Issue 8, Autumn 2012

A Global Village

WHERE POLICY AND POLITICS MEET SCIENCE AND ENGINEERING

Conflict and Warfare
WMD Free Middle East | Aid in Conflict Zones | Mental Health in the Military

Materials
Critical Metals | Nanomaterials | Nuclear Waste Disposal

Resistant Diseases
Antibiotic Resistance | Multi Drug-Resistant TB

Health Financing
Competition in Healthcare | Launching a Biopharma Product

imperial college union

Foreword

Forty years ago an organisation called the Club of Rome launched a Report called Limits to Growth. It would probably have drifted into obscurity at the time if the first OPEC Oil Crisis had not surprised the world a year later, suggesting in a media frenzy that we were running out of everything. Well the world has clearly not run out of anything (except perhaps wisdom). Indeed the Limits to Growth Report was junked with Malthus as doomsayers of disasters that never happened – there will always be enough resources etc.

A tattered version of the Report is still in the College Library. Unfortunately if you read it the big surprise is that it didn't predict Armageddon until 2030. Since its models were fitted to the 1970's growth rates of variables like population, and those growth rates have been maintained for decades, it is not actually a bad predictor of 2005. The 2030 – 2040 bad patch has stubbornly refused to move in subsequent revisions and refinements of the model over the last 30 years. Of course 2030 is just when today's Imperial graduates expect to take Command of their Ship.

The response to the original report seems rather muddled as far as I can judge from a 2012 perspective. For example, the Review of Economic Studies set aside a special edition on the subject. It was ignored by the major economists of the time with other weighty things to worry about. So a few young unknowns (like Stiglitz and Nordhaus!) had their day. Markets would solve the allocation problem it seemed. Well, in the sense that markets are there to allocate, that was true, but whether Government thought they would get a better deal by just rolling tanks over borders was never addressed.

As was then fashionable in economics, there was little distinction between Main Street and Traders as far as markets were concerned. Today it seems totally implausible to expect markets with liquidity (and so volatility) necessarily provided by traders to deliver the job. No one is going to discover a price for a 30 year asset from algorithmically traded commodities. So all in all it is not going well. On one hand we have Governments hoarding resources and buying helicopter gunships while dead-locking diplomatic texts for embryonic international law. On the other hand we have traders who would view thinking about the next coffee break as horizon scanning. Anterograde amnesia (OK I looked it up because I couldn't remember) is the *sine qua non* of financial journalism.

Well this issue of *A Global Village*, as ever on the ball, has plenty to say about resources and conflict. My estimate is that the world has around 500 million villages. I conjecture that at this moment about 5 million are consumed in disputes about resources. In mine it is fences and driveways but elsewhere it is much, much more serious. I would further conjecture that a few hundred thousand villages are not handling that dispute at all well. The rest will eventually sort it out with a reluctant shake of hands. So the Global Village has two pathways if the metaphor still holds. Which way will it be? The technology that we parade here buys us breathing space providing it is not inflated by public relations delusions of cornucopia. But Captain Jack, if your shipmates have you walking the plank because you tried to steal the gold, asking them to push the plank out further can only be to buy time to make peace with them. Otherwise, 12 feet later, you will still end up in the sea.

David Fisk
Laing O'Rourke Director of Systems Engineering & Innovation Research, Imperial College London

From the Editors

A global struggle over rare earths and metals? This may seem farfetched to some but, as *Dr. Kartik Rao* argues on page 6, it is becoming increasingly likely considering their critical role as key components of almost all modern technologies. Highly restricted supply lines combined with opaque and volatile trading systems may spur a scrabble for these precious ores in years to come – is Iridium the new gold of an information age?

Neave O'Clery Editor In Chief

Advances in materials science are often associated with innovation in the fields of computing, nanotechnology or bioengineering. On page 22, *Hosam Jiroudy* provides a refreshing alternative, demonstrating a sustainable housing strategy in Syria using local materials and expertise in place of expensive imported techniques. Modernist architecture has celebrated the power of engineering ... the revival of traditional building principles heralds a new age for culture to triumph alongside science.

Nazeeha Hasan Deputy Editor, Design

In today's most insecure and remote operating areas, humanitarian aid agencies often struggle to reach the people most in need. As *Dr. Lydia Tanner* and *Jennie Thomas* highlight on page 34, a crucial issue vexing international NGOs remains political neutrality in the delivery of aid – can humanitarian aid ever truly remain neutral amid political crisis? And what can local community-based organisations offer in these situations?

Claire Roseren Deputy Editor, Content

With fewer drugs in the pipeline, the launch strategy of any new biopharma product is becoming increasingly important. On page 50, *The Boston Consulting Group* analyses the industry's traditional approaches, and draws similarities to the opening weekend of a Hollywood movie in suggesting new strategies for a successful launch, from war-gaming and innovative pricing to improved data collection.

Lars Bergemann Deputy Editor, Finance

Due to technological and clinical advances, the survival rate during warfare – even amongst people sustaining horrific injuries – is fast growing. *Dr. Richard Pinder* and *Philip Hunter,* on page 38, discuss the historical precedence for mental health issues associated with war within this context, and outline strategies for good mental health in the armed forces today. Is mental health finally becoming a priority for global health?

Georgia Lockwood-Estrin Global Health Editor

Most people associate the term cybercrime with opportunistic cybercriminals taking advantage of individuals and businesses for personal gain, yet the sabotage of vital state operations and resources by actors at state level could be considered an act of war. *Clement Guitton* explores this thorny issue on page 29, raising the chilling possibility that the next big arms race might take place in cyberspace. Could a state-sponsored cyberattack be the next Hiroshima?

Tessa Gardner Editorial Leadership Programme

Benjamin Lindsey Global Health Editor

Dharshani Weerasekera Editorial Assistance

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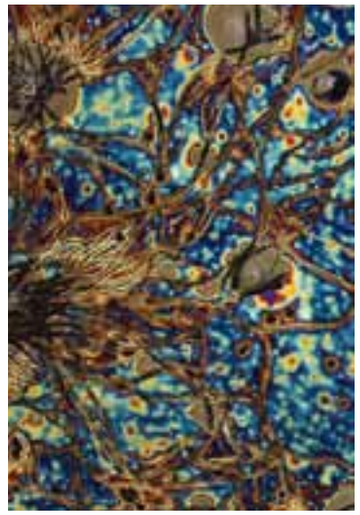

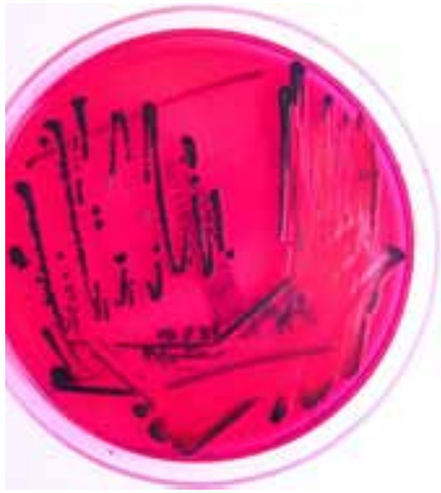

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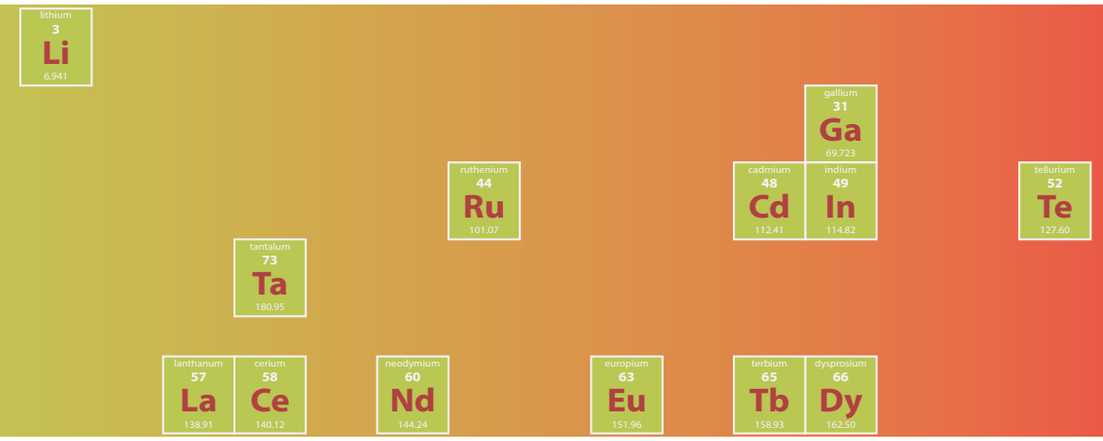
The Age of Minor Metals

Easing Supply Concerns Amid Volatile Markets



Dr. Kartik Rao, Metalysis Ltd.

The progress of mankind has been classified by some in terms of the key resource of their age, such as stone, iron and bronze. Mineral resources that have enabled economic and cultural development have usually never been scarce, however, the technologies to extract, and exploit them have been guarded. As we look to the future, with progress increasingly driven by advanced technologies, the resources that we are increasingly relying on are unknown to most of us today, yet these metals have become critical to maintaining and improving our quality of life.

Access to such mineral resources will be essential in the future, yet just as important will be the technologies for extracting and processing them. Many countries are rich in mineral resources, but are not necessarily reaping the full benefits of their wealth. Recent friction in the field of rare earths and platinum group metals demonstrate that it will be essential to find a mutually beneficial outcome for the mineral wealthy and the technology rich.

In the past few hundred years, the production of iron and steel has been an essential catalyst for economic development. Advances in technology for the mass production of iron and steel in the UK was one of the foundations for the industrial revolution that heralded an unprecedented and sustained period of economic growth.

Much of the raw material for the increase in iron production such as coal, iron ore and limestone was produced in the UK, allowing rapid expansion of projects without fear of supply disruptions. This production of iron and steel enabled growth of the heavy manufacturing industries such as shipbuilding, rail and major infrastructure projects in the UK. It was a period of transition for the UK economy as it evolved from a light agricultural based economy to one reliant on manufacturing and overseas export.

The last few decades have seen China take over from western nations as the leading producer of iron and steel, mirroring the industrialisation of the UK in the 18th century. This rise in production has been necessary for China to develop into an export driven heavy manufacturing economy. This has been a conscious effort driven by the Chinese political leadership who recognised that foreign capital earned via export was essential for the development of its infrastructure and economy. This strong leadership has resulted in some of the most impressive reductions in poverty levels and deprivation in history.

We have started the transition from the age of iron and steel to that of the minor metals

The Rise of the Minor Metals

Developed economies have benefited enormously from the rise of China, although the closure of many heavy industries due to foreign competition has had a lasting impact on some regions as the workforce has struggled to adapt and find new opportunities. The benefits for western nations have been cheaper goods and a shift to a service-led economy.

This new economy has been driven by the advent of the 'Information Age' with the widespread adoption of devices such as PCs and mobile phones. Whilst the demand for PCs, laptops and mobile phones has in some cases been exponential, there has also been an important linear increase in global demand for flat screen TVs and other consumer electronic goods. All of these devices have advanced rapidly in their capability and have come to increasingly rely on minor metals to provide a competitive advantage in the marketplace by making products thinner, lighter and longer lasting.

Minor metals are traditionally defined as metals whose global production levels are lower than base metals such as iron and aluminium, and which are not traded freely on the London Metal Exchange.

This increasing reliance on minor metals is reflected by the higher percentage rise in demand for metals such as indium, lithium and rare earth elements (REE) as compared to iron and steel. It is important to note that iron and steel production still far outweighs that of all of the other metals, however, the importance of these minor metals for future technologies indicates that we have started the transition from the age of iron and steel to that of the minor metals.

