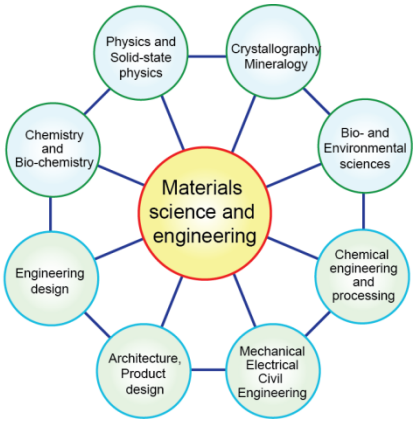
Materials Education Symposia

Reports from 2013

March 14-15: Kanbar College of Design, Engineering & Commerce, Philadelphia University
April 4-5: Murray Edwards College, Cambridge University

> *There is an "exceptional interactive spirit in this community and the community is growing"*

In Spring 2013, over 200 representatives from 33 countries gathered at two key events for materials educators. They came together as a community passionate about materials education, from universities and colleges where they teach undergraduates about materials within engineering, design, architecture, sustainability, and other science subjects. Two days of talks, workshops, discussion sessions, networking, poster sessions, and a social program provided plenty of opportunities to meet people and exchange ideas as they discussed the trends and ideas impacting materials teaching.



Now in their 5th year, the Materials Education Symposia are established as, in the words of one attendee, 'the main forum for discussion of education issues in Engineering Materials'. This report uses attendees' own word together with some highlights from this year's events to give just a taste of the 'exceptional interactive spirit in this community'.

> *It is the main forum for discussion of education issues in Engineering Materials*

A packed lecture theater in the Kanbar College of Design, Engineering & Commerce

Prof. Mike Ashby welcomes attendees to the 5th International Materials Education Symposium

Foreword by Prof Mike Ashby

Chair of the Symposia's Academic Advisory Committee

Teaching methods today are evolving faster than at any previous time. This is particularly true in the sciences, driven by vastly increased access to information (the Internet, the emergence of MOOCs—'Massive Open On-line Courses'), by new approaches to teaching (activity and workshop-based methods replacing passive lecture-based teaching, use of social media, the "flipped classroom" concept), by changing global priorities (globalization of science and industry, the environment, sustainable development), and by evolving student expectations. In the past aspiring students competed for places at desirable universities; today it is aspiring universities that compete to attract desirable students.

"Above all, the Symposia were good fun, with lively engagement among all the participants, reinforcing the sense of community that past Symposia have helped to develop."
Prof. Mike Ashby

Materials science and engineering act as a hub at which the pure and applied sciences meet, placing them in a unique position to connect with, and lead, these changes. This year's two Symposia bear this out. They brought together teachers and representatives of industrial design, engineering materials and design, materials science, industry, and education. The Symposia explored innovation in university education and discussed engagement with current initiatives such as the Materials Genome Initiative. They included workshops and revealing in-class demonstrations, discussion of MOOCs and 'Just-in-time teaching'. And they had a truly global atmosphere with talks, posters, and contributions to discussion from 33 different countries, among them Russia, India, Estonia, Czech Republic, Turkey, and Columbia. They revealed their very different histories of materials teaching and their present efforts to achieve convergence to provide students the qualifications that are recognized not only in their own country but internationally. Above all, the Symposia were good fun, with lively engagement among all the participants, reinforcing the sense of community that past Symposia have helped to develop.

On behalf of the Advisory Committee, I would like to thank all those whose presentations and contributions made the 2013 Materials Education Symposia such interactive and collaborative events—and hope to see you again in 2014! I am personally grateful to all those who joined me on the Advisory Committee, helping to put together this year's program from so many excellent submissions. We are particularly grateful to Professor Ron Kander and Philadelphia University and to Cambridge University for providing such convivial venues for this year's events, and to the following organizations for their support:

- American Society for Engineering Education (ASEE), Materials Division;
- ASM International (the Materials Information Society);
- Philadelphia University (Kanbar College of Design, Engineering and Commerce)
- European Society for Engineering Education (SEFI);
- Federation of European Materials Societies (FEMS);
- University of Cambridge (Departments of Engineering and Materials Science &Metallurgy).

