

Henderson Colloquium

2015

Appropriate Technology

Since 1975 the British Group of IABSE have held a two day colloquium in Cambridge every summer for about 25 invited participants. The purpose of the event is to exchange views on a structural engineering theme of topical importance. Each participant is invited to make a short presentation to trigger constructive discussions in the relaxed surroundings of Christ's College. The theme of the 2015 colloquium is The use of Appropriate Technology.

In order to meet the demands of society, throughout the 19th and early 20th centuries engineering projects pushed the boundaries of what it was possible to construct; major infrastructure was created, and new branches of engineering and material science were born. The technology of the built environment today has advanced to a stage where we are now in a position in which almost anything is possible, and if a project can be conceived then it can be built. However, just because something can be built does not mean it should be, and as such, engineers and architects are now faced with a new challenge – not to design what is possible, but to design what is appropriate.

Today, we are building in increasingly diverse locations, with more focus on sustainability and resources, creating ever more responsive, innovative and adaptive structures. As such, this year's Henderson Colloquium is set to look at The use of Appropriate Technology.

Appropriate Technology is required in the built environment where site conditions or constraints are so different from convention, that the development and execution of a project is forced to move beyond established approaches, and adapt to meet the specific needs of the locale.

The need for this approach is often highlighted in developing countries, where traditional methodologies do not respond to the availability of local materials or skilled labour, and appropriate technologies are required in order to ensure the viability and longevity of a scheme. This approach can also be seen in projects which deal with extreme environments. Structures in polar regions, the desert, disaster zones, at sea, or even in space must all respond specifically to their setting with appropriate technologies. The aim of the Colloquium is to explore how these technologies have been or could be implemented so as to ensure that today's built environment is just as appropriate as it is advanced.

IABSE's Henderson Colloquium has always provided a fascinating insight into a specific topic, and 2015's event certainly continued that tradition. The topic was 'Appropriate Technology', which describes an approach to design and construction which is necessary where conventional methods are not suitable; where 'best practice' may not be best.

The event was chaired by Aecom's Peter Ayres, who is familiar with unusual and challenging sites, having led the design and delivery of the moveable Halley VI Research Station in Antarctica. Peter kicked things off by reviewing the technical challenges of that project, touching on issues such as how to design to accommodate 1.5m of snow accumulation per year - the station's telescopic legs can 'step up' to prevent it becoming buried. Many other challenges needed an 'appropriate' response, from a modular design that allows the station to be re-located on the shifting ice, to the meticulous approach to the site's energy balance. These points were further emphasised later in the event by the guest speaker at the colloquium dinner - John Eager, who recounted many first-hand experiences during his time on Halley VI as the Stations Operations Manager for the British Antarctic Survey. John touched on the blend between ensuring that a design is appropriate at an early stage, with the learning-by-doing approach achieved through first-hand experience. This was a theme that was touched upon throughout the event; how early-stage planning must be matched with pragmatic on-site thinking, and how appropriate technology must be born from first-hand knowledge.

The first session's delegates expanded on this big-picture discussion, speaking of the need to create a 'surplus' in order to advance, of the need to match local resources, and how environmental sustainability must be at the core of any appropriate technology. High-tech as well as low-tech solutions were discussed, which by contrast demonstrated how a move from static to kinetic engineering can enhance sustainability. Highlighting that for a technology to be appropriate at all times, it should be dynamic and responsive.

Following on from the high-tech/low-tech discussion, the dichotomy of response to applied technology in the global north vs south, and how aspiration and desire are fundamental factors in a long-term approach was discussed. Low-tech solutions run the risk of preventing developing countries from 'catching up' with the global north. Cameroon Catalyst's work aiming to provide the information, knowledge and tools needed to spur change became the focus, and how in order for appropriate technology to benefit local communities, they must take ownership of it. Whilst the 'kickstart' can be from an outside agency, the long-term success relies on locals. The group looked at how the local resource of both materials and labour can be used appropriately. The recent trend in 'fly-in-fly-out' missions where charitable northern ventures deliver unskilled labour to a site where there is already an abundance of it was discussed at length. To this end, discussions focused on the work of Bridges to Prosperity, where skilled professionals assist locals in designing and building critical bridge projects. The result is a structure that is built by, and as such wholly 'adopted' by local communities. The transfer that takes place is not one of labour or material, but one of knowledge.

