COST

Domain Committee "Transport and Urban Development"

COST Action TU0904

Start Date (29/03/2010*)*

Integrated Fire Engineering and Response (IFER)

MONITORING PROGRESS REPORT

Reporting Period: *from 25 May, 2012 to 10 June, 2013*

This Report is presented to the relevant Domain Committee.
It contains three parts:

I. Management Report *prepared by the COST Office/Grant Holder*
II. Scientific Report *prepared by the Chair of the Management Committee of the Action*
III. Previous versions of the Scientific Report*; i.e., part II of past reporting periods*

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.D. Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary (max.250 words):

Fire safety is nationally managed across Europe, and the specific experiences of each country determine its requirements. While the political motivation for this is obvious, this leads to similar processes being continually re-researched and re-invented. COST TU0904 *Integrated Fire Engineering and Response* was created with the objective of making a step-change to this process of re-invention. The EU has the greatest concentration of expertise in the world in fire engineering research, but this is unevenly spread. The intention is to change the knowledge and capabilities in countries which are just starting to gain an appreciation of the state of the art, by allowing their researchers to network with the current leaders in the field.

In research terms the Action has involved:

- running two research conferences;
- compiling examples of the state of research in fire engineering;
- providing unique opportunities (via Summer Schools) for over 50 young researchers (MSc/PhD students)when they have learned from world leaders in fire engineering research, presented their research for scrutiny and assistance, and networked widely with established experts and their peers;
- producing a collection of comparative benchmark studies to assist future researchers in verifying their computational approaches.

For practical fire engineering, a volume of advanced design cases has been published, which will promote the use of performance-based methods throughout Europe. A volume on fire and rescue reports and lessons from disasters has also been published.

I. Management Report prepared by the COST Office/Grant Holder

I.A. COST Action Fact Sheet

Title

Integrated Fire Engineering and Response (IFER)

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Details

Draft Mou:
Start of Action: 29/03/2010
End of Action: 28/03/2014
Mou: 284/09
Entry into force: 20/01/2010
CSO approval date: 02/12/2009

Objectives

The main objective of this Action is to break down the barrier preventing the exchange of information and experience between researchers from different disciplines on the one hand and between academia and practitioners (including fire-fighters) on the other hand. Thanks to the exchange of international experience, ideas and state-of-the-art on fire risk concepts and assessment methods, the Action aims at providing concrete applications of the performance-based fire safety design methods to practitioners and at introducing the latest research into standards for fire design.Fire engineering researchers are specialists working in specific areas, such as fire dynamics, structural fire engineering, active/passive fire protection, environmental protection and human response. Since the background sciences of these disciplines are different at present there is little interaction between researchers. Practitioners, including fire engineers and building/fire control authorities, tend to consider fire safety as a whole, but lack in-depth awareness of recent advances in research. Through encouraging integration of different aspects of fire engineering and response, the Action will enable researchers with different fields of expertise and coming from different countries to understand better the recent advances in research in parallel fields, as well as their limitations, so that they see their own research in context, and identify opportunities in involvement of early-stage researchers and application of the results in national standards. Practitioners, fire fighting authorities and building control authorities will benefit from exposure to advanced research findings, discussion with the research community, and the sharing of best practice and others’ experiences. On the other side their input will make researchers aware of real-world constraints, as well as current requirements for new research and for the development of European standards.

Parties

Country	Date	Country	Date	Country	Date	Country	Date
Austria	03/02/2010	Belgium	03/02/2010	Croatia	08/10/2012	Czech Republic	12/07/2010
Finland	20/01/2010	France	10/02/2010	Germany	20/01/2010	Greece	10/03/2010
Hungary	12/07/2010	Iceland	05/07/2010	Italy	03/02/2010	Malta	23/02/2011
Poland	20/01/2010	Portugal	26/01/2010	Romania	03/02/2010	Slovakia	10/05/2010
Slovenia	08/10/2012	Spain	20/01/2010	Sweden	10/05/2011	Switzerland	12/07/2010
The Former Yugoslav Republic of Macedonia	03/02/2010	United Kingdom	20/01/2010				

Total: 22

Intentions to accept the MoU							
Country	Date	Country	Date	Country	Date	Country	Date

Total: 1 (Turkey)

Participating Institutions from non-COST countries	
New Zealand	HERA House
New Zealand	HERA

Working Groups
WG1: Fire behaviour and Fire Safety
WG2: Structural Safety
WG3: Integrated Design

Dr Ana Maria Lacasta, ES	*WG1*
Dr Bart Sette, BE	*WG1*
Dr Bin Zhao, FR	*WG1*
Dr Dan Pintea, RO	*WG1*
Dr Dimitrios Tsatsoulas, EL	*WG1*
Dr Florian Block, UK	*WG1*
Dr Guillermo Rein, UK	*WG1*
Dr Iolanda Del Prete, IT	*WG1*
Dr Jean-François Cadorin, BE	*WG1*
Dr Lajos Gábor Takács, HU	*WG1*
Dr Mariusz Maslak, PL	*WG1*
Dr Miodrag Drakulic, HR	*WG1*
Dr Ulf Goransson, SE	*WG1*
Dr Zenon Drabowicz, PL	*WG1*
Mr Antalné Lörik, HU	*WG1*
Mr Bodvar Tomasson, IS	*WG1*
Mr Carlos Couto, PT	*WG1*
Mr Christoph Klinzmann, DE	*WG1*
Mr Guiseppe Iazetta	*WG1*
Mr Krzysztof Biskup, PL	*WG1*
Mr Luis Laim, PT	*WG1*
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Ms Kalliopi Zografopoulou, EL	*WG1*
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Prof. Fabio Casciati, IT	*WG1*
Prof. Gianfranco De Matteis, IT	*WG1*
Prof. Goran Turk, SI	*WG1*
Prof. Jean-Marc Franssen, BE	*WG1*
Prof. Joao Paulo Rodrigues, PT	*WG1*
Prof. Markku Heinisuo, FI	*WG1*