Demand Pressures

Current technologies that are utilising indium and lithium are consumer electronics. Indium is used in touchscreens as it provides touch-sensitive conductivity, whilst lithium is a major component of re-chargeable batteries that are commonly used in mobile phones and digital cameras.

Although we can highlight some metals that are of particular use in today's technologies, it is somewhat more difficult to ascertain which metals will be important to the technologies of the next few decades and beyond. The UN, the EU and the US government have all attempted to establish which metals will be crucial to further economic development. They all suggest that there is likely to be increasing usage of consumer electronics – no great surprise to many – but there is also a realisation that energy efficency will be a major growth area, especially if there is a concerted effort to tackle global warming.

The US Department of Energy (DoE) has been bold enough to state that the transition to a clean energy economy has already begun with an increasing emphasis on natural gas and sustainable energy sources such as wind and tidal power. They also predict a greater focus on energy efficiency and clean energy technologies of the future such as batteries, electric vehicles, photovoltaic thin films and fluorescent lighting.

Wind turbines and electric vehicles require high strength permanent magnets currently made using neodymium and dysprosium which are more than 10 times as strong as conventional iron magnets per unit weight. Battery electric vehicles also use rare earth metals, with the current Toyota Prius, for example, using between 10 to 15 kg of lanthanum per vehicle. Demand per vehicle is predicted to double in the near future as consumers demand better performance.

Traditionally solar cells using photovoltaic thin film have relied on silicon, yet, as performance expectations rise, the use of indium, gallium and tellurium will increase unless substitute materials are found.

Energy efficient lighting can significantly impact production of greenhouse gas emissions, but the phosphors required for these products include lanthanum, cerium,

europium and terbium, all rare earth metals. These were just some of the elements identified by the US DoE, but there will be others whose supply will also be stressed as demand increases.

dysprosium
66
Dy
162.50

Upward demand pressures will also occur due to higher economic growth rates in developing countries creating an affluent middle-class with the purchasing power to demand the latest consumer technologies. In addition, these same countries will begin to invest in clean energy technologies with increasing international pressure to reduce greenhouse gas emissions.

The changing demand scenario will, in the next few decades, lead to difficult choices for many countries as they seek to secure supplies of metals they perceive as being critical to their economic development. This scenario poses a conundrum for developed nations whose domestic mining industries have shrunk due to foreign competition and lower public tolerance of large scale mining operations. These countries are particularly vulnerable to supply restrictions for critical metals as short term volatility will never be enough to justify long term supply solutions like the re-opening of mines.

Supply Pressures

The minor metals mentioned in this article are traded via low volume opaque markets where prices are volatile, unlike major metals markets which function with a transparent and globally distributed supply chain. The known ore reserves of minor metals are, however, concentrated in traditionally mineral rich countries such as China, Australia, Brazil and South Africa.

By some estimates, China has captured between a 30 to 40% market share of global minor metal production. This is probably due to a combination of large known ore reserves in China, but also because the costs of extraction and processing tend to make mining more commercially viable due to lower electricity, water and labour costs.

indium
49
In
114.82

US Department of Energy (2011) Critical Materials Strategy.
Ad-hoc Working Group on Defining Critical Raw Materials for the European Commission (2010) Critical Raw Materials for the EU.
International Panel on Sustainable Resource Management of the UN Environmental Programme (2011) Recycling Rates of Metals: A Status Report.
Strategic Metal Investments Ltd. (2010) China's Growing Role in the Production & Supply of Minor Metals.
Fuyuno, I. (2012) Japan and Vietnam Join Forces to Exploit Rare Earth Elements. *Nature* [Epub ahead of print].

An additional factor complicating supply is that minor metals are usually harvested as by-products of major metals, for example, indium is usually a by-product of zinc production, a major metal. Today, demand levels for the major metals are such that there is no supply shortage of the minor metals, however, this cannot be expected to last if demand for the minor metals were to increase dramatically. Such interactions are likely to prevent the global market from responding effectively to demand variations for the minor metals thereby causing volatility in pricing.

There are steps that states can take to mitigate supply risks associated with these important metals. These begin with an increased public awareness of the role such metals play in our daily lives. The processing of these metals is often perceived as being environmentally damaging, as it involves harsh acids, a high consumption of water and energy, and in some cases hazardous and toxic reagents.

gallium
31
Ga
69.723

So far, these difficult processes are usually carried out in developing countries whose economies require foreign capital for economic progress. But this will not continue indefinitely, as countries like China, Australia, South Africa and Brazil are all actively seeking to benefit from their mineral wealth and to develop industries that add value to the extracted metals within their own borders.

There is a perception within these countries that they are selling their mineral wealth far too cheaply, and at the cost of the local environment and communities. Recent violent incidents at the Marikana platinum mine in South Africa have exposed tensions between local communities and the mine operators. This tension was generated not only by demands for higher wages, but also by reports of complaints about the domestic water supply being cut-off by mining operations during the day – a fact that was not widely reported in the media.

It is necessary for developed nations aiming to procure critical metals to diversify their supply sources. Businesses are doing this already, and are also building up larger inventories of metals to offset any short term volatility. However, although businesses have identified critical metals for their own production processes, governments have to ascertain for themselves which metals are at risk of supply disruptions that could affect the wider economy.

A man works at the site of a rare earth metals mine at Nancheng county, Jiangxi province, China

In China's Guiyzu town, a migrant worker cooks computer motherboards over solder to remove chips and valuable metals

Once identified, establishing a more globalised and transparent supply chain for these metals will deter the implementation of protectionist policies. If those policies are a result of a predicted domestic supply pressure in the longer term, the argument for maintaining them will be weakened.

lanthanum 57 La 138.91

To do this effectively, government agencies and the private sector should fund mineral exploration globally which would ease the burden on those countries with the largest known reserves. The Japanese government has already identified this as a key policy, and may also go a step further in easing the capital requirements for building processing plants by providing loan guarantees to support production.

It is a long and difficult process to commercialise a mine and processing plant, often taking five to ten years, with significant time and effort being spent navigating the relevant regulatory environment to gain the sufficient environmental approval necessary for operation. Streamlining regulations required for mining and metal processing ventures in the more developed nations is necessary, while maintaining high levels of environmental stewardship.

tantalum 73 Ta 180.95

Mining is a high risk industry, not least due to the low public tolerance for preventable environmental damage. Businesses that choose to take on this challenge can be encouraged by tax rebates on exploration and loan guarantees for high capital projects that will create jobs and establish an export industry.

Another method of minimising the risk of economic harm due to supply disruptions is to promote and establish recycling. The UN Environmental Program released a report in 2010 that found that there were functional recycling rates of less than 1% for most of the rare earth elements. Stricter regulation of recycling of certain metals would spur further research and industrial participation in this area.

neodymium 60 Nd 144.24

tellurium 52 Te 127.60

Finally, the development of new technologies and materials with the potential to ease the coming supply pinch, has to be encouraged. Funding for industrial laboratories and academic studies will not only increase technical know-how, but also generate a pool of talent and knowledge. A strategic approach to funding for mineral extraction and processing as well as recovery and recycling will yield benefits in the medium to longer term, especially if there is collaboration between academia and industry.

Moving Beyond the Majors

The world is moving beyond iron, steel and the major metals into a future powered by advanced technologies that rely on minor metals traded in opaque markets with an often volatile supply and pricing pattern. Developed nations are particularly vulnerable to supply disruptions due to a complicated supply chain where the raw material processors are concentrated in a few nations, some of whom are seeking to secure resources to feed their predicted domestic demand.

It is necessary for developed nations aiming to procure critical metals to diversify their supply sources

lithium 3 Li 6.941

Confrontational actions that seek to pressurise those nations are likely only to result in a more subtle protectionist stance. Instead, a range of policy actions by national governments is required to create a transparent and globalised supply chain that eases the burden on existing producers and processors. There is evidence that the international community is beginning to identify the critical metals of high interest and are starting to develop and implement policies with the potential to minimise the risk of a supply disruption, which would hinder the development of advanced technologies – and especially clean energy technologies – of the future.

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Nanotechnology for Sustainable Development

Dr. Antonio Torrisi, Imperial College London

How do we imagine our world in 20-50 years? With a rising world population expected to reach 9 -10 billion by 2050 according to UN projections,[1] increasing demand for water, crops, healthcare and energy are likely to stretch the resources of the planet, putting our fragile ecosystem under severe pressure.

Therefore, a sustainable model for global development, defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs",[2] has attracted increasing attention. By focusing our efforts on the preservation of the ecosystem and natural resources, we can hope to guarantee a future for the generations to come.

The science of the very small, nanotechnology could play a key role in tackling many of these issues ranging from fresh water supply and food decontamination to green technology.

Thirty years ago, with the invention of the scanning tunnelling microscope (STM), scientists developed the ability to design and control new particles and materials with dimensions between few nanometres and few micrometres. Since then, inorganic particles and organic particles with different shapes and exotic names such as nanorods, nanowires, nanotubes, nanotweezers have been proposed to accomplish specific tasks – including metal coordination, molecules encapsulation, molecules/ions sieving and sensing. This new technology has the potential to tackle many of our most challenging technological, environmental and economic problems of both today and the future.

A key problem facing humanity is that of fresh water supply. Although 70% of the Earth's surface is covered by water, only 2.5% represents accessible fresh water.[3] Environmental problems encompassing depletion and contamination of fresh water coming from aquifers, rivers and lakes, together with the loss of snowpack and water stored in glaciers, present serious risks which undermine the future of agriculture, industrial production and domestic use.

Nanosorbents – including nanoclays, nanoparticles of metal oxides and zeolites – have been developed to remove ions and organic solutes from a liquid. Moreover, nanocatalysts – usually metallic nanoparticles – have the ability to convert toxic organic molecules into harmless products and kill bacteria present in water without generating toxic byproducts. These materials can thus provide an effective solution to water contamination issues.

Furthermore, the California Institute of Technology recently developed a prototype system of nanopolymeric membranes and dendrimers composed of complex branched organic molecules, which offers promising seawater desalinasation solutions.

Nanotechnology is likely to also play a decisive role in combating food-borne illnesses that threaten worldwide food supply. Molecular imprinted polymers can, for example, recognise plants as well as insect viruses,

[1] United Nations Department of Economic and Social Affairs Population Division (2002) World Population to 2300.
[2] Brutland, H. (1987). Towards sustainable development. (Chapter 2 in A/42/427). Our Common Future. Report of the World Commission on Environment and Development.
[3] University of Michigan (2006) Human Appropriation of the World's Fresh Water Supply, University of Michigan.
[4] Zhu, L., Scrand, A. M., Voevodin, A. A. et al (2011). Assessment of Human Lung Microphages After Exposure to Multiwalled Carbon Nanotubes Part II. DNA Damage. *Nanoscience and Nanotechnology Letters* **3**, 94.

while DNA barcodes can track bacteria in agricultural environments, and hence tackle the problem at its source. In addition, alongside improved storage conditions, the detection of food-borne bacteria and toxins by nanosensors could significantly reduce food waste.

Nano Life

Nanomaterials could also help develop greener technologies, hence reducing CO2 emissions and energy consumption for buildings and transport. For example, US buildings account for about 40% of the country's total energy consumption and are responsible for 39% of CO2 emissions. Transport's contribution amounts to another 33%.