After a tour of Christs College, the third session began with a review of military work building emergency hospitals to treat Ebola in Sierra Leone. Where charity, desire and long-term need can spur appropriate technology, so too can an emergency. The need was discussed for the approach to address both the life-saving task at hand, whilst also responding to cultural and religious requirements. Speed was, of course, a critical factor and the inappropriateness of traditional northern contractors (and contracts) was highlighted where an immediate response was required. The disaster-relief dialogue continued, by highlighting the need to establish a 'hierarchy of needs,' in order to formulate an appropriate response. Cultural sensitivity was again brought to the fore, illustrated by a case study of emergency housing in India, which was built but never used as it did not address the cultural and religious needs of those it served. Learning from previous challenges is also difficult, as charities rarely have the time or the money needed to invest in long-term studies of the outcome of their work.

The focus then returned to the high-tech, with discussions on how drones and 3d printing may one day be appropriate technologies, and the appropriateness of robotic intervention vs local education. Where access is difficult drones can be used to deliver medicine, and where shelter is needed one day they may be printed. Difficulties revolve around the cost of these technologies, as well as practical issues such as battery life. The How we might learn from temporary 'event' structures was also tabled, and how building for deconstruction may be an appropriate solution for emergency shelter.

On the final day, learning from nature was the focus of the morning session. Timber and shell structures were discussed, and how material efficiency and locality are key factors in achieving an appropriate result. In order to achieve a material efficiency, designs must be optimised. We spoke about an approach of high-tech modelling in order to achieve optimised structures that could be built and maintained in an accessible, low-tech manner.

The final session returned to the fundamental necessity for sanitation. Decentralized; small-scale; locally-controlled were the afternoon's buzz-words. As with all topics covered, at the core of water and sanitation technology is the requirement to understand the need.

Whilst the group began discussions around a heading of 'Appropriate Technology', by the end of the event it became clear that we had primarily been debating the appropriateness of process. Any technology must be delivered in a sensitive and appropriate way – hence the challenge must first be understood before the technology can be utilised.

The event saw a wide range of topics discussed, from practical to aspirational, and from sites that ranged between the Antarctica and the moon, and from delegates with holistic knowledge of the subject to experts in a specific field. There was no single solution; no silver bullet. Each challenge is unique, and so too is the appropriate response.

Peter Ayres

Aecom

Chair



Peter is a senior structural engineering director with AECOM. He has over 25 years experience leading multidisciplinary design teams on innovative projects around the world, and has the rare distinction of having worked on every continent on earth. He led the AECOM team which won the design competition and delivered the Halley VI Antarctic Station, the world's first ever fully relocatable permanently manned Antarctic base. More recently, he had led engineering teams on major international sports programmes including stadia for the Rio 2016 Olympic Games, Russia 2018 and Qatar 2022.



Nearly all technology would be appropriate somewhere, so a general meaning of the term “Appropriate Technology” is elusive but the term is often used, as I will, in a narrower sense. An accepted meaning is that Appropriate Technology is small scale, labour intensive, creates meaningful jobs, maintainable by the local community, environmentally sound, and energy efficient. A major early proponent was E. F. Schumacher, an economist who visited Burma after World War II and recognized that the technologies effective in Britain and the rest of the industrialized world were inappropriate in much of the world, partly because the capital cost to create a job, a work place, using western technology was prohibitive--£2000 (in 1966). On the other hand, local artisans were using tools costing £2 and were not producing much. Schumacher argued for an “Intermediate” technology, where the capital cost per workplace would be about £100, large enough to be effective, small enough so many jobs could be created. The term “Intermediate” was found to be offensive and was replaced by “Appropriate”.