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Dr Frederic Marimon, ES	*WG2*
Dr Gaetano Della Corte, IT	*WG2*
Dr Giuseppe Cefarelli, IT	*WG2*
Dr Jochen Köhler, CH	*WG2*
Dr Jochen Zehfuss, DE	*WG2*
Dr Leslaw Kwasniewski, PL	*WG2*
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Mr Fernando Morente Belmez	*WG3*
Mr Gianluca De Sanctis, CH	*WG3*
Mr Jim Marsden, UK	*WG3*
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Website
http://fire.fsv.cvut.cz/ifer

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I.C. Overview activities and expenditure

3.rd year Budget

Total Action Budget:
145.000,00

Remaining Action Commitment: ***accrued expenses are marked with ****

Meetings

Meeting Type	Date	Place	Nb of reimbursed participants	LOS	Total
MC and WG Meeting	*8-9/10/2012*	*Zadar (HR)*	*36*	*yes*	***27.218,47***
MC and WG Meeting	*18-19/04/2013*	*Prague (CZ)*	*39*	*yes*	***15.641,34 7.642,72* 2.434,08 estim.***
Core group and WG Meeting	*5-6/06/2013*	*Naples (IT)*	*14*	*yes*	***12.000,00 estim.***

STSM

Beneficiary	Date	Place	Host	Topic	Cost	Total
Robert Pecenko	*07-18/01/2013*	*Sheffield (UK)*	*Ian Burgess*	*Benchmark studies*		***1.200,00***
Carlos Couto	*14/01-15/02/2013*	*Paris (FR)*	*Bin Zhao*	*Verification and numerical validation of benchmark studies*		***1.200,00***
Monika Hajpal	*10-16/02/2013*	*Sliema (MT)*	*Ruben Paul Borg*	*Fire performance of building materials; Limestone and concrete masonry*		***1.000,00****
Neno Toric	*11-25/02/2013*	*Sheffield (UK)*	*Ian Burgess*	*Numerical modelling of steel structures exposed to fire*		***1.200,00***
Maja Ban	*18/02–03/03/2013*	*Bath (UK)*	*Shrikant Sharma*	*People movement and evacuation*		***1.200,00***
Ioan Both	*01-31/03/2013*	*Warsaw (PL)*	*Leslaw Kwasniewski*	*Benchmarks for thermal and mechanical response of structures subjected to fire actions*		***1.200,00***
Martin Prachar	*12/03-02/04/2013*	*Aveiro (PT)*	*Paulo Vila Real*	*Lateral Torsional Buckling of Beams of Class 4 Cross-Section at Elevated Temperature*		***1.200,00***

Jan Hricak	*05-27/04/2013*	*Derio (SP)*	*Fernando Morente Belmez*	*Local Buckling of Beams of Class 4 Cross-Section at Elevated Temperature*		***1.200,00***
Sebastien Durif	*06-20/04/2013*	*Sheffield (UK)*	*Ian Burgess*	*Design developments for cellular beams in fire conditions*		***1.200,00****
Gisele Bihina	*18-24/04/2013*	*Prague (CZ)*	*Frantisek Wald*	*Numerical modelling of steel and concrete composite structural members in fire situation*		***930,00***
Antonio Bilotta	*16-23/06/2013*	*Edinburgh (UK)*	*Martin Gilie*	*Fire behaviour of FRP-RC members: experimental results and numerical simulations*		***1.120,00****

Workshops

Title	Date		Place		Cost	Total
						0

General Support Grants

Beneficiary	Date				Cost	Total
						0

Schools

Title	Date	Place	Details	Cost	Total
Training School	*6-9/06/2013*	*Naples (IT)*	*"Fire Engineering Research - Key Issues for the Future II", 28 trainees, 12 scholars*		***35.750,00 estim.***

Dissemination

Title	Date	Place		Details	Cost	Total
Action Website	*12/2013*	*Prague (CZ)*		*Preparing and service from 6/2012 to 6/2013*		***2.000,00***
Integrated Fire Engineering and Response, Fire Brigade Reports and Investigations	*06/2013*	*Prague (CZ)*		*Print release, 168 pages, 200 copies*		***653,55***
Proceedings of International Conference ASFE, Prague 19-20 April, 2013	*06/2013*	*Prague (CZ)*		*Print release, 516 pages, 250 copies*		***2.171,94***
Fire Engineering Research - Key Issues for the Future II, Materials of Training School	*06/2013*	*Prague (CZ)*		*Print release, 170 pages, 200 copies (Distribution included)*		***1.487,00 estim.***

Others

Financial and Scientific Administration and Coordination	***18.913,00***

Action Total: ***138.562,10***
(estimations included)

II. Scientific Report *prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is "cumulative"). All items listed in Sections A, B, and C, below, must be addressed.*

Additional documentation such as extended scientific reports, proceedings of workshops, seminars or conferences may be provided separately as an annex to this report, and should be referenced in the report.

II.A. Networking during the Action Year 2012 – 2013

The budget for 2012-2013 enabled both the planned meetings and work packages to happen, as well as enabling the Action to support young researchers to a considerable extent. This will clearly be one of the enduring benefits of TU0904 – more than 50 young researchers have attended training courses which will give their subsequent careers a kick-start.

MC/WG Meetings in Zadar, 8-9 October 2012

The meeting received the comments from the DC meeting in Iceland (4-5 July 2012);

"The DC acknowledges the added-value of the Action with regard to producing concrete applications of performance-based fire safety design methods for practitioners and to introducing the latest research into standards for fire design. The DC is very eager to see the final tangible output of the Action."

A major function of the meeting was to receive and finalize publication of WP3 (Fire brigade reports and investigations). The final document would consist of 22 articles, in three categories: organisation of national fire and rescue arrangements in different EU countries, contributions from available statistical data, and lessons learned from disasters. There are clearly problems with comparability of national statistics, collected in very different ways, and it is recommended that questions be included in standardised national fire fighters' reports in future. The contributing experts had prepared full textual versions of their contributions, which were subsequently published at the end of 2012. The ASFE 2013 conference, to be held in April 2013, was prepared at the meeting. It was decided to cover the following themes: people movement, fire and smoke development, structural response, use of fire brigade investigation reports, and benchmark studies. As in previous ASFE conferences, all participants were asked to contribute a poster, with adequate time set aside for poster sessions and competitions for "best poster" and "best young researcher" (the latter judged by international experts on the basis of poster/paper/presentation).