Alongside improved storage conditions, the detection of food-borne bacteria and toxins by nanosensors would significantly reduce food waste

By combining the use of light emitting diodes (LEDs), super-insulating and self-cleaning windows, together with the implementation of more powerful roof-top photovoltaic (PV) panels and nanosensors monitoring energy usage, energy efficiency and environmental sustainability of buildings would be enhanced.

In particular, the improvement of solar photovoltaic (PV) is linked to the development of new materials with higher efficiency in solar energy conversion. Nanostructured organic photovoltaics can now reach a power efficiency of 8%. Although still lower than traditional silicon-based PV, given their high flexibility and relatively cheap industrial production, these organic PV panels have found applications in many sectors, ranging from buildings to transport and electronic equipment.

Improved recycling in industrial processes would enable the recovery of precious transition metal ions from aqueous solutions and mixtures, in parallel to a decrease in solid waste and Green House Gas (GHG) emissions. Such recycling could be achieved through recovery and reuse of magnetic nanoparticles via magnetic separation.

Furthermore, highly porous nanomaterials – encompassing metal organic and zeolitic imidazole frameworks – capture large amounts of CO2, in parallel to metallic iron nanoparticles which degrade organic contaminants like chlorinated hydrocarbons.

The development of new catalytic nanoparticles for transport technology, at lower cost than the currently used platinum-based catalytic converters, would guarantee cleaner emissions. New nanotechnologies based on carbon nanotubes (CNT), leading to new materials between 10 and 56 times stronger than steel but significantly lighter, would reduce fuel consumption.

Nanotechnology could also play a key role in tackling environmental damage caused by the spillage of toxic substances. Membranes made of potassium manganese oxide that can selectively absorb large amounts of oils from water have great potential for ocean-skimming and oil spillage clean-up. These nanoporous membranes have already been used to power a robot constructed at the Massachussets Institute of Technology (MIT) called 'Seaswarm' aimed at preserving the water quality of oceans by tackling oil-related pollution.

Finally, nanotechnology could also promote advances in both medical diagnostics and therapeutics. Inorganic and organic nanoparticles such as mesoporous silica, zeolites, CNT, hydrogels and micelles have been proposed as candidates for drug delivery systems.

Nano Risk

Given their very small dimensions, nanomaterials present potential risks for both the environment and human health that should not be underestimated. Concerns have already been raised about prolonged exposure to nanoparticles, some of which are believed to contribute to the development of lung diseases such as asbestosis, silicosis, asthma and lung cancer. Moreover, nanoparticles assimilated through ingestion could also pass through the intestinal barrier, ending up in the bloodstream with the potential to cause diverse damage to internal organs.

In particular, this latter issue represents a big concern for the deployment of nanoparticles in the food industry and hence the necessity of a thorough investigation of potential hazards before any implementation. This is the mission of the Institute of Materials (IOM) which works in collaboration with SAFENANO (the Europe's Centre of Excellence on Nanotechnology Hazard and Risk). Their combined efforts are aimed at developing clear policy and legislation that regulates the use of nanoparticles in future technological applications.

A few systematic studies investigating the potential toxic effects of nanoparticles and ultrafine particles on animal (including human) cells *in vitro* have already been released. It has been shown that ultrafine particles could cause severe damage to both the pulmonary and central nervous systems. Over the last few years, a cause and effect relationship has been established between oxidative stress induced by the presence of transition metals such as chromium or cobalt and pulmonary toxicity.

Nanomaterials present potential risks for both the environment and human health that should not be underestimated

Nanoparticles are known to form agglomerations whose accumulation mechanism and potential toxicity depend on the substance in question's physical properties such as chemical composition, size, shape and surface area. In 2005, a study from the Institut National de Recherche Scientifique investigated the relationship between the size and deposition rate of nanoparticles in various pulmonary regions. It was found that a bigger size particle had a shorter retention time as well as a closer deposition location in the pulmonary system.

Overall, these few studies appear to give preliminary indications about the diverse toxic effects that nanoparticles might give rise to. Fullerenes, for example, do not seem to present serious risks to the skin, yet studies have demonstrated their toxic effects following ingestion. Similarly, there have been cases where iron present in CNT, thought to be carcinogenic due to possible disrupted cell replication, led to dermatological complications.[4]

Interestingly, it has been observed that the encapsulation of some nanoparticles – especially inorganic ones - can inhibit toxic effects. For example, CdSe quantum dot has significant cytotoxicity in human cells related to its carcinogenic Cd^{2+} ions. The encapsulation of CdSe in zinc sulphide tends to reduce this effect, and when encapsulated in bovin serum albumin, the cytotoxic effects of CdSe almost disappear.

Nano Future

Nanoparticles are already integral components of a wide range of products, from personal-care silver sprays or sunscreens to food additives and colourings. The US Food and Drug Administration (FDA) is currently arguing for a policy change to make the labelling of food and cosmetic products mandatory whenever they contain new ingredients or components differing from those 'Generally Recognised As Safe' (GRAS).

The main concern, however, is that, in the past, the term 'GRAS' has been controversial, as highlighted by the case of asbestos. Either the mandatory labelling of commercial products shall be extended to all ingredients or the term GRAS shall apply to an ingredient only after it passes a complete and thorough series of toxicological studies and tests.

It is crucial that scientists developing nanotechnologies of the future are fully aware of potential risks, and communicate these clearly to the general public through an open dialogue. This, coupled with the development and adoption of a clear, transparent and specific regulatory framework, could play a key role in the prevention of nanotechnology suffering the same fate as genetically modified organisms as a safe technology in the public eye.

Dr. Antonio Torrisi is a student of the MSc in Science Communication at the Department of Humanities, Imperial College London. He has a PhD in Chemistry and has previously worked as a Post-Doc researcher in Materials Modelling at University College London.

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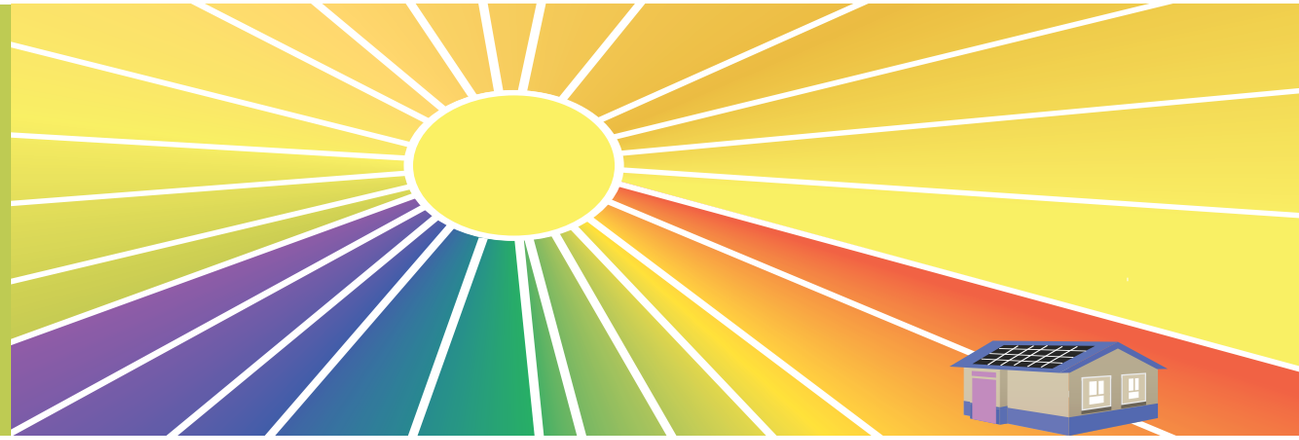
Sunny Side Up

Powering Our Future with Solar Photovoltaics

Prof. Jenny Nelson & Christopher Emmott, Imperial College London



The Sun supplies the Earth with some 3.9×10^{-6} EJ of radiant energy every year. This compares with a global primary energy consumption of 508 EJ and electric power consumption of 62 EJ in 2009.[1] The solar resource is thus clearly capable of meeting the current – and projected – human energy consumption many times over, even allowing for moderate conversion efficiency and allowing for the fact that solar energy can be easily harvested only from a fraction of the Earth's surface.

Until now only a fraction of 1% of energy has been provided by direct conversion of solar energy, but that is set to change: International Energy Agency projections anticipate that some 11% of electric power will be provided by solar technologies by 2050.[2]

Challenges remain, however, in driving up efficiencies and scalability, driving down costs, in order to ensure that solar energy is a competitive and environmentally friendly energy source for the future.

Against this picture where an established technology is growing strongly and becoming cost competitive, the following question arises: what can new materials do for solar power?

Solar energy is harvested through the absorption of light in a material. Three different varieties of solar energy conversion may be distinguished: solar thermal conversion where light energy is converted to heat, solar chemical conversion where light energy is converted to stored chemical potential energy, and solar photovoltaic conversion where light energy is converted to electrical work.

Absorption of a photon of visible light results in the excitation of an electron from its ground state, where it is normally involved in bonding, to a higher energy state where it is freer. That electron could then relax back to its original state, giving up its energy through a series of collisions, generating heat, as is the case in solar thermal technologies. Or it could take part in a chemical reaction and give up its energy to form a new chemical bond. This is what happens in photosynthesis and in the generation of synthetic 'solar' fuels.

Alternatively, if the electron is able to travel through the absorbing material towards a contact with an external circuit, taking some of its additional electrochemical energy with it, then it is able to do electrical work. This latter process is the heart of photovoltaic (PV) energy conversion, the direct conversion of radiant light energy to electricity.

Solar Photovoltaic Technology

PV conversion requires a material with a minimum energy threshold for excitation of electrons, necessary to avoid very rapid relaxation of electrons to their ground state. Additionally it requires that the two contacts between the absorbing material and the external circuit be different, in order to provide a preferred direction for the excited electrons to travel.

In the most common type of device, PV conversion is carried out using a large area film of a semiconductor material such as silicon which has been treated (or doped) differently on the top and bottom in order to provide the differences in the electrical contacts. A semiconductor possesses the required energy gap and is sufficiently conductive for electrons and holes (positive charges) to travel easily, while the difference in doping provides the direction.

Some 80% of solar panels are currently made from silicon (Si) wafers processed into this p-n junction device structure and connected together into modules of around $1m^2$ in area. Silicon PV panels convert some 15-20% of the incident solar energy into electricity.

By 2011, a total of 69 GWp of PV panels were installed worldwide with a capacity to generate some 85TWh of electricity annually.[3] The cost of a typical, grid connected PV system is around $3/Wp of which around half is the cost of installation, mounting and electrical regulation, the so-called balance of systems (BoS).[4]

The cost of PV modules has reduced rapidly over the last 10 years, and especially over the last two years, due to a market expansion partly stimulated by incentives such as feed-in tariffs. At current costs, the price of solar generated electricity is almost competitive with grid power in the sunniest countries[5] and in countries where grid power is already expensive[6], and it will soon become competitive in other countries as the market continues to expand. In Germany, where peak daily electricity usage coincides with peak PV generation[7], the high (25 GWp) installed PV capacity has effectively reduced the price of peak electricity.[8]

Against this picture where an established technology is growing strongly and becoming cost competitive, the following question arises: what can new materials do for solar power?

New Materials for Solar Power

Until the last few years, Si PV was widely seen as too expensive for widespread use. That led first to the development of alternative 'thin film' semiconductor materials which could be deposited more cheaply than Si wafers, which absorb light more strongly and so required less material, and which could easily be deposited into integrated module structures eliminating the need for costly processing of individual cells into interconnected modules. Two particular thin film materials, cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) have been developed commercially and offer module efficiencies of 13% and 16% respectively (cf 18-22% for Si).[9] CdTe in particular has been developed with encouragingly low manufacturing costs.[4]

However, concerns about the availability of rare elements used in these materials (In and Te) and toxicity of materials (such as Cd), as well as the ambition to reduce the cost of PV device manufacturing even further, have led to a surge of research into very different materials.