The reasons Schumacher pushed appropriate technology in the Third World are probably evident—the capital investment required to create many jobs is not feasible if industrialized world technology is used but would be feasible with a smaller scale technology. Appropriate technology would reach many more people than high technology, reducing economic inequality. A second advantage is that jobs would be created in the villages, avoiding social disruption, such as caused by urban migration. Another advantage expected was that the artisans using these improved but still comprehensible tools would develop attitudes of self-reliance and responsibility. Further, proponents of small-scale technologies believe such technologies are easier on the environment.

Another reason why “appropriate” was used is a reaction to the many attempts to transplant a technology into a situation where it did not fit. Machines that worked well when used and maintained by experienced operators in Britain and the US failed permanently at the hands of untrained staff lacking support. When machines were

exported to less industrialized regions, spares and lubricants did not always follow. Local people tend to be ingenious and motivated but are at a tremendous disadvantage without the engineering ecosystem we take for granted. A gross simplification, which has a kernel of truth, is that people in less industrialized countries have an excess of time and a lack of capital. The opposite is true in industrialized countries; hence the risk of transplanted technology being inappropriate.

One concern about appropriate technologies is whether it can produce sufficient goods and services to meet needs. The answer, of course, depends on the situation and the technology chosen. Another concern is whether users or designers will accept a simple solution when a more complicated one is available—perhaps this bias toward complexity is a North American phenomenon. I suspect people doing planning for third world nations have a concern that promoting appropriate technology will permanently exclude a nation from participating in modern industry. A suspicion may exist that appropriate technology is in fact a strategy to keep less industrialized nations that way forever. A final concern about appropriate technology is that it is difficult to manage because it supports self-reliant artisans working on locally selected projects.

How did thinking about appropriate technology evolve? In the first place appropriate technology is becoming accepted. I am struck when I visit places in Africa and Asia that appropriate technology is recognized as a viable option. In the United States people seem less familiar with the term but the ideas are gaining hold. Thinking about appropriate technology changed in another way—a recognition that technology is only part of the solution. In the Third World, aid organizations that once focused heavily on designing devices are now focusing more on the entire value chain—realizing that creating jobs requires attention to suppliers and customers, as well as technology. A third way that thinking has evolved how local people are involved. At least some aid organizations are paying much attention to existing community knowledge, choosing technologies that build on what the community has been doing, using appropriate technology ideas to help people do things better.

So, is appropriate technology really useful beyond helping poor farmers in remote places? Are the ideas applicable in other contexts? I see several generally useful themes coming out of the appropriate technology effort:

- Bias for simplicity, for small scale solutions
- Avoidance of technology that creates major cultural change

- Recognition that successful innovation requires more than technology advances
- Being attentive to the quality of jobs produced

Schumacher would be disappointed that community development is not included but appropriate technology ideas do not seem to be leading in that area.

I should elaborate. People become engineers because they like to make things. They feel rewarded when their solution to a challenging problem works and often feel more rewarded when the solution is sophisticated. This aspiration for technological elegance can overcome awareness of what is needed. Aiming for perfection narrows a designer's vision. A solution that satisfies and meets other requirements is needed in many cases, especially in unfamiliar settings, and such a solution is very likely to be small scale

Appropriate technology tends to be close to the traditional technology so the cultural change required when it is introduced is usually small. The work people do after the new technology is introduced is similar but more productive. Successful implementation of appropriate technology has, in most cases, focused on villages—where poor people tend to live. Having productive jobs in a village retains village culture, easing the adjustment to the different sort of life a new technology will bring. The admonition to the engineer introducing a new technology is to learn about the existing culture and forecast, as best as possible, the affect of an engineering advancement.

The history of appropriate technology, and other instances of attempting technology change, is that for sustainable improvement much more must be done than simply deliver a new device. Certainly problems of spares and lubricants must be addressed but broader problems must be considered. For example, how will the customer get the cash to pay? Who will sell the new technology? Who will buy the output? Must insurance be provided and who will organize that? And so forth. As noted, improving devices is not sufficient for significant change.