MC/WG Meetings in Prague, 18-19 April 2013

Using an arrangement which had proved successful in earlier meetings, the WG and MC meetings in Prague were interspersed so that WG presentations on benchmarking studies were held in plenary session during the MC meeting. The 22 presentations included both first drafts of the benchmark studies from experts from the Action and three general presentations on the principles of benchmarking within the different areas covered. The latter were given by one European expert outside the Action (Professor Bart Merci) and two well-known international authorities (Professors Venkatesh Kodur and Kang-Hai Tan). These were of such quality that it has been decided to include them in the published volume of benchmark studies. The meeting also recorded that 10 STSMs had been associated with benchmarking collaborations between institutions; all of these were complete, and were contributing considerably to the credibility of the work package.

ASFE 2013 Action Conference, Prague, 19-20 April 2013

The Conference was held over two days, with a combination of plenary and parallel (themed) sessions. As planned, a considerable emphasis was given to poster presentation, including open voting for the best poster overall, and selection by international experts of the best young researcher. The Conference Proceedings, including all 72 papers, 62 slide presentations and 55 posters, all in PDF form, are available for download from the Action's website, and so the subject areas covered need not be detailed here. The two-day schedule, together with the parallel sessions, made it possible to give the necessary emphasis to all aspects of the conference, including sufficient time for the poster sessions at which detailed discussions took place.

Core Group meeting in Naples 5-6 June 2013

The main tasks of the Naples Core Group meeting mainly concerned planning of activities in accordance with the budget for the final year of the Action. These included: devising a fair process for selecting papers from the ASFE 2013 conference for journal publication; proposals for follow-on COST actions and for educational projects spun-off from the current Action; finalizing the current deliverable on benchmark studies; initial planning of the next deliverable, on suggestions for Eurocode upgrades. Two proposals for follow-on COST actions will be developed further, one on the resilience of the built environment against disasters and

the other on the effects of smoke in building fires; a further proposal for Master's course provision will also be developed for the upcoming Erasmus for All programme. Importantly, the budget will allow the Action to capitalize on one of its most successful aspects so far – the training of the young researchers who will be the next generation of leaders in research and practice in fire engineering. After a detailed and constructive discussion it was decided to provide a further training event in Lulea (March 2014) focused on integration of the major analytical computations involved in performance-based fire engineering: the movement of building inhabitants, growth of the fire and smoke movement, and thermo-mechanical modelling. This will be offered to researchers who have contributed to the current benchmarking studies, with the possibility that those who have not so far been involved can enter this work package in the next few months. This event will also include an interactive day during which the students will present and discuss their benchmark studies. The arrangements for finalizing and publication of the first volume of benchmark studies in late 2013 were also determined. It is hoped to utilize 14 STSMs which the budget will fund in the 2013-2014 year to provide real depth and credibility to the comparisons inherent in the benchmark studies; various groupings, to provide comparative studies, were formed during the meeting. The next deliverable of the Action is consideration of necessary upgrades/amendments to the Eurocodes for fire, and the arrangements for this phase were decided; a questionnaire will be devised and managed by Dr Jyri Outinen, and the general leadership and coordination of this phase will be undertaken by Professor Paulo Vila Real.

Training School at Naples 6-9 June 2013

The Training School for Young Researchers was conducted from the afternoon of 6 June to the evening of 9 June 2013. The highly successful format of the Malta course in 2012 was followed; the first 1½ days was devoted to presentations from some of the most active research leaders in fire engineering in Europe, together with the industrial design and the fire and rescue service viewpoints. However, the presentations were in 2013 enhanced by one from the most prominent researcher in fire engineering in the USA, Professor Venkatesh Kodur from Michigan State University, plus research presentations from the host institution, the University of Naples 'Federico II'. The objective, as previously, was to give thought-provoking presentations which encouraged wide-ranging discussion and seeding of new ideas to the potential next generation of research leaders in the field. The next two days were filled with "brainstorming" sessions in which each of 28 young researchers (a new cohort compared with those in 2012) introduced his/her own work, and an open discussion including the experts was held to attempt to focus thought and help with perceived problems. Clearly considerable value was added by the networking opportunity for these young researchers to make valuable contacts for their future careers in fire engineering research or practice, and to discuss their work informally with research leaders.

II.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*
- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*
- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

The work of the Action is inherently inter-disciplinary, since it brings together researchers from different disciplines (structural fire engineering and fire science). The viewpoint of responders has been fundamental to WP3, published within the year of this report, and at both training courses held so far one of the presentations to the young researchers has been from Jim Marsden, who is an experienced ex-fire-officer. Interaction between researchers in fire science and structural fire engineering, which is very rarely possible within their home academic departments, has been a particular feature of the Summer School in Naples, at which the presentations from young researchers, and detailed subsequent discussions, covered both fields. Comments from both the participants and the experts involved in the course made it clear that this had been a useful cross-fertilization exercise which will yield scientific and potentially economic benefits throughout the professional careers of the young researchers.

II.C. New networking

- *Additional new members joining the Action during period 2012-2013*

  During the period 15 new members joined the Action: Oliver Bahr (DE), Eva Caldova (CZ), Gianluca De Sanctis (CH), Iolanda Del Prete (IT), Metod Gaber (SI), Giuseppe Iazetta (IT), Michal Jandera (CZ), Jerneja Kolsek (SI), Luis Laim (PT), Cesar Martin Gomez (SP), Fernando Morente Belmez (SP), Andras Nador (HU), Robert Pecenko (SI), Seradar Selamet (TR), Kalliopi Zografopoulou (EL).

- *Total number of individual participants involved in the Action work*

  At present 162 individuals have participated the Action, of which 17,90% have been female and 33,95% early-stage researchers.