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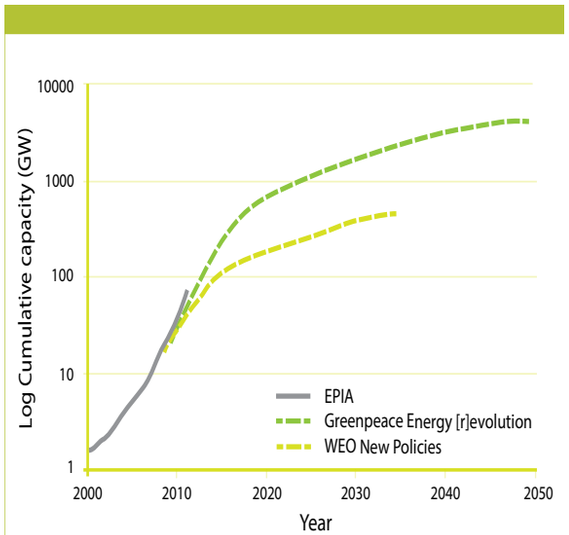

The historic growth of PV capacity as recorded by the EPIA (solid line) and two examples of projected future developent of solar photovoltaics (dashed line) [1,3,11]

These include efforts to reduce module cost using organic, inorganic and hybrid (organic:inorganic) semiconductor materials that can be processed directly from solution using printing or coating techniques. Solution processed semiconductors can be combined with flexible substrates to make very light weight solar cell materials in varying shapes and colours.

The goal of reducing the cost of PV power has also led to research into materials enabling higher efficiency PV energy conversion. In one high efficiency approach, materials that are sensitive to different parts of the solar spectrum are combined into a so called multi-junction device in order to improve the efficiency of converting different wavelengths of light.

What can these new technologies deliver?

Exploiting the Potential of New Technologies

The original motivation for new photovoltaic materials was to reduce PV power costs by reducing the cost of the modules compared to crystalline silicon. Whilst new materials with cheaper manufacturing costs make this possible, the margin by which power costs can be reduced is becoming narrower, both because of recent reductions in the cost of Si solar cell manufacture and because the module now comprises only around half of the cost of the PV system. However, there are other ways in which the cost of the PV system could be reduced by using new technologies, for example, by making use of lighter module weight, and by integrating modules into building components so that the cost of mounting structures is reduced.

In minimising the overall cost of the PV system it is important to consider the particular application, location, demand pattern and available resources. A low efficiency, flexible PV technology may be ideal for a large membrane roof or applications in the developing world where local demand is low. On the other hand, an expensive, high efficiency technology may work best under high insolation and clear skies and especially where mechanical components can be used to allow the solar cell to follow the Sun.

New PV technologies can bring other benefits than simply reducing the cost of the PV system, especially in terms of the goal of reducing carbon emissions. One important aspect is how quickly PV capacity can be scaled up to meet the growing demand for low carbon electricity. The graph opposite shows that PV capacity will have to increase by over a factor of 50 by 2050 to meet international projections. Such growth would demand high availability of component materials and a module manufacturing technology that can be rapidly scaled.

These issues have stimulated research into alternatives to rare elements such as In and Te for inorganic thin films and alternative contact metals to silver, and research into in thinner silicon structures. In this context, organic photovoltaic technology has the advantage not

[12] Hsu, D. D., O'Donoughue, P., Fthenakis, V. M. et al. (2012) Life Cycle Greenhouse Gas Emissions of Crystalline Silicon Photovoltaic Electricity Generation: Systematic Review and Harmonization. J*ournal of Industrial Ecology.* **00**(00):1–14.
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[16] de Wild-Scholten, M. J. & Veltkamp, A. C. (2007) Environmental life cycle analysis of large area dye sensitized solar modules; status and outlook in 22nd European Photovoltaic Solar Energy Conference and Exhibition.
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only of abundant, synthetically available, hydrocarbon-based raw material but also the widespread availability of plant and know-how in printing and coating capacity that could facilitate rapid scale-up.

However, organic PV is disadvantaged by having much lower module efficiencies (~3%) than commercially available inorganic technologies, as well as having limited module lifetimes of a few years. Nevertheless, organic PV has shown astonishing improvement over the last decade with efficiencies of research cells increasing from 2% to 10%,[10] and confidence that 12-15% is achievable. These promising cell efficiencies should soon be translated to modules.

At Imperial College, a large research effort is focussed upon the goal of developing new and better organic and hybrid PV materials. This effort includes the design and synthesis of new semiconducting polymers and molecules, the characterisation of these materials in terms of their light absorption, electrical properties and material structure, the development of deposition processes that allow control of the structure during printing or coating, and the fabrication, measurement and modelling of solar cell devices.

Some 11% of electric power will be provided by solar technologies by 2050

Outstanding challenges in this field are, firstly, knowing how the electrical current generation processes in the material are related to the chemical structure of the materials used, and secondly, determining and controlling the physical structure within the films, and finally, designing semiconductor and contact materials that are stable with regard to chemical and physical degradation.

The amount of energy used in the manufacture of PV systems is another pertinent consideration in the goal to reduce carbon emissions. Whilst conventional PV systems have a carbon intensity of around 45 gCO^2 / kWh generated,[12] this drops to less than 20 gCO^2 / kWh in the case of cheaper, thin film or printed PV technologies.[13–16]

A consequence of this is that in the near term carbon emissions could be reduced more quickly using low carbon intensity PV materials, even if the efficiency is lower. At Imperial College, methods to assess the carbon emissions mitigation potential of new, pre-commercial PV technologies are being developed in order to identify the materials, production processes and applications for maximum impact on carbon emissions reductions.[17]

Engineering Efficiencies

A final and fundamentally important goal of research into new PV materials is to find ways to improve the power conversion efficiency, not only by improving the quality of the semiconductor materials, contact materials and device structures used in typical solar cells, but also by exploring the fundamental mechanisms of power conversion efficiency. Herein lies the tantalising challenge of finding new ways to harness some of the solar energy that can't be converted in a conventional device.

In a solar cell made from a single semiconductor material some 70% of incident solar energy is lost due to transmission of photons with energy lower than the absorption threshold of that material and to thermal relaxation of charges generated by photons of higher energy. In principle these losses might be reduced by using materials that absorb either low or high energy photons and re-emit photons of different energy, so effectively changing the shape of the incident spectrum.

Another approach is to exploit the properties of nanoparticulate or molecular semiconductors to slow down the rate at which charges lose energy. A different and still unexplored goal is to combine the functions of photovoltaic and photochemical energy conversion in a single device, so that some solar energy can be chemically stored until needed. Development and understanding of synthetic solar 'fuels' that can store solar energy is one of the future goals of solar energy materials research.

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Christopher Emmott is a PhD student in the Department of Physics and the Grantham Institute for Climate change at Imperial College London.

Burying Our Nuclear Legacy

New Materials for Deep Geological Disposal

Georgios Katsigiannis, Imperial College London

Deep geological disposal of nuclear waste has gained growing attention from both the Government and the scientific community in the UK spearheaded by the International Atomic Energy Agency (IAEA), the Royal Society of Chemistry and the Geological Society over the past few years. Given its realistic implementation in the country, as well as its promising long-term safety potential, geological disposal appears to be the best available approach to long-term nuclear waste management in the UK.

According to the Geological Society (1999) "only deep geological disposal can provide a long-term, safe and sustainable solution for radioactive waste", while the Royal Society (2006) argued that "the confidence that could be placed in geological disposal in the UK sites has been understated".

Unlike above ground storage methods – referred to by some as the 'store and wait' approach - proposed by some environmental organisations, the design concept and the sealing properties of deep geological disposal can ensure the effective isolation of the nuclear waste.

The design concept and the sealing properties of deep geological disposal can ensure the effective isolation of the nuclear waste

Such facilities have already been adopted in a number of countries possessing significant amounts of high level nuclear waste,[1] including Canada, France, Finland and Sweden. Yet repositories of this kind must still overcome public opposition.

The UK has been producing nuclear waste since the 1940s, and the development of sustainable storage solutions has been actively discussed ever since. A major programme aimed at building an underground research laboratory in Sellafield – offering a potentially sustainable nuclear waste storage option – stems from the 1980s, yet the initiative stalled in 1997.

Over the following few years the situation was reviewed by the House of Lords and the Government, resulting in the initiation of the 2001 the Managing Radioactive Waste Safely (MRWS) programme. Some years later the Independent Committee on Radioactive Waste Management (CoRWM) suggested a short-list of options for the safe disposal of the country's nuclear waste. In 2006 the Government agreed that deep geological disposal, combined with safe interim storage, was the best approach for its management.

Things started then to move faster. In 2008 the White Paper: 'Managing Radioactive Waste Safely' was published, whilst in 2009 the Joint Research Centre of the European Commission stated that "our scientific understanding of the processes relevant for geological disposal is developed well enough to proceed with step-wise implementation".[2]

In the UK, the Nuclear Decommissioning Authority (NDA), the implementing body for the deep geological disposal, is developing a parametric cost model for such a facility, which amounts to £4 to £12 billion.[3] By exploiting international experience in the field to carry out its own research and site specific investigation, UK scientists can reasonably aim to develop a reliable, safe and environmentally friendly permanent disposal site in the near future.

However, the development of a nuclear waste disposal site in the UK is not solely a technical or cost challenge, but social one as well. One of the most critical issues is that of site selection, which has to proceed on a volunteer and mutual agreement basis rather than a primarily geological criteria. Local residents of potential sites often exhibit 'not in my backyard' opposition despite favourable regional seismic conditions.

Sites in Cumbria and Romney Marsh are being examined as a possiblity. Should the discussions move ahead, the selected host area would start to store British radioactive waste from 2040 onwards.[4]

With the development of any site depending on local public opinion, it is up to the scientific community to communicate the design and its advantages including substantial job creation.

Nuclear Barrier

Several concepts have been proposed for the safe deep geological disposal of high activity nuclear waste. They all have in common a combination of natural and engineered barriers that effectively isolates nuclear waste from human beings and the environment.

Digging a deep geological repository is restricted to accessible areas – mainly on-and near shore sites – within rock that is geologically stable with limited groundwater flows to depths between 250 and 1000m.[5]

Having been processed to a suitable form for disposal (e.g. in glass form via a procedure called vitrification), the waste is placed into a copper container of high strength and corrosion resistance. This is in-turn surrounded by a compacted layer of a key soil material called buffer, which both protects the canister against corrosive attack and rock movements, and prevents water from penetrating into the canister.

Additionally, this buffer has the potential to retard any potential leakage of radioactive substances from the canister. The last layer of the repository is composed of the rock itself, providing the ultimate effective barrier aimed at limiting the flow of groundwater, gas release or the movement of radionuclides.