Finally, I would like to add my appreciation to that expressed by so many of the attendees, and thank the team from Granta who, as ever, have enabled these community events to run so smoothly.

Highlights from the North American Symposium

Kanbar College of Design, Engineering & Commerce, Philadelphia University
March 14-15, 2013

Dr Ron Kander (Executive Dean, Kanbar College of Design, Engineering, and Commerce, Philadelphia University) welcomed attendees to the 4th North American Materials Education Symposium, held in the newly opened DEC Center, With flexible learning space for studios, seminars, lectures, and team projects, this building has been designed to 'advance the project-based learning and collaborative problem-solving curriculum of Kanbar College'. And it certainly provided the ideal venue for the collaborative problem-solving Materials Education Symposium!

Inspirational ideas for Engaging Student Interest

Session one; chaired by Dr Ron Kander, Philadelphia University

Attendees at the Symposium were engaged from the very start, as **Dr John Nychka** (University of Alberta, Canada) looked at the creation of more effective visual teaching and learning tools to generate greater interest in the amazing behavior of steel, its properties, processing, and structure. As examples: use potatoes immersed in iodine to mimic carburization and case hardening; and Silly Putty™ analogues for pearlite. By engaging students through visualization, he concluded, more effective learning is possible and there is increased awareness and excitement about designing with steel.

> *"By engaging students through visualization, more effective learning is possible and there is increased awareness and excitement" John Nychka*

Prof Deb Newberry (Dakota County Technical College, MN) continued the theme, discussing how she uses simple materials and experiments to enhance students' critical thinking. Working with multiple disciplines (physics, chemistry, biology, materials science, engineering, etc.) and across grades 11–14, she has observed how students progress from confusion, to inquiry, to investigation and application.

Prof Steve Krause (Arizona State University, AZ,) demonstrated how he's been increasing student engagement by providing tools to deal with the areas where they are struggling. Collecting at class-end the brief, anonymous, written, 'Muddiest Point' comments allows students to reflect on their own learning and highlight specific issues that may have arisen. Building on this has led to 'Muddiest Point' YouTube tutorials, an idea which appealed to many of the participants (www.youtube.com/user/MaterialsConcepts).

Dr Rebbeca Rosenblatt (Department of Physics, Illinois State University, IL,) wrapped up a packed morning with her insights into developing a singular assessment instrument using the 'item based creational process', providing ideas for testing the efficacy of instructional reform efforts in materials science and engineering.

Making the most of emerging opportunities:
teaching on modeling, research, and the Materials Genome Initiative

Chaired by Dr Brian George (Philadelphia University)

Reflecting the latest industrial trends, many universities are seeking to integrate databases, visualization, simulation, and computation into the materials science and engineering curricula. Discussions included the Integrated Computational Materials Engineering (ICME) and Materials Genome Initiative (MGI) grand challenges, and how they affect the education of materials scientists and engineers. **Dr Adrian Hightower** (Harvey Mudd College, CA) looked at integrating finite element modeling into semester-long materials design projects, showing how incorporation of these projects, assigned in parallel to skill-based materials engineering instruction, improves a student's ability to correlate material properties and performance.

Great job, good people, lots of time to interact

"Learning is a lifelong pursuit and doesn't end at finding a job."
Steven Arnold

The first day ended on a high with 'Observations from an outsider' by **Dr Steven Arnold** (NASA Glenn Research Center), demonstrating some of the real-life materials data management approaches used by industry, continuing the

The presentations were great!

theme of integration. He made a number of observations regarding gaps in the education and training of both professionals and students. His talk was peppered with specific examples and illustrations, and drove home the point that learning is a lifelong pursuit and doesn't end at finding a job.

Poster Teasers and Poster Sessions

A particular feature of these Symposia is the 'Poster Teaser' session, which invites poster presenters to give a one minute introduction to their work during the program. These have been praised as a wonderful opportunity to get a quick overview of the many interesting ideas being presented. Coming just before the first break, they also helped match faces to names (and posters), enabling great discussions and networking opportunities right from the start.