- *Involvement of Early Stage Researchers in the Action*

  10 STSMs had been planned for grant year 2012-2013. The budget after Prague meeting allowed more STSMs, which were approved:

  1. *Robert Pecenko, 07-18/01/2013, from Ljubljana (SI) to Sheffield (UK), host Ian Burgess, topic Benchmark studies*
  2. *Carlos Couto, 14/01-15/02/2013, from Aveior (PT) to Paris (FR), host Bin Zhao, topic Verification and numerical validation of benchmark studies*
  3. *Monika Hajpal, 10-16/02/2013, from Budapest (HU) to Sliema (MT), host Ruben Paul Borg, topic Fire performance of building materials; Limestone and concrete masonry*
  4. *Neno Toric, 11-25/02/2013, from Split (HR) to Sheffield (UK) , host Ian Burgess, topic Numerical modelling of steel structures exposed to fire*
  5. *Maja Ban, 18/02– 03/03/2013, from Split (HR) to Bath (UK), host Shrikant Sharma, topic People movement and evacuation*
  6. *Ioan Both, 01-31/03/2013, from Timisoara (RO) to Warsaw (PL), host Leslaw Kwasniewski , topic Benchmarks for thermal and mechanical response of structures subjected to fire actions*
  7. *Martin Prachar, 12/03-02/04/2013, from Prague (CZ) to Aveiro (PT), host Paulo Vila Real, topic Lateral Torsional Buckling of Beams of Class 4 Cross-Section at Elevated Temperature*
  8. *Jan Hricak, 05-27/04/2013, from Prague (CZ) to Derio (SP), host Fernando Morente Belmez, topic Local Buckling of Beams of Class 4 Cross-Section at Elevated Temperature*
  9. *Sebastien Durif, 06-20/04/2013, from Clermont-Ferrand (FR) to Sheffield (UK), host Ian Burgess, topic Design developments for cellular beams in fire conditions*
  10. *Gisele Bihina, 18-24/04/2013, from Paris (FR) to Prague (CZ), host Frantisek Wald, topic Numerical modelling of steel and concrete composite structural members in fire situation*
  11. *Antonio Bilotta, 16-23/06/2013, from Naples (IT) to Edinburgh (UK), host Martin Gilie, topic Fire behaviour of FRP-RC members: experimental results and numerical simulations*

  During the grant period applications to Conference grant for early-stage researchers were supported by the Action. Unfortunately, these were unsuccessful.

  Training School "Fire Engineering Research – Key Issues for the Future" ran the second time This time in Naples (IT) 6-9 June, 2013. A total of 28 young researchers participated the 3 and a half day of intensive course:

  - *Ioan Both (RO)*
  - *Josip Radeljic (HR)*
  - *Piotr Smardz (PL)*
  - *Bartolomiej Sawicki (PL)*
  - *Tai Ikumi Montserrat (SP)*
  - *Francisco Nieto (SP)*
  - *Maria Perez (SP)*
  - *Flavio Arrais (PT)*
  - *Andre Reis (PT)*
  - *Mikko Partanen (FI)*
  - *Timo Jokinen (FI)*
  - *Iolanda Del Prete (IT)*
  - *Antonio Bilotta (IT)*
  - *Urska Bajc (SI)*
  - *Dusan Ruzic (SI)*
  - *Milica Jovanoska (MC)*
  - *Kalliopi Zografopoulou (EL)*
  - *Elena Trimcheska (MC)*
  - *Eva Caldova (CZ)*
  - *Kamila Horova (CZ)*
  - *Magdalena Dufkova (CZ)*
  - *Cristian Maluk (UK)*
  - *David Rush (UK)*
  - *Naveed Iqbal (SE)*
  - *Abdulaziz Alarifi (UK)*
  - *Ross Johnston (UK)*
  - *Katarzyna Ostapska (PL)*
  - *Guan Quan (UK)*

  Early-stage researchers are involved in the work of the Action´s work packages. During Zadar meeting, Prague meeting and ASFE conference, there were many contributions done by early- stage researchers. Topic of STSMs were mainly focused on Actions work package 4 Benchmark Studies.

- *Involvement of researchers from outside the COST Countries*

In the Action there is one member from a non-COST country – Stephen Hicks, of HERA, New Zealand; unfortunately he was not able to participate in our meetings during this year. A new member form Turkey, Serdar Selamet joined the Action during the Prague meeting.

Three experts were invited to the Prague meeting, 2 of them from non-COST countries:

1. *Bart Merci (BE), Fire and smoke modelling: Where are we (going)?,*
2. *Venkatesh Kodur (USA), Bench marking for Evaluation Fire Response of Materials and Structural Systems,*
3. *Kang Hai Tan (Singapore), Effect of unprotected interior beams of membrane behaviour of composite floor systems in fire.*

They contributed to WP4 Benchmark studies. Prof. Venkatesh Kodur also participated Training School with the course to The US view post 9/11.

- *Advancement and promotion of scientific knowledge through publications and other outreach activities*

  All documentation concerning the progress of the work of the Action is available for download at the Action's website http://fire.fsv.cvut.cz/ifer. This includes all presentations from meetings, papers and full versions of printed publications.

  The main deliverable output of the year 2012-13 is a volume "Integrated Fire Engineering and Response: Firemens' Reports and Investigations". The final printed version contains 16 contributions from across the participant nations, in a volume of 168 pages. A total of 200 copies have been printed and are being distributed by the participants within individual countries.

  Proceedings of the International Conference Applications of Structural Fire Engineering, Prague 19-20 April, 2013. The volume includes 76 contributions in 516 pages. A total of 250 copies have been printed.

  The Training School conducted in Naples has given rise to the publication "Fire Engineering Research - Key Issues for the Future II". The printed volume includes the presentations of 11 scholars and the abstracts of the work of the 28 participating young researchers. The presentations of the trainees will be available from the project website.

  Several papers of members of the Action were published in Journal of Structural Fire Engineering in March and May 2013.

  Local seminars were organized in Croatia and Macedonia.

- *Activities and projects with COST network colleagues*

  Two proposals for future COST actions are currently being developed by members of the Action, together with a proposal for a Master's-level educational project. These will be developed further before the meeting at Aveiro in October 2013.

- *The capacity of the Action members to raise research funds*

  The networking offered by this Action has provided opportunities, beyond those which would normally exist via the academic meetings/conferences circuit, to meet and discuss potential research proposals. Proposals to the RFCS programme were made in the previous year; unfortunately these were not funded because of insufficient budget in the scheme, but they are currently being revised for resubmission.

II.D. Self evaluation

Indicate in no more than 1 page what, in the opinion of the MC, were the main successes, drawbacks (if any) and the key difficulties encountered (if any).

The third year of the TU0904 Action has reflected the strengths and the (relative) weaknesses in the partnership across Europe of academic researchers, practitioners and fire authorities.