To genuinely improve people's lives better jobs are needed, as well as more jobs. One aspect of a better job is being more productive, so some sort of a surplus is created. Anecdotes abound of how a better tool has taken a farmer or artisan out of poverty to middle class, allowing, for example, school fees to be paid and a cement floor installed in the home. Another aspect of a better job is giving opportunities for users to think resourcefully and to advance themselves.

Avery Bang

Bridges to Prosperity

Standardized Innovation Reaching the Rural Poor



Bridges to Prosperity (B2P) is a non-profit organization that focuses on being a primary depository and training centre for low cost, robust, long-span bridge structures for rural applications. By building cable-supported bridges over impassable rivers, B2P and our partners act as a catalyst in rural communities, providing access to health care, education and market opportunities. With projects in over 16 countries on four continents, Bridges to Prosperity relies on partnerships with bridge engineering experts to develop safe and locally appropriate technologies.

Cable-supported pedestrian bridge designs that are developed within Bridges to Prosperity, are prototyped in coordination with industry partners. By involving industry experts in both the design process, and on-site in some of the most remote communities in the world, the result is practical design, construction and safety best-practices. Standardized designs and approaches are then used in B2P training programs, intended to create local capacity, while resources are shared with organizations worldwide.



Christina Barstow
DelAgua

Appropriate Technology for Large Scale International Development

The term “appropriate technology” within the international development community is often linked with E.F. Schumacher’s highly regarded book, *Small is Beautiful*. Briefly, he defines appropriate technology with decentralized, small-scale and locally grown solutions to the developing world’s most significant problems including indoor air pollution, contaminated drinking water and insufficient water supplies, to name a few. An appropriate technology solution may include a stove made by a local pottery cooperative or a bicycle-powered water pump. The theory being that a solution that is home grown and available locally is more likely to be maintained and valued by the end beneficiaries. While in many contexts this method will provide the needed solution for a community, it can often be impossible to bring to scale and thus difficult to have meaningful impacts on the millions who are suffering.

This talk will examine the idea of appropriate technology in terms of a holistic sustainability approach. Specifically a comparison between a locally made and an imported cookstove will be examined within the context of environmental, economic and social factors which influence how truly appropriate a technology solution is.

Nick Francis

Royal Engineers

*Building to Beat Ebola, Designing and Constructing
Emergency Ebola Treatment Units in Sierra Leone*



The Ebola outbreak in West Africa raised fears of a global pandemic and prompted an international response to contain and treat the disease. In September 2014 the UK Government committed to construct 6 specialist Ebola Treatment Units as part of its support to Sierra Leone.

Design of the Treatment Units was driven by clinical safety and the need to reassure uneasy international partners, requiring an understanding of epidemiology and extensive engagement with stakeholders. Local contractors were employed to construct the units in remote locations across the country. However, the urgency of the work, and variable capability of the existing workforce, necessitated robust project management and direct support from the British Royal Engineers.

Whilst projects of this scale typically take several years to plan and deliver, the exponential spread of the disease required that the design, tender, and construction programmes were extraordinarily accelerated. Extensive innovation and gruelling programmes ensured that all 6 treatment units were receiving patients within 3 months of their need being identified.

This presentation chronicles the experience of running multiple major construction sites simultaneously in the developing world during a humanitarian disaster. The presentation aims to identify lessons learned during design, tender, construction and handover. It also aims to capture the clinical principles underpinning the design of emergency health facilities to counter pandemic disease.



Knut Göppert
Schlaich Bergermann und Partner

Adaptive Structures

The growing demand for adaptive building envelopes requires new approaches in the development of cladding supporting structures. The design of roofs and façades resisting weather, noise and other environmental influences considering a sustainable building performance plays an increasingly important role in the world of structural engineering.

For an optimal result, engineers, architects and experts from other disciplines must start their cooperation at an early stage of planning. The presentation will cover basic principles and various successfully implemented solutions.