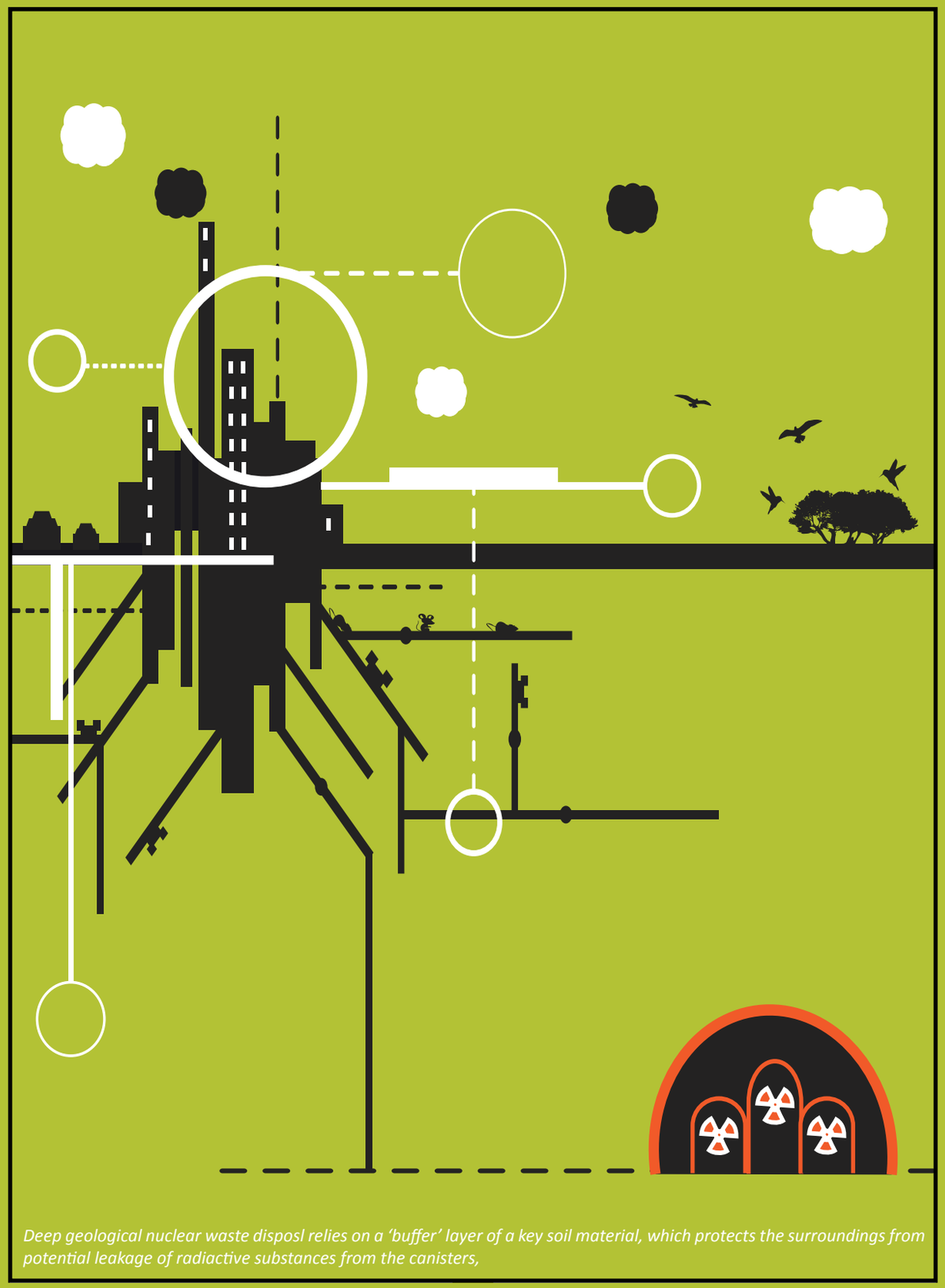
Within this framework, the buffer governs the overall behaviour of the system. Buffer materials are chosen depending on both the nature of the waste to be stored and the type of rock hosting it. However they possess common physical propeties that are critical to the efficient isolation of radioactive waste, namely: very low permeability, high swelling and self-sealing potential, adequate thermal conductivity and mechanical resistance, high exchange capacity and radionuclide retention properties.

Compacted bentonite-based materials and mixtures of bentonite with sand or crushed rock satisfy these requirements, and have been proposed as potential buffer materials. Other substances have been examined in different countries with the choice depending mostly on local availability.

The deep geological repository to be implemented in Sellafield could be built based on the KBS-3V concept developed in Sweden. Under this model the buffer consists of one solid bottom block, 6 ring-shaped blocks surrounding the metallic canister and 3 solid top blocks. A space between the blocks and the deposition hole walls – filled with high density bentonite-briquette shaped-pellets – has to be left to facilitate the installation procedure.

Following the assembling of the system, buffer interactions with both the wet host rock and the canister take place. The dense bentonite-based materials, initially unsaturated (i.e. voids only partly filled with water), absorb

A tunnel in the Swedish Äspö Hard Rock Laboratory, where research for future nuclear waste storage is being carried out.



Deep geological nuclear waste disposl relies on a 'buffer' layer of a key soil material, which protects the surroundings from potential leakage of radiactive substances from the canisters,

water from the wet host rock and start swelling, thus filling the space left between the canister containing the waste and the rock hosting it.

Researchers over the last decades have investigated the properties and the behaviour of potential buffer material. Its mechanical behaviour has been examined through a series of standard soil mechanics tests, starting with oedometer tests which allow simple volume and load control measurements.

Experiments examining swelling pressures and swelling strain, water chemistry, shearing behaviour, hydraulic and temperature gradient experienced by the buffer have also been developed.

Large scale tests – aimed at enhancing our understanding of the very complex processes taking place in the buffer in experimental conditions similar to those of an actual repository – have taken place at the Prototype Repository and the FEBEX project, both funded by the European Union. The Prototype Repository is a research programme investigating the Swedish concept of deep nuclear waste disposal KBS-3V.

Feasability studies of disposing of spent fuel in Sweden are being carried out in a prototype repository at the Äspö Hard Rock Laboratory (Äspö HRL) near the Oskarshamm Nuclear Power Plant.

Swedish bedrock is both mechanically and chemically very stable, witnessing only very slow changes, and hence provides an excellent study environment.[6] In this model, electric heaters are used to reproduce the heat energy flow that would emanate from the nuclear waste.

Besides providing crucial information relating to the interaction of bentonite clay, copper canisters and the rock hosting it, research carried out in this prototype repository has also enabled the study of both the bedrock's ability to filter radioactive substances, and the groundwater's flow and chemical constituents.

With the development of any site depending on local public opinion, it is up to the scientific community to communicate the design and its advantages including substantial job creation

This project has been going on since September 2001, and is still providing valuable large-scale testing information required to start building a deep geological repository for spent nuclear fuel.

The FEBEX (Full-scale Engineered Barriers Experiment in crystalline host rock) project is based on the Spanish deep geological disposal proposal. Under this model, the copper canisters isolating the spent fuel are placed horizontally and are surrounded by bentonite blocks.[7] The project included a full scale in-situ test in Switzerland, a mock up test in Madrid and several lab tests.

Other large scale underground experiments are taking place in Bure (France), in Horonobe and Mizunami (Japan), in Nevada (USA) and in several other countries including Belgium, Canada, Korea and Finland.

Finding a safe, long-term disposal method for the UK's arsenal of radioactive waste accumulated over the past decades remains a thorny problem. Despite receiving a cautious welcome by a concerned public, deep repositories offer a promising way to store spent fuel and seem to be our only hope of a viable long-term solution to our nuclear waste problem.

It's simply a matter of taking responsibility, and not passing the buck. Nuclear waste is a problem that we created, it's a problem that needs a resolution now, and it's a problem that shouldn't be shouldered by future generations.

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Re-Thinking Rural Architecture in Syria

A Traditional Approach to Contemporary Living

M. Hosam Jiroudy, The Prince's School of Traditional Arts

A model house at Dier El-Boukhet, Daraa province, Syria, aims to illustrate the potential for designing and building load-bearing structures using traditional architectural systems of vaults and domes for ceilings in the region – without the use of expensive reinforced concrete. This is a model for developing rural housing in Syria by means of relying on local resources including labour, materials and techniques.

The purpose of this project is to reduce inflated construction costs which are the result of using imported steel, to enhance living standards, and to help address contemporary socio-economic and environmental issues in the region.

The Syrian economy relies mainly on agriculture, oil industry and tourism. In the last couple of years, challenging climatic conditions and drought have badly affected the agricultural sector, yet this decine has been countered by increasing crude oil prices.

According to World Bank data, the population of Syria in year 2011 reached more than 20 million inhabitants. 90% of Syrians are Arabs and around 35% of the population lives in the four major cities (Damascus, Aleppo, Homs and Hama) while the remaining inhabitants are spread across the Euphrates in towns and villages and along the coastal plain.

Since March 2011, Syria has witnessed an unprecedented period of crisis and escalating violence due to the current political turmoil, and this has led to a devastating economic downturn.

Due to the growing population in Syria, the demand for housing solutions is becoming greater every year. However, with the increasing price of steel and fossil-fuel based energy, the cost of building a house in rural areas is becoming unattainable for the low income rural population.

Syria is considered a geologically rich and a diverse country. It has a great deal of natural components that can be transformed, using simple methods, into durable building materials. This includes lime stone in northern regions, coral stone near coastal areas, sand stone in the central province, lava stone in southern areas, and clay in river beds that can produce mud brick in the eastern part of the country.

The aim was to identify building materials that would challenge the dominance of conventional building methods

Furthermore, the long line of traditional crafts that Syria celebrates can be found in the construction of historical houses and buildings including stone masonry, glass blowing, brass making and intricate wood work. These skills are slowly dying due the invasion of modern imported commodities and techniques.

Today, most rural residents rely on the reinforced concrete and cement block model to build a conventional house, and such projects are mainly financed through government loans. The loan is paid back to the government with interest over a period of 15-25 years and the monthly loan repayment usually consumes 50-60% of the debtor's income.

Almost 45% of the cost of such structures relates to one single commodity: imported steel. This steel is mainly imported and subsidized by the government, which creates a vicious cycle: the government is paying an inflated price for an imported item and low-income dwellers are trapped in a high-debt poor-housing long-term situation.

This has indirectly resulted in increased rates of unemployment and poverty, leading to the obstruction of real development among the majority of rural residents. As a result, migration from rural parts to major neighbouring cities or countries has increased, leading to less government attention for rural areas and more challenges for a denser urban population in major cities.

An Innovative Design Approach

The southern part of Syria (Horan area) is very rich with a volcanic or Lava stone named Basalt which is considered to be one of the strongest rocks on earth. Basalt is a dark and very fluid rock that tends to flow during volcanic eruptions to form flood basalts and shield volcanoes that may cover several thousand square kilometres.

The house is located in a village called Dier El-Boukhet that belongs to Daraa Municipality, in the south-west region of Syria, around 45 km south of Damascus city. The majority of the 8,000 inhabitants of the village have low-middle income.

The area is mainly dry and hot during summer and has around 300 days of sunshine during the year. The weather is partially influenced by cold winter wind due to its altitude which is 670m above sea level. The microclimate of the site was taken into consideration in order to provide maximum thermal comfort.

The design of the house is based on the social and functional needs of the client and his family, while also taking into consideration environmental and climatic challenges.

On the other hand, the design also attempts to respect a cultural identity through the continuity of local and traditional housing solutions in addressing contemporary requirements.