The largest single group of partners in the Action consists of structural fire engineering researchers from universities, with the second-largest group being fire science researchers. In a period of economic cut-backs in the funding of public services it has proved to be quite difficult to guarantee consistent attendance from representatives of Fire and Rescue Services, although there was a reasonable representation of these services at the start of the project. The most difficult of the deliverables to bring to fruition was therefore

WP3 (Fire Brigade Reports). This is unfortunate, because it is the Fire and Rescue community which is least aware of the state of the art in research on subjects such as fire spread and the real effects of fire on structures of different types; clearly there is considerable hands-on experience within this group, but this has largely been accumulated from the older structural types (largely domestic). Nevertheless, although less extensive in volume than we would have wished, the WP3 publication contains useful examples of lessons to be learned from fire events, and guidance about best practice.

On the other hand, the training courses ("Summer Schools") have been very successful. It has been possible to attract some of the world's key experts in several areas to come to give their views on the current boundaries of research and advanced practice to the young researchers from around Europe. These experts have also been willing to contribute very fully in the discussions, both on the expert presentations and on the students' own work. This added very considerably to the value of the training courses to the young researchers. As in the previous year's training course the brainstorming sessions enabled the participants to think about each other's work and to attempt to assist in its development; this broadening of the research context should be very valuable for their development as research workers or as practitioners. The informal networking and the new contacts made among the young researchers will also be useful to them in future.

The ASFE conference is now well-established in the calendar of the fire engineering research community, and seems destined to continue as one of its major events. Its format is particularly advantageous for young researchers, in giving them experience of research presentation using a range of different media.

III. Previous scientific report(s)

1) Scientific Report of the 2nd grand period

II.A. Networking during the Action Year 2011 – 2012

Having struggled in the previous year with a budget which did not allow all of the originally planned activities to take place, given the eventual number of signatory countries, it was fortunate that the 2011-12 budget had increased substantially. Although 22 countries have now signed-up to the Action it proved possible not only to fulfil the original intentions for the year, but to include a successful Training Course for young researchers.

Working Group Meetings at Chania, Greece on 14-15 October 2011

The Working Group and Management Committee meetings at Chania were interspersed so that Working Group presentations, which were held in plenary session, took place between the opening and closing sessions of the MC meeting. Presentations were given at the meeting in two sessions (16:00-19:00 on 14 October, and 09:30-14.00 on 15 October). The 35 presentations represented final drafts of the design case studies which have subsequently been published in hard-copy as a compendium providing a guide to the practice of performance-based design. A template for the final format of these had been prepared by the Action Chairman, and a check-list of information to be covered had been prepared by Dr Florian Block. The case studies contain a considerable amount of integration between structural fire engineering, fire behaviour and provision for response, and therefore their associations with the themes of Working Groups were; 15 WG1, 18 WG2 and 11 WG3. The common factor in all of the case studies was their association with real construction or refurbishment projects for which fire safety issues had been dealt with as part of the building design, usually on a performance basis.

The Chania MC meeting received the feedback from the 2011 DC meeting, that progress was "In Line" with the MoU, with advice; 1. to develop promotion activities in non-specialist publications, in order to advertise itself more effectively; 2. to emphasize inputs to standardisation. Arrangements were made to finalise and publish the compendium of Case Studies. The MC noted the greatly improved budget, but the desire to run a worthy Training Course for young researchers (postponed from 2010-11) suggested that the planned meetings at Luleå would prove too expensive. An offer to conduct the MC and Training course in sequence in Malta in April 2012 provided a potential solution to this problem. The vice-Chairman outlined a tentative scheme for the Training Course, which would be entitled "Fire Engineering Research - Key Issues for the Future", and would run for 3½ days. The proposal was accepted.

MC Meeting and Training Course at Sliema, Malta 10-14 April 2012

The Sliema MC meeting was partly devoted to preliminary discussions for future Work Packages (benchmark studies, the Prague ASFE conference in 2013, Eurocode recommendations, educational dimension), and partly to the intermediate (draft) stage of the next deliverable, Fire Brigade Reports. This will probably be the most challenging of the deliverables, since it is outside the research scope of the majority of national delegates to the Action, who are mainly academic researchers. A total of 27 draft presentations were given, generally falling into three categories: organisation of national fire and rescue arrangements, contributions from available statistical data and lessons from disaster. In all of these categories there seemed to be a

clear need for recommendations and templates to achieve standardization in both the approach and presentational format. It was therefore decided that a special two-day Core Group meeting should be held during June 2012 to decide these issues.

The Training Course for Young Researchers was conducted from the afternoon of 11 April to the evening of 14 April 2012. The first 1½ days was devoted to presentations from some of the most active research leaders in fire engineering in Europe, together with the industrial design and the fire and rescue service viewpoints. The objective was to give thought-provoking presentations which encouraged wide-ranging discussion and inspiration of new ideas to the potential next generation of research leaders of the field. The next two days were filled with "brainstorming" sessions in which each researcher introduced his/her own work and an open discussion was held to attempt to help with any perceived problems. Clearly a major advantage of the event was the opportunity for these young researchers to make valuable contacts and discuss their work informally.

II.B. Inter-disciplinary networking

The work of the Action is inherently inter-disciplinary, since it brings together researchers from different disciplines (structural fire engineering and fire science), and also includes interaction with the key players in design of buildings for fire resistance and in response to fire emergencies. The viewpoint of responders is fundamental to the Work Package which is currently in progress, and it was considered essential that this viewpoint be emphasized to young researchers in the Malta Training Course.

II.C. New networking

- *Additional members joining the Action during 2011- 2012*
  ***Croatia:** Prof. Dubravka Bjegovic, Prof. Bernardin Peros, Dr. Miodrag Drakulic, Ms. Marija Jelcic Rukavina.*
  ***Slovenia:** Prof. Goran Turk, Dr. Tomaz Hozjan.*

- *Total number of individual participants involved in the Action's work*
  At present 118 individuals have participated in the Action, of which 16,95% have been female and 40,67% Early-stage Researchers. The latter number has increased particularly because of the Training School.