I loved the one-minute poster highlights

The poster presenters assembled to give one minute 'teasers'

The poster sessions themselves provided many opportunities for discussion and exchange of ideas

Workshops

Interactive workshops were introduced at last year's North American Materials Education Symposium. These proved so popular that this year's event included two such opportunities for the community to get together in small groups for some hands-on experiences.

> *Hands-on workshops were great*

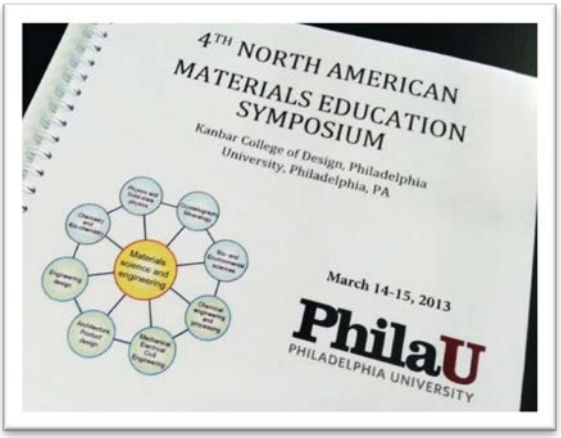
On Day One, **Prof Jonathan Stolk** (Franklin W. Olin College of Engineering) looked at 'Designing project-based learning experiences', and on day two **Maribeth Kradel-Weitzel** and **Dr Ronald Kander** (Philadelphia University) got everyone involved in 'tools and techniques to actively engage students: from instant design challenges to improvised comedy.'

> *I found the suggestions [during the workshop] for activities for an introduction to engineering really useful*

Whether it was constructing platforms out of rolled up paper, or filling the gaps in entertaining storytelling, the combination of innovative thinking, practical suggestions, and interaction meant those involved came away inspired.

How crossing disciplines has helped engineering, design, and architecture

Session three: chaired by Dr Kihong Ki, Philadelphia University



Dr Ronald Kander (Philadelphia University) opened the third session with many valuable insights about learning style differences between the designers, engineers, and business students found in common core courses on Materials Selection in the new Kanbar College of Design, Engineering and Commerce. Similar themes emerged in **Dr Chad Sinclair's** presentation (The University of British Columbia, Canada), looking at cross-disciplinary materials selection and applications to environmentally responsive architecture. There was particular interest in his "just in time" teaching concept, and how this can be more broadly applied. **Dr Hugh Shercliff** (Cambridge University, UK) wrapped up the morning's presentations highlighting how a material's properties relate to its internal architecture and processing, He highlighted how students can be encouraged to make comparisons between fibers and bulk materials, and use performance charts to track the evolution of performance of specific products through time.

Eco Design & Sustainability, a common concern in interdisciplinary teaching

Session four: chaired by Dr Chris Pastore, Philadelphia University

Excellent conference and training

Prof Mike Ashby (University of Cambridge, UK) opened the final session with a look at "Sustainable technology" and the key concepts of Natural Capital (the planet's resources), Human Capital (the health, education, and social development of the human population of the planet) and Manufactured Capital (the value of man-made institutions, infrastructure, and wealth). He explained how introducing this complexity into teaching is challenging, but offered a framework for exploring sustainability from a materials perspective. Following on from Prof Ashby's case study of an electric car, **Prof John Abelson** (University of Illinois at Urbana-Champaign) demonstrated how his students are challenged to design a net-zero energy home. He gave illustrations from one of his engineering colleagues, Prof Ty Newell, who has performed extensive simulations on homes with ultra-high energy performance, and designed and constructed his own home, *Equinox House* (http://buildequinox.com/).

Considering the vastly different climate zones within the US, students have to make significant changes to the use of materials, especially those involved in insulation, daylighting, and solar PV power. His presentation included both salient examples and highlighted the learning challenges for the students.