Jessica Gray
Price and Myers

The Appropriateness of Fully Optimised Structures

We are currently working on a research project focussing on structural optimisation to reduce environmental impact. The goal will be to develop sophisticated tools, using BIM, that can optimise structure taking into account numerous variables, structural performance, cost, environmental impact etc. As the modelling and results are complex, I will discuss when this may or may not be an appropriate approach, thinking about the level of complexity required in the early stages, reliance on computer modelling and buildability of fully optimised structures.



Cameroon is located in the western part of the Central Africa region. It's environmental, epidemiological and geographical challenges, including low-productivity of agriculture, a high disease burden and high transport costs, render Cameroon vulnerable to persistent extreme poverty.

The Cameroon Catalyst development model is centred upon community-led infrastructure solutions across North East Cameroon, at the scale of a village. In each village, interventions span six key sectors: health; education; business; energy; water and sanitation. Instead of a rigid blueprint for interventions at any site, our bottom-up approach works to design a range of solutions together with local villagers themselves in order to address the specific priorities desired by each community. Much of our work at each site involves facilitating local learning about how to deliver interventions and is strongly characterized by a process of “learning by doing” that is attuned to the realities of each community.

Our projects to date have provided an insight into how the complex inter-relationships between sustainable development, poverty alleviation and infrastructure service provision operate. This presentation will demonstrate how the use of appropriate technology to close the infrastructure gap is vital in creating appropriate community engagement and empowerment mechanisms, as well as helping to stimulate community income.



Doug Harper
Engineers Without Borders UK

All in it Together: appropriate technology in the global north

There are concerns that the use of appropriate technology may permanently exclude the communities that embrace them from partaking in modern economic society. Conversely, there is an increasing trend in the global north to take seriously the problems of climate change and of resource depletion with a commensurate individual commitment to take preventative measures, i.e incorporate 'appropriate technology' at a local or individual level.

I am concerned that the use of the phrase 'appropriate technology' is helping to reinforce an 'us and them' attitude among the global community. I would like the use of the term 'appropriate technology' to broaden to encompass initiatives using similar technology that are taking place across the global north. In Germany, more than 6% of total power generation is achieved through solar panels, many of which are installed on a small scale or domestically. We herald this as a triumph yet do not refer to it as 'appropriate technology' in the same way as we would if we installed a similar system in a rural African community or somewhere in the aftermath of a natural disaster. Similarly, in France it is now a legal requirement to install green roofs or solar panels on all new commercial zone buildings. Again, we view this positive decision by the French government by aligning it with different parameters to projects in the global south.

Appropriate technology should be appropriate to the context in which it is applied but its use should also be broadened to encompass technology that is relevant to the underlying global context in which we live.

Ibrahim Al-Khattat

SustainableScience.org Inc.

An “appropriate” building technology to upgrade timber engineering and stop global deforestation



The LPSA (light prestressed segmented arch) system contributes timeless solutions that inter-connect three vital domains: (a) engineering science, (b) environmental sustainability and (c) socio-economic development, worldwide. It is an indirect application of the Author's PhD work in mechanics and computation at Stanford University. Its central concept is a simple slide-fit connection mechanism. In the use of SDT (small diameter timber) in building structures this concept leads to a final resolution of the connection problem. SDT makes up over 90% of all wood fibre in nature. Mostly unmarketable, it provides fuel for forest fires. Limited quantities are marketed as low-value biomass or as fence posts at best. Through the LPSA system, SDT is offered to the three domains above as an environmentally sustainable, low-cost, low-tech, high-quality structural material.