- *Involvement of early-stage researchers in the Action*
  STSMs
  6 STSMs had been planned for grant year 2011-12, but the budget was modified after the second meeting to allow more STSMs. The STSMs approved under the 2011-12 budget are:

  1. *Eki Lehtimäki, 05/12/2011 – 18/12/2011, from Tampere (Finland) to Sheffield (UK), host Ian Burgess, theme Integration of structural analysis in fire with building information model.*
  2. *Marcin Balcerzak, 10/03/2012 – 20/03/2012 from Warsaw (Poland) to Leeds (UK), host Florian Block, theme Computer simulation of structures in fire.*
  3. *Antonio Bilotta, 08/05/2012 - 17/5/2012 from Naples (Italy) to Edinburgh (UK), host Guillermo Rein, theme Fire behaviour of FRP-RC members: experimental results and numerical simulations.*
  4. *Jiri Jirku, 17/5/2012 – 26/05/2012 from Prague (Czech Republic) to Manchester (UK), host Yong Wang, theme Heat Transfer in Fire.*
  5. *Eva Dvorakova, 03/06/2012 – 13/06/2012 from Prague (Czech Republic) to Zurich (Switzerland), host Andrea Frangi, theme Numerical modelling of timber-concrete composite floors.*
  6. *João Ribeiro, 10/06/2012 – 15/06/2012 from Aveiro (Portugal) to Lulea (Sweden), host Milan Veljkovic, theme Impact Fire.*
  7. *Daphne Pantousa, 18/06/2012 – 25/06/2012 from Volos (Greece) to Sheffield (UK), host Ian Burgess, theme Numerical analysis of steel structures under fire conditions.*
  8. *Josef Sura, 05/06/2012 – 15/06/2012 from Prague (Czech Republic) to Bratislava (Slovakia), host Ludovít Fillo, theme Fire Design of Concrete Columns.*
  9. *Naveed Iqbal, 03/06/2012 – 09/06/2012 from Luleå (Sweden) to Coimbra (Portugal), host Aldina Santiago, theme COMPFIRE modelling.*

  Conference funding for young researchers
  Two requests were made for Conference Grants for Early-stage Researchers: Antonio Bilotta and Giuseppe Cefarelli (both from Naples) for the Structures in Fire conference 2012, Zurich. The response is awaited at present.

  Training School for young researchers
  This ran from 11 - 14 April, 2012 in Sliema, Malta. A total of 25 young researchers participated in the 3½-day intensive event "Fire Engineering Research - Key Issues for the Future":

- *Guillermo Abril* *Spain*
- *Alexandru Botici* *Romania*
- *Giuseppe Cefarelli* *Italy*
- *Carlos Couto* *Portugal*
- *Josep Culí* *Spain*
- *Aleksandra Cvetanovska* *FYR Macedonia*
- *Gianluca De Sanctis* *Switzerland*
- *Diana Duma* *Romania*
- *Roberta Fonti* *Italy*
- *John Gales* *United Kingdom*
- *Monika Hajpal* *Hungary*
- *Cecile Haremza* *Portugal*
- *Tim Heisterman* *Sweden*
- *Kamila Horova* *Czech Republic*
- *Tomaz Hozjan* *Slovenia*
- *Naveed Iqbal* *Sweden*
- *Jiri Jirku* *Czech Republic*
- *Pawel Krol* *Poland*
- *Daphne Pantousa* *Greece*
- *Robert Pecenko* *Slovenia*
- *Mikko Salminen* *Finland*
- *Ruirui Sun* *United Kingdom*
- *Csaba Szilagyi* *Hungary*
- *Teemu Tiainen* *Finland*
- *Neno Toric* *Croatia*

Networking activities

Early-stage researchers are involved in the work of the Action's work packages. During the Chania Meeting 16 contributions to WP2 were prepared in cooperation with young researchers. In the Malta Meeting 11 contributions to WP3 were based on the work of young researchers. In the published Case Studies 19 of the papers were prepared by young researchers.

- *Involvement of researchers from outside the COST Countries*

  In TU0904 6 researchers (5,08%) are from countries outside the COST Action. One external participant, Dr Stephen Hicks of HERA, New Zealand, participated in the Chania meeting, delivering a presentation "Fire performance of an office building with long-span cellular floor beams – Britomart East, Auckland", which is now published in the Case Studies document. From countries with a newly declared intention to participate in the Action, Prof. Dubravka Bjegovic, Prof. Bernardin Peros and Dr. Miodrag Drakulic joined the Chania and Malta Meetings. With their young researchers they published the paper "Reliability of steel roof structures of The Spaladium sports hall in case of fire" in the Case Studies.

  At the Training School early-stage researchers from countries outside the Action participated. Neno Toric from Croatia presented "New numerical models for behaviour of steel and concrete structures exposed to fire", Dr. Tomaz Hozjan from Slovenia presented "Analysis of steel–concrete composite beam with interlayer slip in fire conditions" and Robert Pecenko, also from Slovenia, presented "Fire analysis of prestressed hollow-core slabs".

- *Promotion of scientific knowledge through publications and other outreach activities*

  All documentation concerning the progress of the work of the Action are available for download at the Action's website http://fire.fsv.cvut.cz/ifer. This includes all presentations from meetings, papers and full versions of printed publications.

  The main deliverable output of the year 2011-12 is a volume "Integrated Fire Engineering and Response: Case Studies" describing practical fire engineering design applied to real projects in recent years. The final printed version contains 33 contributions from across the participant nations, in a volume of 374 pages. A total of 200 copies have been printed and are being distributed by the participants within individual countries.

  The Training School conducted in Malta has given rise to the publication "Fire Engineering Research - Key Issues for the Future". The printed volume includes the presentations of 8 scholars and the abstracts of the work of the 24 participating young researchers. The presentations of the trainees are available from the project website.

  Promotional text on the Action has been translated into local languages, to be published in different countries. This year an article has been published in the Finnish national journal of the Fire and Rescue Service. Two other articles, in Portuguese and German, are awaiting publication. An article about COST TU0904 was published in Newsletter 32 of the International Association of Fire Safety Science. This can be downloaded from the Action website.

  During the Chania Meetings information about the Action was published on the Greek web news. The article is available from the Action website.

  A local seminar was organized in the Czech Republic during February 2012 on the theme of the integration of performance-based calculation methods into fire safety solutions for structures. The COST action is promoted in the printed publication connected to this seminar. Other local seminars are under preparation for Spain (Ana Lacasta) and Greece (Daphne Pantousa).