Dr Paul Eason (University of North Florida), caught the attention of attendees when he looked at the hot topic of meeting the sustainability and environmental aspects needed to achieve ABET outcomes. The day concluded with many lively discussions on interdisciplinary teaching, before Prof John Abelson formally announced the venue for next year's event, which he will host at the University of Illinois at Urbana-Champaign.

> *Great job everyone – I had a great first experience at this Symposium!**

Networking and exchange of ideas during the campus tour and dinners

The North American Materials Education Symposium owes much to its relaxed and collaborative atmosphere. This is enhanced by the many opportunities for discussion, exchange of ideas, and networking. As well as extended periods for questions and discussion during the main speaker program, participants appreciated getting to know each other outside the lecture hall.

At this year's event, a tour of the new facilities at Philadelphia University provided a great way for people to get to know one another, as well as see how materials can be part of a truly interdisciplinary School. In particular, there was great enthusiasm about the textile department, where students make and design with their own materials.

The dinner venues also gave a sense of history: diners were treated to pre-dinner drinks in the library of the Chemical Heritage Foundation Museum, before a fantastic meal which proved the backdrop to many fruitful discussions.

Following the formal close of the Symposium, many delegates stayed for a final dinner at The Restaurant School at Walnut Hill College. The discussions from the day's presentations spilled over well into the night, leaving participants with a strong sense of community and shared purpose.

> *The site visit to the textile department was great*

Highlights from the International Symposium

Murray Edwards College, Cambridge University
April 4-5, 2013

Prof Mike Ashby (Emeritus Professor at Cambridge University Engineering Department and chair of the Symposia's Academic Advisory Committee), welcomed delegates to Cambridge University's Murray Edwards College for the 5th International Materials Education Symposium. The packed lecture theater saw many familiar faces and plenty of new ones, all ready for two days of innovative and inspiring talks and discussions.

Fun, inviting, updating... confirmation that this is a community

Refreshingly varying lectures; a wide area was covered

The program at the International Symposium had a particular focus, Prof Ashby highlighted, of "Materials in a fast changing world". He promised talks on '*Igniting the flame*', '*International Perspectives*', '*The Human Dimension*', '*Sustainable Living*', and '*Handling Data Overload*', all of which would put the emphasis on how to inspire, engage, and challenge students, equipping them with the skills they need to be the engineers, designers, and architects of tomorrow.

Igniting the flame: inspiring and engaging students

Session One, chaired by Prof T. W. Clyne, University of Cambridge, UK

I was challenged about my teaching perspectives with ideas like the flipped classroom, and how to approach knowledge transfer

Prof Peter Goodhew (University of Liverpool, UK), opened the first session with a truly inspiring talk looking at a number of recent developments in higher education which could—and probably should—impact on the teaching of materials and other engineering disciplines. **Dr Claes Fredriksson** (University West, Sweden) extended the discussion with his examination of the impact of Sweden's

newly adopted national curriculum across pre-schools, primary, and secondary schools, and how the latest teaching approaches can be used to foster excellence across the age-groups. Continuing with the emphasis on producing innovators and entrepreneurs, **Prof David Embury** (McMaster University, Canada) argued that simply adding to the course-load of students wasn't the best way to drive entrepreneurial activity. An alternative suggestion is to encourage students to examine the history of materials science both to seek role models or case studies and to develop their critical faculties. **Dr Alexandre Mège-Revil** (Cité Scientifique, École Centrale de Lille, France) emphasized the benefits of a phenomenological approach in materials science education, allowing highly mathematical students to improve their understanding and leading them to ponder on the validity of the models they apply in other scientific domains.

To conclude what had already been a highly engaging morning, **Dr Noel Rutter** (University of Cambridge, UK) had everyone on the edge of their seats as he sought to carry out as many practical demonstrations as would fit into 15 minutes in order to share existing practice, to improve upon what exists, and to generate new ideas.

"The challenge in engaging and maintaining interest in the large-lecture environment is one in which the lecturer has to seek to "entertain" as much as to educate."
Noel Rutter

Many of these demonstrations feature in the teaching and learning packages available on http://www.doitpoms.ac.uk/

Materials Education Symposia

If the challenge in engaging and maintaining interest in the large-lecture environment is one in which the lecturer has to seek to "entertain" as much as to educate, participants certainly agreed he was up to the challenge!