(a) In engineering science and practice, SDT becomes a serious competitor to structural steel, concrete and conventional mature timber. In the abstract, a SDT post unit is a predictable axisymmetric natural composite with its tough growth-ring structure preserved. In the absence of the old carpentry-based SDT connection techniques, computer-aided modelling and analysis methods can be applied, for the first time, to predict strength and performance of SDT structures. This generational leap forward opens up new rewarding fields of innovation to researchers, designers, planners and construction engineers. Almost all existing structures can have less costly LPSA equivalents because of savings in materials, energy, time, equipment and the added new capability of dismantling for reuse. All LPSA structures have the inherent unique capacity to absorb and harmlessly dissipate kinetic energy (from earthquakes, storms, flooding) via small, distributed rigid-body displacements. In short, an engineering tool is created to transform many “possible” technologies into “appropriate” ones.

(b) Achieving environmental sustainability of the World's forests becomes a source of profit, rather than cost, because commercial value is created for a vast, inexhaustible resource, SDT. Environmental capital (the whole forest) is preserved, protected and enhanced as a result. One fifth of all global warming gases (due to global deforestation) may be eliminated.

(c) Socio-economic development, poverty alleviation and infrastructure opportunities are created both by the new added-value forest resource and the resulting manufacturing and construction industries.

Some LPSA structures will be discussed. These include a bridges project where school children in the USA assembled two 20 m bridges outside their schools as an environmental education exercise. The project was supported by a multi-level public/private-sector alliance with a, b and c domains (above) in mind.

It's relatively easy to build safer, stronger buildings. The technical challenges are limited, but aid agencies rarely construct more than a small proportion of the required housing after a disaster. Most people rebuild their own houses, either by themselves or by employing their own builders. They tend to rebuild them with the same structural flaws they had before, for reasons that are often very complex and are rarely just a lack of knowledge.

Xavier De Kestelier
Foster and Partners

The Appropriateness of 3D Printing



3D printing has often been quoted as potentially the third industrial revolution. There isn't a day that passes by without seeing a headline with the first ever 3D printed ... (fill in the blanks with any possible product). Even in architecture we have now 3D printed concrete houses in China and 3D printed metal bridges in The Netherlands. What is the status quo on 3d printing. Are we already in this third industrial revolution or is it only a lot of empty media headings. The main question stays ... when is 3D printing an appropriate technology?

Mirko Kovac
Imperial College

Aerial Robotics for structural assessment, servicing & construction



Aerial Robots or Unmanned Aerial Vehicles (UAVs) are a step changing technology with an estimated market value of \$89bn over the next ten years. While current commercially available UAVs can be used for aerial photography, more research is needed to make the UAVs mission robust and employable in changing and natural terrains such as in forests, in urban arenas or construction sites and for emergency response on disaster sites such as during floods and oil spills.

In this talk, I will introduce the end-user oriented UAV research program at Imperial College London on the next generation of UAVs that can move robustly in outdoor terrain using biologically inspired design principles and I will give examples of current projects that aim at building UAVs that can be used to autonomously assess, repair and manufacture in the build environment.



Bruce Martin

Expedition

Ferrocement revisited: placing concrete only where it's useful

The governing criteria determining the thickness of the concrete section is typically the bending capacity. In bending a thin zone of concrete close to the compression face may be highly stressed; the remainder of the concrete acts largely as fill to keep the compression and tension zones apart. Ferrocement is an old technology which may merit a return visit. Ferrocement can be considered as ultra thin reinforced concrete, typically 15mm to 40mm thick. Ferrocement can be located so that the concrete is used most effectively. High quality ferrocement construction can be achieved using low technology construction methods available in the developing world and contemporary technology may provide labour efficient and economical construction methods for ferrocement construction in the developed world.

Hugo Mulder

Arup Advanced Technology & Research

Kinetic Architecture



The notion of appropriate technology touches on something that I have always understood to be good engineering: keeping things simple. This has definitely been the maxim of my years as a designer of movable structures in Arup; not so much the act of value engineering, but rather simplification of the concept seem to be key to success in kinetic architecture. However, as the mission statement for this year's Henderson Colloquium outlines, appropriate can also refer to technology that reacts or even adapts to environmental fluctuations. Although this is a given in nature, in technology this comes not natural at all.