- *Activities and projects with COST network colleagues*

  Prof. Dubravka Bjegovic is currently preparing a WP7 Educational Dimension proposal; at the Malta

Meeting she proposed that an educational project related to fire safety should be prepared by the Action. She has undertaken to distribute a brief summary, to generate a discussion of the form and content of this proposed initiative, and to allow members of the Action to propose their own contributions to it.

- *The capacity of the Action members to raise research funds*
  The networking offered by this Action has provided opportunities, beyond those which would normally exist via the academic meetings/conferences circuit, to meet and discuss potential research proposals. Initial discussions are progressing on several themes at present.

II.D. Self evaluation

The relative margin in the second year's budget, after the need to postpone the Training Course in the first year of the Action, allowed this important aspect to be improved over what could have been achieved in the first year. It proved to be possible to invite 25 young researchers to the course, and to provide a format which was suitable for high-level researchers, enabling them to hear and discuss controversial opinion pieces from some of the key researchers of the current generation. The brainstorming sessions enabled the participants to think about each others' work and to attempt to assist in its development; this broadening of the research context should be valuable for their development as research workers. The informal networking and the new contacts made among the young researchers will also be useful to them in future.
The Case Studies compendium has provided a useful library of practical experiences which will allow fire engineers throughout Europe to view state-of-the-art advanced fire engineered construction projects and the techniques employed. These will be invaluable in propagating performance-based fire engineering, which is a prime objective of the project.

III. Previous scientific report of the 1st grant period

III.A. Networking during the Action Year 2010 – 2011

Kick-off Meeting, Brussels 29-30 March 2010

The Management Committee (MC) kick-off meeting in Brussels was attended by representatives of 13 of the 14 countries which had joined the Action at that time. The Chair and vice-Chair of the Action were elected. It was explained that new COST Actions were part of a grants framework, and that CVUT Prague would therefore be considered as the grant holder. The Action budget had been calculated on the basis of the current number of signatories, with the implication that the joining of subsequent signatories would demand careful budget management during the year; this has influenced the activities of the year considerably, as will become apparent. The role and scope of each of the Working Groups (WGs) was debated, an initial allocation of MC members among the 3 WGs was made, and Chair and vice-Chair of each were elected.

Workshop at UPC Barcelona on 5-6 July 2010

The initial Workshop included presentations by all WG members, and meetings were held of the MC and the three WGs. In order to begin the process of integration, which is the major theme of the Action, all presentations were made to the whole membership and illustrated the current themes and expertise of the presenters' research groups. There were 52 10-minute presentations, all of which are now available on the Action website. As an additional means of communicating background information among the membership, participants prepared poster displays; 55 posters were produced which are also available via the Action website. Within the 3 WGs the scope of expertise is reflected in the subjects presented:
WG1: Fire Behaviour and Fire Safety: The presentations (12) showed a balance between:
- *summaries of fire science and fire safety research in various of the represented countries (Poland, Finland, Spain, Romania, Greece),*
- *research problems concerned with thermal analysis of steel and aluminium structures in fire,*
- *observation of thermal behaviour in real tests,*
- *approaches to the behaviour of fires and heating of structure in unusual design cases.*

WG2; Structural Safety: Among the academic research participants in COST TU0904 this is the most developed area of active research, and this provided the largest single group of presentations (26) on a variety of structural fire engineering themes:
- *summaries of structural fire engineering research and practice in various of the represented countries (Poland, Switzerland, Spain, Romania, Slovakia, Germany, Macedonia),*
- *new design proposals for fire safety in the Nordic countries,*
- *current research summaries for academic groups at ETH Zurich, TU München and CVUT Prague,*
- *the structural behaviour of concrete materials and structural elements, both during and after fires,*
- *observation and modelling of timber joints in fire,*
- *the effect of elevated temperatures on the structural behaviour of natural stone masonry,*
- *tests on loaded connections in car parks under the effect of localised fires,*

- *thermal analysis of steel connections in composite structures in fire,*
- *advanced numerical simulation of structural response to building fires,*
- *analyses of structural fire effects on structures already damaged by earthquake actions,*
- *steel beams under end moment in fire,*
- *temperature-dependent properties of fire protection materials,*
- *the need for design for robustness in future structural fire engineering practice.*

WG3: Integrated design: At the start of the Action it was important to update participants on the current context linking the engineering disciplines of fire safety and structural fire resistance design with national regulations and practice. There were 14 presentations from WG3 members:

- *summaries of regulations and current practice in various of the represented countries (Romania, Portugal, Czech Republic, UK),*
- *case studies in fire safety engineering from Portugal and Italy,*
- *case studies on protection of built heritage - report on recent projects and their possible impact on integrated design (Belgium),*
- *current research on fire safety at Warsaw University of Technology,*
- *analytical design studies of buildings for the case of fire after being damaged by earthquakes,*
- *mathematical and stochastic modelling in fire safety and design against extreme loadings in general.*

Working Group meetings before and after these presentation sessions concentrated on planning for the State-of-the-Art Report (WP1). The discussions produced different formats from the WGs, reflecting the different contexts, and the intensity of current research activity, of each of the subject areas:
WG1: Fire Behaviour and Fire Safety: a subject-based subdivision;
WG2; Structural Safety: summaries of research expertise in the participants and the countries of the Action;
WG3: Integrated design: a contextual summary for each country, based on a common questionnaire.

The Barcelona MC meeting was forced to take immediate account of a serious shortfall in the annual budget which, in conjunction with a post-budget increase in signatories from 14 to 20, made it necessary to abandon the objective of holding an Autumn MC meeting in Luleå. It was fortunate that the final conference of COST C26 in Naples was to be attended by all countries of TU0904; this enabled the Autumn 2010 MC meeting to be reorganised at no cost to the Action.

MC Meeting, Naples 17 – 18 September 2010

The main discussion of this MC meeting concerned the feasibility of proceeding with the remaining planned events for 2010-11, given the budgetary shortfall in this year. It was decided to defer the Prague Conference from 29-30 February 2011 to 29 April 2011, and to run it in a one-day format in order to minimise expenses. Reimbursement to COST TU0904 members would be limited to whatever the budget available at the time could afford; the conference would go ahead regardless of external support.