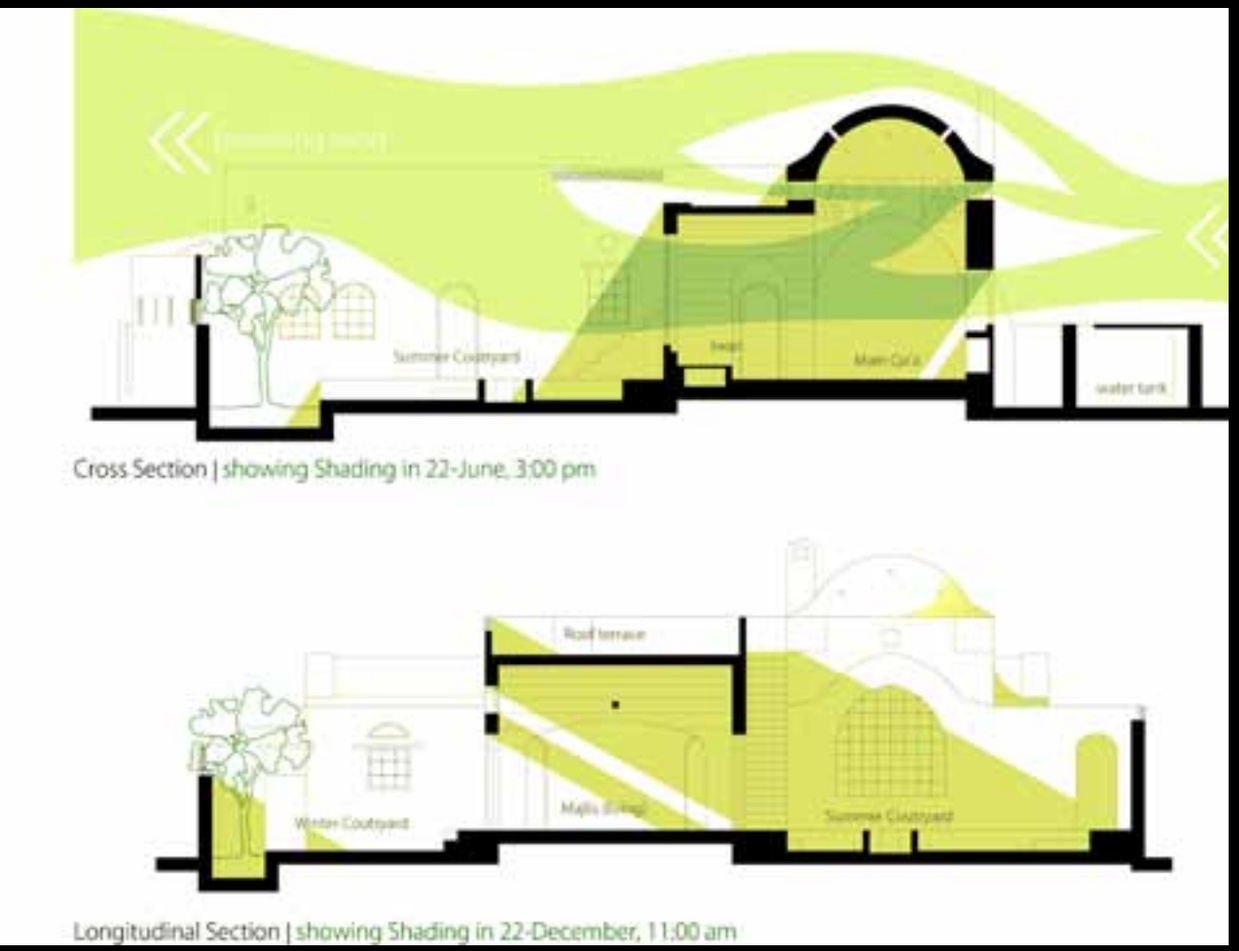
Specifically, it reintroduces traditional elements that naturally enhance the architectural space, with the use of courtyards, domes and vaults for ceilings, wooden doors and windows, stained glass to diffuse and filter light, thick bearing walls for heat insulation and Basalt external flooring to provide a cool external surface.

The open courtyards are the focal point of all activities, with all living spaces overlooking the courtyards. Their accompanying vegetation and use of water fountains and air circulation provide a naturally controlled microclimate, which is a celebrated aspect of most Arab traditional architecture.

A New Material Composite

The aim was to identify building materials that would challenge the dominance of conventional building methods, namely the use of reinforced concrete roofs that are both prohibitibly expensive and normally result in poor housing conditions in such areas. These materials should be simply and quickly made on site by unskilled or semi-skilled labour, have sufficient mechanical strength and be less expensive than other available building materials.

Such an approach would also establish a new socio-economic model in providing an affordable alternative to imported materials by using local resources to enhance employment opportunities for locals. In addition, technical supervision and training should be carried out on-site hence resulting in the transfer of knowledge and subsequent empowerment of the local community.



Cross Section | showing Shading in 22-June, 3:00 pm

Longitudinal Section | showing Shading in 22-December, 11:00 am

Using the traditional structural system of load-bearing for construction implies the use of materials that work in compression (such as stone or bricks) for the construction of arches and domes, rather than materials that work in tension (such as steel).

This building method provides a more efficient and economical means of construction. Here, thick walls naturally provide heat insulation and acoustic control. A curved ceiling is physically stronger than flat one, is less exposed to direct sunlight than a flat one, and also helps increase air flow internally due to the difference in air pressure between shade and non-shaded areas over a curved roof.

Contributing to the reduction in cost, instead of employing a contractor, the client and his relatives were trained on site to use simple traditional techniques to make the stone blocks, and to build load-bearing walls and domed ceilings. They went on to complete the construction under expert supervision.

Our initial plan was to build the house using the available Lava stone. However, it was very expensive and challenging to find a local stone mason that would build the house using Lava stone due to a loss of specialist expertise over time. However, after extensive research and experimentation, we were able to develop a new composite construction material that is made from local Lava stone.

This new Basalt solid block consists of 80% multiple granulometry of crushed basalt, 2% lime stone powder, 8% cement and water. It is easy to make locally, less expensive than stone cutting or conventional cement block construction, strong and durable and has a similar thermal and moisture insulation to raw stone due to the nature of its special mixture.

The design also attempts to respect a cultural identity through the continuity of local and traditional housing solutions

The main advantage of this new material is that it enables people to build their own houses up to three floors without the use of reinforced concrete or steel by means of load barring walls and domed or vaulted ceilings, while employing ordinary block masons or non-skilled labour.

Bringing Back Traditional Construction

Load-bearing design and construction belongs to a long tradition that was dominant in most of the Arab countries before imported building materials took hold in the early twentieth century. Yet attempts have been made in the past to return to more traditional methods.

In the early fifties the prominent Egyptian architect Hassan Fathy started to work on reviving indigenous housing solutions for the inhabitants of rural Egypt at a minimal cost, aiming to lower costs and improve the standard of living in rural areas by utilizing traditional design methods and materials.

The following generation of traditional architects such as Abdel Wahed El-Wakil and a few others continued to build houses, public buildings and mosques on a larger scale around the Arab world using the same principles based on climate control and economical construction techniques.

In 1987 a series of traditional stone construction schools and a house were initiated by Syrian architect Raif Muhanna in the Horan area in Syria. This system relied on low-cost, effective, speedily erected buildings with a high dependency on locally sourced basalt stone and a construction system based on stone arches. These structures were among the first attempts to reintroduce traditional notions in response to contemporary challenges in the southern part of Syria.

Employing a similar approach in combination with the new composite material, the model house was 35-40% less expensive to build than the conventional low quality houses that are being built in the region today.

The Future

The rich and diverse wealth of historical buildings spread across the Arab and Islamic world demonstrate past mastery of engineering and craftsmanship in the use of locally available building materials and construction techniques.

Such traditional construction may be implemented as widely today using a variety of natural local load-bearing materials such as raw stone, brick or block provided that it meets a certain minimum mechanical strength. The fundamental traditional craftsmanship skills, the building materials and a local labour force are available, but the challenge remains to re-institutionalize traditional building practice as a replacement for current conventional building systems.

Such challenges can be addressed by collaboration between government and the private sector, by establishing training of traditional techniques, by introducing regulations and facilities that encourage the use of natural and local materials, and by presenting a clear business case.

The adoption of this type of model for a cost-effective sustainable housing strategy on a broader scale could help rural people build their own houses at much lower cost, and eliminate the need for expensive imported materials and expertise thus providing local employment opportunities. Most importantly, it is a chance to revive local pride in timeless tradition, culture and wealth.

M. Hosam Jiroudy received his Degree in Architecture from Damascus University in 2000 and is considered to be one of the young emerging forces in the field of Traditional Islamic and vernacular architecture. He is currently undertaking research at The Prince's School of Traditional Arts in London.

A WMD Free Zone in the Middle East

Looking Towards the Upcoming Helsinki Conference

Ziad AbuZayyad & Hillel Schenker, Palestine-Israel Journal

In March 2010, the Palestine-Israel Journal (PIJ, www.pij.org) published a double issue called 'A Nuclear Free Zone in the Middle East: Realistic or Idealistic?' The PIJ plans to publish a follow-up edition dealing with the nuclear question which will provide civil society input in connection with the 2012 Helsinki Conference.

The follow-up issue will be organized in partnership with the Centre for International Studies and Diplomacy (CISD) at SOAS, headed by Dr. Dan Plesch. In December, 2012, the PIJ plans to hold a public conference in Jerusalem on the topic. The PIJ will also be a partner in the 7th annual London SOAS public conference on a Nuclear Free Zone in the Middle East on November 19th in London at SOAS. Another partner in these efforts is the CSCME (Conference on Security and Cooperation in the Middle East) civil society initiative.

Nuclear proliferation in the Middle East is high on the regional and international agenda. Fear of a nuclear arms race in the region driven by tensions between Iran and Israel, and continued mistrust surrounding the Iranian nuclear programme, threaten preparations for the upcoming conference on a Nuclear and Weapons of Mass Destruction (WMD) Free Zone to be hosted by Finland at the end of 2012.

A grave danger looms in the Middle East. If Iran achieves the capability to produce nuclear weapons, it would most likely lead to further nuclear proliferation in the region. Saudi Arabia, Turkey and Egypt consider themselves threatened by any Iranian nuclear weapons capability, and have each indicated that this might provoke them to pursue their own production capacity.

The emergence of a nuclear arms race in the region would not only threaten both regional and international security, but exacerbate an already precarious situation.

Following the tumultuous Arab Spring, the Middle East is undergoing a period of heightened instability. Regime change in Egypt and North Africa, and the continuing uncertainty in Syria which is known to have a serious arsenal of unconventional primarily chemical weapons, continue to amplify tensions in the region. The emergence of a nuclear arms race in the region would not only exacerbate an already precarious situation but also threaten regional and international security.

Nuclear Weapons Free Zone

The Nuclear Non-Proliferation Treaty (NPT) was formulated in 1968, and it entered into force in 1970. Its objective is to prevent the spread of nuclear weapons, and further the goal of nuclear disarmament. It has been ratified by 190 nations, with notable exceptions including India, Pakistan, Israel and North Korea.

To date, nine Nuclear Weapons Free Zone (NWFZ) treaties have been negotiated and signed between 1961 and 2009. They cover, in the order that they were signed, Antarctica, Outer Space, Latin America/Caribbean, Seabed, South Pacific, ASEAN, Mongolia, Central Asia and Africa. Regions that lack a NWFZ are Europe, the former Soviet Union, the North Pacific, South Asia and the Middle East.

There are two unique elements in the quest for a NWFZ in the Middle East. One is that, unlike in all of the other treaties, it is defined as a quest not only for a nuclear free zone, but as a quest for Weapons of Mass Destruction (WMD) Free Zone. This is due to the existence and the precedence for the use of chemical weapons in the region, alongside the danger of nuclear weapons proliferation. The other unique element is that the quest for a WMD Free Zone is tied to the thus-far elusive quest for comprehensive peace in the region.

The creation of a NWFZ in the Middle East was first placed on the agenda at the United Nations in 1974 by Egypt and Iran, yet the most serious attempt to discuss the creation of a WMD Free Zone took place at the post-Madrid Conference ACRS (Arms Control and Regional Security) Talks between 1992-1995.