The authors of the seminal work *Kinetic Architecture*, Zuk and Clark, described their age as one "of change, of dynamism, of unrest, or revolution. This is an age of rapid transportation, of instant communication, of high-speed computers, and of an explosion in knowledge." This dynamism has appeared to be a constant since they wrote this in 1970 and may have only accelerated, amplifying their justification for a kinetic architecture "of necessity, in order to adapt more quickly and efficiently to man's ever-changing needs."

A more contemporary phenomenon, the digital-physical synthesis in the built environment, enables and feeds expectations about participation of the users in our buildings' performance. Technology that initially resided primarily on computer systems has found its way into the hardware that forms our homes and offices. In this light, it might be patronising to talk about appropriate, as "who is to decide? Architects and engineers have ceased to be the sole authors of the built environment. Very little is known about the effects of this on the users of these smart, intelligent or adaptive buildings and generally it is assumed that more, or more sophisticated technology automatically results in better buildings. Rather than arguing however for holding back on the use of technology, I would propose to further the research on how humans and buildings can form synergetic collaborations. This opens up for a future where the buildings and their users decide what is appropriate.



Tom Newby
CARE International

Promoting Safer Building

The humanitarian shelter sector rarely manages to effectively transfer safer building practices to those small contractors and self-builders who do the lion's share of building in disaster-prone places, and persuade those builders and those who employ them that it's worth the small extra investments in time, money and materials it takes to make a step change in construction quality. Transferring the knowledge alone is not enough; we have to change the behaviours that lead to weak buildings and vulnerability. That's not just a training course, and it certainly isn't a new building code. It's developing an understanding of what prevents safe building in each context. It's a long-term programme of teaching, supporting and persuading. It's also a programme that fits in with local practices and culture, the incremental way in which most houses are built, and ideally one that works in tandem with the government's buildings policies.

I'd like to see a more systematic approach being developed, before and after disaster, to promoting better construction, and doing so to much wider audiences. To do so needs understanding of what drives people to invest in better building (and what stops them) and how we can work with that. This should be coupled with pulling together the best communication and teaching methods and training tools that are out there so we can effectively and physically show both how to do things better and show why they are better.

James Radford
Mott MacDonald



Adequate and Equitable Sanitation and Hygiene for All

An estimated 2.4 billion people globally lack access to improved sanitation, even basic facilities like 'long-drop' latrines. This contributes to 2.3 million deaths every year – more than Malaria and HIV/Aids combined. Put another way, every 20 seconds a child under the age of five dies as a result of poor sanitation. The economic impacts are huge as well, costing some countries up to 7% of their GDP. Since being added to the Millennium Development Goals in 2001/2, international aid for water and sanitation has grown by 9%p.a., reaching US\$10Bn in 2012-13. However despite this, the number of people without access to improved sanitation has remained almost constant since 1990.

Clearly more needs to be done and different approaches are required to deliver "adequate and equitable sanitation and hygiene for all" by 2030 – in line with the new Sustainable Development Goal 6. This presentation will consider what is appropriate technology in the context of the global sanitation crisis of the 21st Century.



Roger Ridsdill-Smith
Foster + Partners

Appropriate Technology and the Cost of Construction

My approach to appropriate technology is through consideration of the cost of construction. Minimising the cost of construction is sometimes seen as having a detrimental effect on the sustainability of a building. I propose instead that there is a relationship between aspects of the cost of a building and its appropriateness, and that cost can be a useful evaluator of the sustainability of a design in the context of materials and labour.



The Use of Appropriate Technology

I will approach the topic from my own background of International Development and Humanitarian Aid. The arguments I put forward are not necessarily representative of other areas for innovation in engineering, especially when working in extreme environmental conditions. However, for the use of technology to enhance the lives of under-developed communities around the world, I feel the following arguments are important issues to consider.

The colloquium is addressing the topic of the use of appropriate technology. Appropriate technology is put forward as a solution for addressing particular physical challenges, where: Site conditions or constraints are different from convention, and where the development and execution of a project is forced to move beyond established approaches, and adapt to meet the specific needs of the locale.