Conference on Applications of Structural Fire Engineering, Prague 29 April 2011

The Conference was held as planned, in a one-day format. In order to maximise value for the participants it was decided to limit oral presentation time to 6-7 minutes per paper, while still keeping to a single session, but to encourage discussion by placing emphasis on poster presentation, including open voting for the best poster overall. The Conference Proceedings, including all 72 papers, 62 slide presentations and 55 posters, all in PDF form, are available for download from the Action's website, and so the subject areas covered need not be detailed here. In order to encourage young researchers to develop their presentation and dissemination skills an award was made for "Best Young Researcher", judged on the basis of their oral and visual presentations and their posters. Although the one-day format was intense, the conference was undoubtedly successful. Future events, whether one- or two-day, would clearly be enhanced by running a full 2-hour poster session at which voting and discussions could take place.

MC Meeting, Prague 30 April 2011

Once again the need to work meaningfully within a very tight 2010-11 budget was a major influence on the discussion. The decision to postpone the Training School for young researchers was inevitable, since this could have been very expensive if places were taken up by all the partner countries. The State-of-the-Art Report had been published before the Prague meeting, and was distributed to members. Meetings of WGs, and a full session of all three, focused on the next deliverable, a collection of practical design Case Studies. As a first step, it was decided to issue a check-list as an aid to the groups developing the Case Studies; Dr Florian Block (UK) agreed to produce this check-list. The Chair of the Action will prepare a template to standardise the structure and presentation of the Case Studies.

III.B. Inter-disciplinary networking

Inter-disciplinarity is at the heart of this Action, and the nature of the State-of-the-Art reports, as well as two open events held without specialist sessions, is to disseminate knowledge from within the 3 WGs across the

entire group of disparate specialists. This spreads awareness of research, issues and practice in the complementary disciplines. For researchers in WGs 1 and 2 the Barcelona presentations from fire responders on national attitudes and policies concerning performance-based design provided invaluable information about the context in which their results will be practised, and the key drivers for building control authorities. A similar but wider benefit was gained from the WG3 State-of-the-Art questionnaire responses on the national controls and processes in different countries; this will be useful even across European control authorities. Clearly there is benefit for researchers in both the "fire science" and "structural fire" communities in making associations between progress in their complementary fields.

It is perhaps too early to state categorically whether socio-economic impacts will be observed within the period of the action. However, if the two research-based WGs can influence control authorities on policy, and designers on the practice of performance-based methods, there is a very clear route to socio-economic impacts. In most countries only prescriptive fire resistance methods are commonly used or permitted at present. Although lip-service is paid to the need to move to performance- and risk-based methods, regulators need more knowledge of these methods, and the ways in which colleagues in the leading countries are taking them into account.

III.C. New networking

- *Additional members joining the Action during 2010-11: Czech Republic, Hungary, Iceland, Slovakia, Sweden, Switzerland*
- *Total number of individual participants involved in the Action work: At present there are 91 individual participants, of which 14,3% are female, and 16,5% are Early-stage Researchers.*
- *STSMs: Because of the restricted budget available in the year 2010-11 only two STSMs have been granted, although 2 more are expected before June 2011. Current approved STSMs are:*
  1. *Kamila Horová, 21/2/2011 – 7/3/2011 from Prague to Tampere (M. Heinisuo), (Design fires),*
  2. *Gang Dong, 19/6/2011 – 25/6/2011 from Sheffield to Coimbra (L. Simoes da Silva), (Reverse channel components in fire).*
- *Conference funding for young researchers: Requests were made at the Prague MC meeting for conference attendance grants for Petra Kallerová (CVUT Prague); Guillermo Rein (Edinburgh); Antonio Bilotta (Naples). They were asked to submit the forms as soon as possible. Members have been asked to submit applications for the 2011-12 Action year.*
- *Training Schools: It has been necessary to postpone the Training School scheduled for June-July 2011 because of insufficient funding. It is very much hoped that it will be possible to reschedule this for later in the action.*
- *Involvement of researchers from outside the COST Countries: At this stage one external participant (Dr Stephen Hicks, HERA, New Zealand) has joined the Action. In 2010-11 his active participation was curtailed by the NZ earthquake, but he will be invited to participate in subsequent phases. One international expert (Prof Venkatesh Kodur, Michigan State University, USA) participated in the Prague conference.*
  - *Publications and other outreach activities: Apart from the State-of-the-Art Report and the Proceedings of the International Conference, which represent the main outputs of the Action so far, local articles have been published in national journals. Two articles are already in print (Konstrukce 4/2010, Czech Republic; Inzynieria i Budownictwo 11/2010, Poland), and others are in the pipeline, see fire.fsv.cvut.cz/ifer/WP5/index.htm.*

III.D. Self evaluation

In difficult budgetary circumstances the first year of TU0904 has succeeded in running the Action much as originally envisaged. Two major scientific events have been staged, in Barcelona and Prague, producing documents (72 research papers, 110 posters and 114 slide presentations) which provide an excellent picture, freely available, of current performance-based fire engineering research, particularly in Europe which is the principal centre of this research worldwide. In addition, the 238-page State-of-the-Art Report gives an overview of the background knowledge relevant to performance-based fire engineering, in fire science and safety, structural behaviour, and the regulatory context within which it must be practised, in a wide range of countries. This last is vital for the growth of performance-based practice in the design of buildings to resist fire; regulators need to be persuaded that their national building construction and maintenance regimes and objectives do not differ fundamentally from those of other countries, and that it is possible to adapt practices which have proved successful elsewhere.

The relative failures of the year have been caused by financial constraints. It is a matter of particular regret that it was not possible to stage the planned Training Course for young researchers in this year, because a key objective is to accelerate and enhance the training of the next generation of world-class researchers in the fire engineering field by bringing them together with established experts, so that their future research will complement that in other parts of Europe rather than duplicating it. It is very much hoped that a future year's budget will allow this course to be run.

The fact that the Action Conference became a single-day, rather than a two-day, event had both positive and negative aspects. The printed papers published as Proceedings allowed a relatively detailed document of record for fellow workers in their fields, while short oral presentations maintained interest for participants in cognate fields. The requirement for posters was a stimulus for detailed discussions with their authors; the only problem was the lack of time for a further 2-hour session which could have been devoted to these discussions. This lesson will influence the organisation of the future public events of the Action.