Thirteen Arab States participated, with Israel, a Palestinian delegation, and a number of extra-regional entities also in attendance – although not Iran. The Egyptian delegation said that the creation of a WMD Free Zone had to precede comprehensive peace, while the Israelis comprehensively disagreed and the talks broke down.

At the 2010 NPT Review Conference held in New York, the Arab states insisted that a Middle East NWFZ had to be placed on the international agenda. Otherwise, they suggested that they would reconsider their commitment to the NPT, and thus endanger the entire nuclear non-proliferation regime. It was agreed a conference in 2012 devoted to a WMD Free Zone in the Middle East should be held.

US President Barack Obama, following his speech in April 2009 in Prague in which he outlined a vision of a world free of nuclear weapons, agreed to assume responsibility for this conference together with the UK, Russia and the UN Secretary General. They were entrusted with the role of finding a host country and a facilitator for the process.

This was not an easy task. It took over a year to identify Finland as the host country, and Finish Under-Secretary of State Jaakko Laajava as the facilitator. Other contenders, Canada and Holland, which had been under serious consideration, were rejected because they were considered to be "too pro-Israeli".

Regional Players

In particular, the participation of Egypt and Syria, and especially Iran and Israel in the Helsinki Conference is crucial. Egypt, having been a strong advocate of the creation of a NWFZ in the Middle East since the beginning of the discussion on this topic in the 1970's, is unlikely to shift its position.

Given its arsenal of chemical weapons and current instability, Syria remains at the centre of discussions on security issues in the Middle East. However, its state of ongoing civil strife casts serious doubts on any capacity that Syria might have to show commitment to the cause of the creation of a NWFZ in the region. Furthermore, another issue that may unexpectedly impose itself on the agenda is the fear of a total collapse of the current Syrian regime and the fate of its chemical and biological weapons.

Iran's participation in the Helsinki Conference would allow Tehran to shift international attention away from its nuclear enrichment programme and redirect it towards Israel's nuclear hegemony.

Israelis, on the other hand, share similar, if opposing, concerns as the Iranians. They can be expected to participate should the talks not solely be focused on their nuclear status in the region but instead also invoke Iran's nuclear programme and other weapons of mass destruction and delivery systems in the region.

The major sticking point, however, is likely to continue much in the same vain as previous rounds of negotiation. The unresolved Middle East conflict continues to be a major argument used by Israel to resist demands that it signs the NPT and open its nuclear reactors for international inspection by the International Atomic Energy Agency (IAEA). This argument extends also to the creation of any nuclear or WMD free zones.

[1] Saab, B. Y. (2012) The 2012 Conference on a Weapons Of Mass Destruction-Free Zone in the Middle East, Prospects, Challenges and Opportunities, A special Roundtable Report. *James Martin Center for Nonproliferation Studies, Monterey Institute of International Studies.*

A UN monitor inspects mortar shells for chemical leakage. Throughout the 1980's and 90's Iraq under Saddam Hussein was suspected to he harbouring large stockpiles of WMD.

Very few Israelis are aware of the fact that the official Israeli government position is actually in favour of a WMD Free Zone – but after comprehensive Israeli-Arab peace is achieved. The challenge facing the Helsinki 2012 Conference is to find a formula which will enable the beginning of a process of creating a Middle Eastern WMD free zone, alongside the quest for Israeli-Palestinian and Israeli-Arab comprehensive peace, without mortgaging the issue till the conflict is resolved.

Contrary to the official Israeli position, many peace activists believe that Israel uses the Middle East conflict argument to maintain its hegemony in the region, regardless of the practicality of using WMD in any future confrontation in the region.

More challenges abound. The timing of the Helsinki conference vis-à-vis the US presidential elections due in November 2012, is unfortunate and bound to limit crucial US involvement and focus needed to drive results and Israeli participation.

This, combined with a stalled Middle East peace process and the buildup of the Iranian nuclear programme, has led many observers to believe that the conference will not cumulate in agreement on decisive action. Instead, it will try to maintain the momentum of the process by leaving the door open for follow up meetings and consultations.

Disarmament for Peace

The forthcoming 2012 Helsinki Conference on a Nuclear and WMD Free Zone in the Middle East is a historic opportunity, not only to achieve an agreement on the creation of such a zone, but also to set in motion a process leading towards a comprehensive Israeli-Arab peace settlement.

Bernd W. Kubbig, a Senior Research Fellow of the Frankfurt-based Peace Research Institute in Germany, has emphasized that "confidence and security-building measures need not strictly precede steps that tackle the armaments themselves".[1]

Instead of focusing on the traditional question of "nuclear disarmament first" versus "regional peace first", he highlighted the fact that "peace and disarmament are mutually reinforcing, and share a common goal enhance security for all."

Peace and disarmament go hand-in-hand. With the participation and commitment of all parties, a positive outcome to the Helsinki Conference may be a critical step towards a more stable and peaceful Middle East.

Ziad AbuZayyad is a former Palestinian Authority minister and has headed the Palestinian delegation to Arms Control and Regional Security Talks.

Hillel Schenker is a former Spokesperson for the Israeli International Physicians for Prevention of Nuclear War and an International Advisory Board member of the Global Majority Centre for Non-Violent Conflict Resolution.

Together they are co-editors of the Palestine-Israel Journal, receiving a joint Outstanding Contribution to Peace Award at the 2012 International Media Awards.

Preventing State Conflict in Cyberspace

Clement Guitton, King's College London

In June 2010, software programmer Sergey Ulasen was working for a small Belarusian anti-virus company when he discovered a computer worm, soon to be known as Stuxnet. Although a common hazard for the casual PC user, this particular worm revived a definitional debate on the meaning of war and conflict, and prompted discussion on the deployment of operational strategies by states in cyberspace.

Stuxnet differed from other worms on two aspects. First, it inflicted damage on critical infrastructure by targeting a particular configuration of a specific type of industrial-control system, as opposed to simply causing disruption by breaching information security components. Second, the actor who engineered the worm may not be an individual or even a group of individuals, but sovereign states.

As the United Nations is about to vote on a new binding treaty on telecommunication, can a normative solution to state-sponsored cyber attacks bring peace to cyberspace?

Three months after Ulassen discovered the Stuxnet worm, multiple security firms independently came to the conclusion that the target of the worm was an industrial control facility; it aimed at destroying Iranian nuclear centrifuges. Although Iranian officials initially denied that the worm had affected its nuclear plant, a report from the International Atomic Energy Agency noted that 984 centrifuges had been taken offline at Iran's Natanz plant between June 2009 and June 2010. Additionally, Iran's President Mahmoud Ahmadinejad announced at a press conference in November 2010 that 'they [enemies of Iran] succeeded in creating problems for a limited number of our centrifuges with the software they had installed'.[1] For some security experts, this was sufficient proof that the worm had caused physical damage to the centrifuges.

In June 2012, a reporter from the New York Times claimed to have had access to unnamed official sources alleging that Stuxnet was the result of a joint US-Israeli manoeuvre

Not only was the worm destructive, it was elaborate; it had tricked the monitoring system by feeding it with previously recorded values from the sensors while the attack was taking place. The technical knowledge required to programme such a worm is not widespread; the attacker needed a high level of intelligence and funding to develop this sophisticated weapon.

In June 2012, a reporter from the New York Times claimed to have had access to unnamed official sources alleging that Stuxnet was the result of a joint US-Israeli manoeuvre to delay the Iranian nuclear enrichment programme. Suspicion of US-Israeli involvement in Stuxnet grew as computer security experts began to unpick another worm, Flame, capable of a wide variety of spying activities including taking screenshots and recording audio conversations. Flame, as well as another intelligence-gathering worm named Duqu, specifically targeted computers operating in Arab countries deemed hostile to Israel and appeared to embed spying modules that may have informed the Stuxnet project.[2]

The Stuxnet worm was not the first incident where a computer worm caused physical damage. In 2000, a rejected potential employee of an Australian local council who had installed part of the sewage systems used his credentials to open up the sewage valves, flooding the downstream city of Maroochy. Yet what was different about the Stuxnet incident is that it spurred many political and strategic questions:

- If a given state has the capacity to attack, is it also correctly equipped to defend such threats?
- What is the legal status of such acts of cyber sabotage?

Defence Against a Future Stuxnet

Stuxnet was a wake-up call to the risks faced by the weak security of industrial control systems. Many critical national infrastructures (e.g. pipelines, electrical grids, traffic management systems) implement industrial control systems. As an indicator of their criticality, control systems may operate processes that cannot be stopped for more than five minutes a year. The criticality of the processes also implies that patching (correcting security holes) or probing (testing for known vulnerabilities) needs to be planned long in advance.

Despite their criticality, many industrial systems are connected online and anyone with an internet connection can look for them

Even a port scanning (looking for open points of access) or a ping (to test the reachability of a system) can result in unintended consequences. For example, the US National Institute of Standards and Technology reported a ping inducing a three-meter long factory arm to pivot at 180 degrees, potentially causing physical damage to workers.[3] Yet despite their criticality, many of these industrial systems are connected online: anyone with an internet connection can look for them simply using a web browser. Additionally, many of them still run the default usernames and passwords.

Fuelled by fear and lacking real unbiased data, it has been difficult to assess the extent of the threat to industrial systems. In December 2011, the US Congress started working on a legal act, the Cybersecurity Act of 2012 (S.2105), to force private operators of control systems to submit reports of attacks to a mandated authority. Collecting such data would help assess the extent of the threat in order to devise the best policy to counter it. The Bill, not yet enacted, is in line with the US commitment to 'enhance states' ability to fight cyber crime', as outlined in the 'International Strategy for Cyberspace'. Launching a worm such as Stuxnet onto an information system is already a domestic crime in the US; such legislation would not change the criminal responsibility of the perpetrators.

Yet if the perpetrator is a state, it begs the question if it is a crime under international law to launch a cyber attack. Does the current international legal framework suffice to cover cyber attacks emanating from states?

Much of the current international legal framework, for instance the Council of Europe Convention on Cybercrime, focuses on domestic implementation of cyber crime, defined as breaches of information security, or on the use of computer to further support a criminal act. It also enables legal cooperation between states on cyber crime, but does not rule on the state as a perpetrator.

The other set of norms that could ban 'cyber attacks' is if one considers them as an act of war; it is only in this case that the law of arms conflict then becomes relevant. Before delving into the issues surrounding cyber attacks as an act of war, we need to consider what it means for a state to be responsible for cyber attacks.

The International Court of Justice set the threshold for state responsibility in attacks in the 1984 case US v. Nicaragua by requiring 'effective state control' and not only logistical support from the state.[4] If officials in the US government were involved in Stuxnet, as the New York Times claimed, it seems *a priori* that the court could hold the state liable for damages caused by Stuxnet. Yet there are many uncertainties surrounding attribution of cyber-incidents that can prevent a court from convicting a state, or that can thwart the execution of punitive deterrent strategies for the victim state.