> *I particularly liked the overall high standard of the presentations (with their attractive variations in style and message) and the nice one-minute intros for the posters*

Poster Teaser and Poster Session

Before the mid-morning break, delegates had been treated to one minute 'teasers' by those presenting posters. With **Dr Arlindo Silva** (T. U. Lisbon, Portugal) keeping everyone to time with the 'threat' of more applause, this provided a fast-paced introduction to the wide range of topics up for discussion.

> *I liked the discussions after the talks, at the end of the day, and in between…*

International perspectives: sharing ideas across the community

Session two,
chaired by Prof Sybrand van der Zwaag,
Delft University of Technology, The Netherlands

At this truly international symposium, the second session provided a fascinating insight into the differences and similarities between student attitudes, practices, and teaching approaches around the world. **Prof Seh Chun Lim** (National University of Singapore, Singapore) set the

> *I heard about some interesting developments and caught up with several people (plus made a few new contacts)*

ball rolling discussing teaching engineering materials with a design-centric program, before **Prof Camilo Ayala** (Universidad de Los Andes, Colombia) looked at how hybrid methodologies are being used to improve materials education for design students in a local context. **Prof Larisa Petrova** (Moscow Automobile and Road Construction State Technical University, Russia) highlighted the challenges faced by the influx of graduate students, following the introduction of the Bologna process, who have no previous knowledge of materials education.

The discussion on international benchmarking in materials education and the focus of materials education was particularly valuable

In India, there is an awareness of a mismatch between institutions and industry as each conduct their own induction and orientation programs. **Prof Raj Rajendran** (B. S. Abdur Rahman University, India) illustrated how extra-curricular courses, like SAEINDIA, combine industry-led education with physical activity to produce well-rounded and well-equipped young engineers.

The contact with other colleagues from other countries was highly valuable

In chairing the session, **Prof Sybrand van der Zwaag,** (Delft University of Technology, The Netherlands) encouraged plenty of discussion between and after these talks. Educators from around the world shared common trends and highlighted areas where different countries take approaches. From the feedback received, this international sharing was perhaps one of the most valuable outcomes.

I could hear different aspects of materials science education, in different fields, and an international outlook

The human dimension: a look at engineering, architecture, and design

Session three, chaired by Prof Mark Miodownik, University College London, UK

Day Two saw the community 'crossing disciplines', and looking at the link between materials, design, and architecture. **Prof Mike Ashby** (University of Cambridge, UK) got everyone thinking with his enlightening presentation on 'why should engineering students care about industrial design? And if they don't, how to enlighten them?' He observed that most students of engineering or of materials science are attracted by the systematic, analytical rigor of their subject. To them the word "Design" means "provision of function in ways that are safe, reliable and affordable". To them, the language of Industrial Design carries little meaning or sense. Yet successful products depend as much on provision of usability and satisfaction as provision of function. Failure to understand the role and importance of the Industrial Designer is failure to engage fully with the mission of Engineering, he argued. He is not alone in his thinking, as **Prof Jenny Faucheu** (Ecole des Mines de Saint-Etienne, France) showed in her talk on the sensory properties of materials for product design, looking at how this can link designers into engineering education.

> *"Failure to understand the role and importance of the Industrial Designer is failure to engage fully with the mission of Engineering."*
> *Mike Ashby*

Following another high-paced set of Poster Teasers and plenty of discussions during the mid-morning poster session, **Dr Elvin Karana** (Delft University of Technology, The Netherlands) really caught the attention of participants with her discussion on teaching materials in design, citing three approaches from three universities in Italy, The Netherlands, and Turkey. Many of her themes were again picked up in discussions later in the day.

Turning attention towards materials for architectural design, **Dr Hugh Shercliff** (University of Cambridge, UK) looked at the thermal performance of laminated materials for buildings. (It was good to see the impact of the North American Materials Education Symposium a few weeks before, where Dr Shercliff had been inspired by **Prof John Abelson** (University of Illinois at Urbana-Champaign), and done some additional calculations to reflect this!)