For developing countries, the brief suggests traditional methodologies do not respond to the availability of local materials or skilled labour and appropriate technologies are required in order to ensure the viability and longevity of a scheme.

This would suggest that traditional construction materials and methods are not appropriate in locations where they have historically been used. In the Ayeyarwaddy Delta 2008 after Cyclone Nargis, I watched a massive house building and protection operation take place, where NGOs and Government organisations constructed large coastal embankments to protect villages that had been devastated and imported timber to replace traditional thatch housing and. The technology and approach was appropriate to the authorities, who had a social responsibility to protect their people and land, ensuring sturdy houses and protection from future cyclones and flooding. However, the embankments restricted many from accessing their main livelihood of fishing, where houses often reached out over shallow water ways; the new-builds were of poor quality and hot with tin roofs and no insulation and reduced airflow. What was deemed appropriate to the

authorities was not appropriate to the recipients. If it is a question of appropriate technology, then it should be asked appropriate how, when and to whom?

I would argue that it is not a question of the use of appropriate technology, but rather the appropriate use of technology. From my experience, all technology is appropriate in some circumstance, and the challenge is in framing the question, not fitting a technology to a situation. I will argue that in international development, we need to re-establish the importance of the 'engineering approach' to ensure a full understanding of the need for a solution and then consider what technology is appropriate to meet that need. In some cases this may require adaptation of new technology to a developing world situation. IMC Worldwide is currently managing the construction of schools in Pakistan. The scale of the project presents particular challenges, but also opportunities for the introduction of new technologies, including double glazing in combination with heat exchange air-conditioning. These options will be explored as to how appropriate they are under the circumstances and how reliant appropriateness is on local context. This discussion leads onto a potential situation, where it could be argued that technology is not yet appropriate for a situation and its introduction will either adapt a context to make it appropriate or will become appropriate in the future. This will be illustrated with the example of the construction of two Bridges in Nepal, using high yield steel.

My presentation highlights that we should look at ways in which we can ensure the necessary emphasis on framing the question, understanding the context and recognising the threats to any potential application of technology. To do this we need Engineers who can understand the context and have the ability to question. This points towards Engineers who can explore the political, social, cultural, economic and environmental issues, as well as future trends, and steer a project to select a solution that is the 'most appropriate' possible for both the immediate situation and over the design life and decommissioning of the system. I will advocate that we need a back to basics approach to engineering, and the innovation should come in how we look at problems and how we educate and provide experience for engineers, and not necessarily focus on the technology itself.

Mike Tonkin Tonkin Liu

Appropriate Technology, Shell Lace Shelter



Mike Tonkin will explain the principles of the single surface structure technique invented by Tonkin Liu called Shell lace structure. The technique developed in conjunction with Ed Clark's team of engineers at Arup utilises contemporary tools of design and production to make stiff three-dimensional form from tailored flat sheets. The technique has been pioneered through a number of competition entries for a variety of project at different scales. One of the competitions for a disaster relief shelter provoked interesting questions about the circumstances of a disaster relief situation and asked was Shell Lace Structure the appropriate technology?

Tim White Arup International Development

An approach for success



Tim will be presenting thoughts on appropriate technology from his personal experiences working in development in Africa and Asia. His experiences have taught him the importance of using an 'appropriate approach' alongside 'appropriate technology' if we are to achieve lasting success.



Adam Wildi Stage One

Appropriate, Adaptable, Aesthetic

Stage One is primarily involved in Event Infrastructure, as such Adam will discuss the Appropriateness of Temporary Architecture, outlining his views on Temporary Architecture from the perspective of 'Appropriate, Aesthetic and Adaptable'. This will be illustrated through three Case Studies of recent work: The Chanel Mobile Art Pavilion designed by Zaha Hadid, The 2014 Serpentine Pavilion designed by Smiljan Radic, and The UK Pavilion for the Milan Expo 2015.

