COST C25, the Dean of the Faculty for the Built Environment, the Pro-Rector of the University of Malta, and the representative of the Chairman of COST Action C25.

The Symposium and Training School were advertised in various Universities and Research Institutions throughout Europe, during the months preceding the event. A Brochure and posters were distributed through internet/e-mail and post. Furthermore, the International Symposium and Training School were advertised through the University of Malta Website Home Page, the regular weekly e-mail newsletter to academics of the University of Malta, through the Malta Chamber of Architects and Civil Engineers, and also the local media, in particular the Sunday Times of Malta.

A website dedicated to the conference was set up at the University of Malta [[www.um.edu.mt/events/sustainableconstruction2010](http://www.um.edu.mt/events/sustainableconstruction2010)]. The website was regularly updated with all the relevant information. An Intranet section for document upload and download by partici-

pants was also set up. Internet access was provided throughout the events. A number of local students of the University of Malta also participated and supported during the event. Furthermore a number of academics from the University of Malta participated in the event, and local experts in specific areas also participated and presented specific topics.

The conference pack was distributed to all the participants of the Symposium and Training School, and included useful information and technical data. The two publications, namely the symposium proceedings and the lecture notes publication, were presented to all participating researchers and lecturers during the event. Additional material and documents were provided as digital data to each participant, and also made available for download on the Intranet service on a regular basis. The training School teaching methodologies included, lectures, practical work conducted under the supervision of the lecturers, Work group sessions for the group work, and also student presentations and discussions. In addition a number of technical visits were organized, including a visits and lectures, at the Archaeological Park UNESCO World Heritage Site (Mnajdra and Hagar Qim Megalithic temples), and the Xrobb il-Ghagin Sustainable Development Centre and Nature Park. A social and cultural programme for students and lecturers was also organized throughout the events, together with various group activities. A feedback questionnaire was also compiled and completed by participants, to help assess the Symposium and the Training School.

#### *4.3 The Early Stage Researchers Collaborative Research projects.*

The Early Stage Researchers (ESR) made presentations during the Symposium, at the start of the events. Following this, and on the basis of the presentations of their research work, the ESR were organized into 6 different groups, with each group addressing and working on a specific topic of interest to the group members. The group work went on throughout the summer school. At the end of the Training School the ESR groups made presentations of the work conducted and presented abstracts of their research proposal. In addition the groups remained in contact, and after the summer school, each group developed research papers on the respective topics.

The Collaborative Research projects with the active participation of lecturers, were also considered to be an effective approach.

#### *4.4 Review of the Teaching Material*

The researchers participating in the training school consisted of architects and engineers in various stages of research ranging from; progressing into a PhD; those completing PhD research; nearing the end of a thesis, and those having already completed a PhD and currently working within the field of research, considered as early stage researchers.

A basic assessment of the teaching material available during the Training School was carried out. The available teaching material was assessed and classified with respect to criteria as follows: basic to specific knowledge of sustainable construction; relevance for different disciplines; tools to assist with sustainable design. For the basic assessment and convenience, the teaching material was classified under the specific titles.

The Basic level refers to a general, broad field of knowledge on sustainability and sustainable construction; the Intermediate level refers to a more advanced level of knowledge where particular areas within sustainable construction are being highlighted in more detail; and Advanced Level refers to very specific tool based exercises & assessment workshops that were conducted. The teaching material can be divided up into these education & knowledge levels as follows:

##### *Basic Level of Knowledge*

The basic teaching material available included lectures on the following topics:

- Sustainability of Constructions: Integrated Approach to Life-time Structural Engineering.
- Sustainable Construction and the Integrated Life Cycle Approach.
- Environmental Assessment of Buildings & Building Material.
- Eco-efficient Structures.
- Eco-efficiency & Sustainable Construction; A case study of a Residential Modular Building designed for 2 climate regions.
- Sustainable Rehabilitation Strategy: Xrobb il-Għaġin Sustainable Development Centre & Nature Park.
- Intelligent use of Energy & Renewable Energy Sources (RES).

This general material was familiar to all demonstrators present and therefore also appealed at a multi-disciplinary level.

#### *Intermediate Level of Knowledge*

The intermediate material available included lectures on the following topics:

- Sustainable Constructions; Life Cycle Inventory Analysis.
- Durability Design of Metal Structures.
- Design for Deconstruction, Demolition and Recycling.

This material appealed to all those present but in two different ways. For engineers the new knowledge received was practicable in their field of expertise, whereas for architects without a specialism in engineering these topics were of an introductory interest and of value to contributing to their overall understanding of LCA.

#### *Advanced level of Knowledge*

The advanced knowledge was delivered in the form of lectures and informal tool based exercises allowing scope for experimenting and feedback. The areas presented included:

- Sustainable Technologies for Maintenance of Structures & Case Studies.
- Multi-criteria Decision Making Methods in Refurbishment, Deconstruction and Demolition of Existing Structures.
- Life Cycle Design Methodologies.
- Life Cycle management of Structures.

These tool based exercises exposed new knowledge & tools to those engineers with a more advanced knowledge of LCA. These ‘advanced’ teaching & discussion sessions then gave rise to an opportunity for those at a higher end of the learning spectrum to contribute their opinion and knowledge to the development of that tool.

#### *4.5 General Conclusions*

A wide spectrum of teaching material was made available across a variety of disciplines. This therefore highlights that new information was provided for all those present and that there was a wide spectrum of knowledge levels considered to allow all researchers present to be exposed to new knowledge in their field of expertise. The basic material gave a good introductory platform

for those at the beginning of PhD research and the exposure to the different levels of knowledge also emphasised the opportunities available for valuable exchange of knowledge at such training schools. The advanced material then supplied those with a high level of research knowledge to experiment, practice and also develop their knowledge and new tools that would eventually lead to effective contributions in the field of engineering & LCA.

## 5. CONCLUSION

The Symposium and Training School were effective for students and led to the development of collaboration on research work. In addition the events were useful for the dissemination and sharing of knowledge. The teaching material developed for the Training School, can be used as a basis for the development of teaching materials to be used in Built Environment Schools in different countries. The teaching material from the training school in Malta can be considered as useful to assist with the curriculum reform in participating universities. The student feedback following the Symposium and the training School, also provided useful information for the future development of Training Courses. In particular the work group sessions, and discussion sessions were commended, and teaching method which rely more on active methods of teaching and learning and reflective practice are encouraged.

## ACKNOWLEDGEMENTS

The Lecturers and the Early Stage Researchers participating in the International Early Stage Researchers Symposium and the Training School in Malta during the Summer of 2010, are acknowledged for their contribution in the International Symposium and Training School. All the researchers participating, and L. Robinson & J. McCullough (Queen's University, Belfast) are acknowledged for their feedback and critical review. The Faculty for the Built Environment and the University of Malta, Malta are acknowledged for supporting the events and the publications.

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