> *A great opportunity to join this new environment and deepen the connection between design and engineering courses*

> *The discussions about design combined with the traditional materials field were particularly valuable*

The architectural theme continued with **Dr Jacqueline Morkel** (University of Pretoria, South Africa) demonstrating some of the resources she uses for teaching architecture and engineering at Pretoria.

'Sustainable living', and 'handling data overload'

Session four, chaired by: Prof Mike Ashby, University of Cambridge, UK

'What is Sustainable Technology?' asked **Dr Karel Mulder** (Delft University of Technology, The Netherlands), as the final session got underway. He has observed that many engineers call all their work 'sustainable' as engineering always has been about efficiency. But it is more involved than that. In finding ways to teach about sustainable technology development, he highlighted how engineers should be trained to cooperate with the various stakeholders, and learn to think about long term perspectives. This powerful introduction was followed by an example of one such well-integrated project: **Dr Ricardo Gomez Val** (UPC, Spain) demonstrated how the architectural department has been encouraging students to look at the use of wastes to create new building materials. Although many of the students abused of the use of polymeric resins to construct the new materials, (such that even using wastes the new materials were not so sustainable!), the project provided an excellent experience for attracting students into materials research.

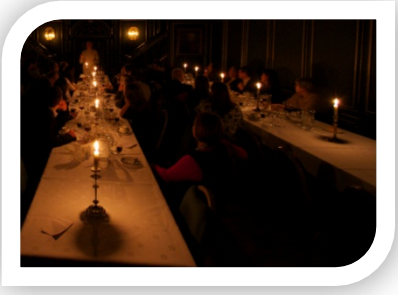
I've got a new interesting perspective on materials teaching

Appropriate for the final talk at the end of such a packed event, **Dr Tim Bullough** (University of Liverpool, UK) tackled the subject of data overload with a new "TripAdvisor for e-learners" in engineering. *Kritikos* (kritikos.liv.ac.uk) allows students to search for learning resources such as videos, animations, presentations, documents, and images which are specific to their discipline, and rate and comment on the usefulness and relevance to their degree programmes. The rich intelligence produced is also enlightening about which resources students use and find the most useful for their learning.

Interesting discussions both at the Symposium and the Symposium dinner

Social program and further opportunities for networking

Even before the first presentation, the Symposium was providing opportunities for networking and collaboration. The candle-lit Presenters' Dinner, held in Magdalene College on Wednesday night, brought together those speaking or presenting posters. Thursday's Symposium Dinner, held in Jesus College (which boasts some of the oldest buildings in Cambridge together with modern award-winning architecture) was 'a great opportunity to mix with other



Materials Education Symposia

Relaxed and open atmosphere

people', and provided a relaxed atmosphere to continue the first day's international discussions on inspiring and engaging students.

Participants also enjoyed a walking tour of Cambridge on the Saturday and a punting trip on the Cam. Together, these events helped build the community, avoid 'data overload', and establish relationships and possible collaborations. It is no surprise that so many come back year after year – and often bring a colleague as well.

The scale was good: not too big to get in touch with most participants

A great community event

The closing discussions, in which the day's speakers were joined by contributions from the floor, highlighted how important it is for those teaching about materials across engineering, science, architecture, design, and more, to come together like this. With the broad range of presentations, and the many international perspectives, delegates left inspired, challenged, and looking forward to next year!

…lots of ideas of how to develop my teaching

See you all next year!

Following the success of this year's events, the Academic Advisory Committee will meet to decide on next year's Symposium themes in June. They encourage those interested in sharing their materials education experiences to keep an eye on the Symposium website and consider submitting an abstract for a talk or poster... or both!

95% of Symposium attendees who gave feedback said they would 'recommend the events to a colleague', and many have already done so!

- **March 20-21, 2014** University of Illinois Urbana Champaign
- **April 10-11, 2014** University of Cambridge
- **December 11-12, 2014** National University of Singapore

To find out more, and register your interest, please visit www.materials-educations.com.