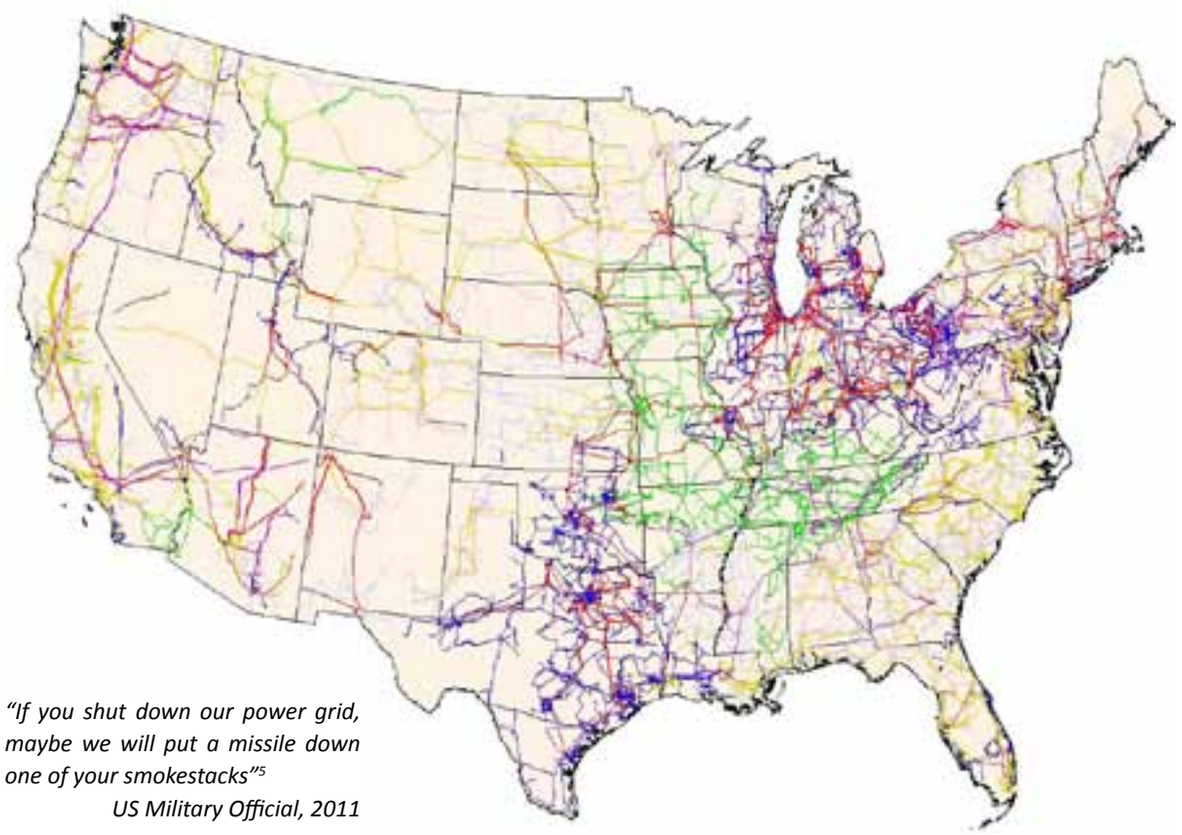
[1] Reuters (2010) Iran admits cyber attack on nuclear plants. *Reuters*, 29 November.
[2] Perlorth, N. (2012) Researchers Find Clues in Malware. *The New York Times*, 30 May.
[3] Stouffer, K., Joe Falco J. and Karen Scarfone K. (2011) Guide to Industrial Control Systems (ICS) Security. In Special Publication 800-82. Gaithersburg, MD: National Institute of Standards and Technology.
[4] Tams, C. J. (2009) The Use of Force against Terrorists. *The European Journal of International Law* **20**(2): 359-97.
[5] Gorman, S. and Barnes E. J. (2011) Cyber Combat: Act of War. *The Wall Street Journal,* 30 May.
[6] Rid, T. (2011) Cyber War Will not Take Place. *Journal of Strategic Studies,* **5**(1), 5-32.

Attribution of cyber attacks to a state is a very different process than attribution to individual hackers, and much more uncertain.

Computer mediated communication has enhanced the difficulty of identifying agents. This is largely due to the means used to carry out the attribution process based on the unravelling of a number (the IP address in the case of the Internet) which is easily masked, and identifying a machine or network of machines, some of whom are quite possibly owned by innocent and unaware participants, rather than a more visible individual or group.

If the agent is an individual, states have historically enacted legal procedures to counter-balance the rise of technology supporting the enhancement of anonymity. Similarly, legal acts have recognised the IP address as part of personal data so magistrates could use digital evidence in courts, and fostered the use of transactional data to identify the agent in the first place, raising at the same time concerns over privacy. But if the agent is a state, attribution is a fraught scientific, political and diplomatic process with few certainties.

International law makes the distinction between *jus ad bellum*, that regulates the right to engage in armed conflict, and *jus ad bello*, that regulates the conduct of armed conflicts. Only the former is of interest to assess if cyber attacks constitute legally an act of war. The main texts regulating *jus ad bellum* are Article 2.4 of the United Nations Charter that bans the 'threat or use of force against the territorial integrity or political independence of any state', and Article 51 that allows for retaliation following an act of force.



"If you shut down our power grid, maybe we will put a missile down one of your smokestacks"[5]

US Military Official, 2011

It appears that the US considers a cyber attack with physical indirect consequences as an act of war. The US therefore interprets the term 'force' as including coercion, which a cyber attack can provide the means to do. Yet considering a 'cyber attack' as an act of war is far from being deprived of issues.

Thomas Rid, a researcher at the War Studies Department at King's College London, notes that all cyber attacks to date constitute merely a form of sabotage ('attempt to destroy or weaken a system'), espionage, or subversion ('to undermine the authority, the integrity, and the constitution of an established authority or order').[6] An act of war on the other hand, according to military strategist Clausewitz, needs to be lethal, instrumental, and political. The Stuxnet example is an illustration of an overt act of sabotage involving espionage, but being neither instrumental nor lethal. Espionage is 'neither legal nor illegal' under international law as few countries have ratified treaties banning it.[7] In short, following customary law, the widespread practice of espionage by all the states indicates to some extent its legality in the international legal system, although many states ban espionage domestically. Therefore, Duqu and Flame do not count as 'use of force', nor as weapons, as they were merely intended to spy.

Other authors, such as the information warfare expert John Arquilla and the legal scholar Jonathan A. Ophardt, argue that cyber attacks cross the threshold of 'use of force' considered by the United Nations.[8] Furthermore, it has been suggested that the use of the term 'cyber warfare' has tended to add hype to the debate, and lead to a difficult assessment of the situation with proponents considering worst-case scenarios that may be misrepresentative.

[7] Radsan, A. J. (2007) The Unresolved Equation of Espionage and International Law. *Michigan Journal of International Law* **28**(597):30.

[8] Ophardt, J. A. (2010) Cyber Warfare and the Crime of Aggression: The Need for Individual Accountability on Tomorrow's Battlefield. *Duke Law & Technology Review* **3**: 27.

[9] People's Republic of China (2011) Add new articles on network and information security to ITRs - CWG-WCIT12 Contribution 59, Geneva: ITU, 23 September.

[10] Côte d'Ivoire (2012) CWG-WCIT12 Contribution 78, Geneva: ITU, 17 February.

Far from resolving this academic dispute over the traditional restrictive or modern definition of 'war', the legal status of cyber attacks may soon be settled following a United Nations treaty to come at the end of 2012.

A Treaty Banning Cyber Attacks?

In 2002, member states of the International Telecommunication Union, a United Nations specialised agency, reached a consensus to update the main binding treaty regulating telecommunications, the International Telecommunication Regulations dating from 1988. The update will ensure the treaty encompasses new modes of communication, such as the internet, as well as new threats. Member states are due to vote on the final treaty during the World Conference on International Telecommunications in Dubai in December 2012.

Despite the important impact on internet governance of the regulations, much information concerning the treaty has remained confidential, sparking criticisms from non-governmental organisations involved in ensuring sound internet policy (e.g. the Electronic Frontier Foundation and the Internet Society). However, some information has leaked out about how states seized this opportunity to regulate 'cyber attacks'.

The legal status of cyber attacks may soon be settled following a United Nations treaty to come at the end of 2012

China was the first state to mention cyber-security into the debate. In September 2011, it submitted to the United Nations General Assembly an 'International Code of Conduct for Information Security' along with Russia, Tajikistan and Uzbekistan. As the security expert Jeff Carr noted, the suggested code of conduct did not include provisions for cooperation in criminal cases, and left ample room not to ban the use of espionage technologies.

China reiterated this call and promoted the use of attacks as a defence strategy. It also wishes that states retain an important role in protecting 'user information security'.[9] However, by not defining security, censorship and any other content, blocking mechanisms could fall under such a call. In response, other states – including Algeria, Egypt and Portugal – shared their intent to draft their own texts on cyber security, but have yet to do so.

Australia, Canada and the US refused to touch upon cyber security, noting that it goes beyond the scope of the regulations and of the mandate of the International Telecommunication Union. Answering queries about counter spamming measures, they argued that this field was too fast-changing to be included in a treaty. However, Côte d'Ivoire sought to insert the concept of harm and malicious code transmitted 'by any telecommunication facility or technology, including Internet.'[10]

Harm relates to 'attack' and may be more suited to describe breaches of information security. Harmful relates to the decrease of a person's welfare, be it in economic, physical or psychological terms. Computer-related incidents are more likely to fit within the category of harmful than attack. A worm slowing down a system for instance, is expressed as a loss of time, or as an increase in stress and anger, posing an annoyance to the user, and hence is 'harmful'.

Meanwhile, calling annoyances 'attacks' presupposes the action was harmful, aggressive and potentially violent, which may not be the case. Such a wording would ban cyber attacks, but has not been retained in the current final draft. Instead, the final draft encompasses an article talking of 'strengthening security' and ensuring stability' of the internet. While Stuxnet, Duqu and Flame breach these articles, sanctions for the instigators remain very limited.

The current draft articles do not include banning state sponsored cyber attacks, despite calls to do so. Industrialised states such as Australia, Canada and the US that rely intensively on information systems appear to have prevented such moves, instead preferring to rely on internal counter measures.

It remains to be seen if a normative approach to deter cyber attacks would be effective. It appears that, in the short-term at least, strategies to develop defence, deterrent and counter-attack capabilities are likely to precede legal and regulatory attempts to combat cyber attacks.

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Hope for Humanitarianism
Empowering Vulnerable Communities

Dr. Lydia Tanner, Oxford University & Jennie Thomas, HART

The concept of 'complex emergencies' has emerged to describe situations in which political, economic and social factors combine to form seemingly intractable violent conflicts. In this setting, international humanitarian organisations wish to deliver assistance apolitically. But can humanitarian aid ever really be non-political? How far should NGOs go to avoid being drawn into the power-struggles inherent to warfare? And what happens when international organisations are denied access, and local communities become the only humanitarian actors?

Western perceptions of humanitarian aid have traditionally been steeped in notions of almost unquestionable morality, self-sacrifice and human goodwill, inspiring visions of Florence Nightingale-style aid workers trekking to the far corners of the earth to assist far flung neighbours in need. Indeed, the founding principles of organisations like the International Red Cross – to treat victims from both sides of any conflict – suggest that humanitarian aid is the very antithesis of political agenda or imperial ambition.

Local organisations give communities the 'dignity of choice'

Yet, by 1997, the new UK Labour government had begun to see regional stability as a central concern in the provision of humanitarian assistance. Almost simultaneously, the UK's newly formed Department for International Development (DFID) became embroiled in a controversy that remains a sensitive issue today.

In response to a military coup that ousted the elected government in Sierra Leone, DFID suspended much of its humanitarian aid. DFID claimed that the civilian need was 'unproven', that aid would legitimise the military action, and that NGOs (Non-Governmental Organisations) on the ground lacked the capacity to ensure effective delivery. Other international actors, however, felt that this reflected a sinister shift in the mandate of humanitarian assistance. Aid, they argued, had become a tool to deliver the priorities of foreign states' political institutions.[1,2]

9/11 saw a seismic shift in the way many aid-giving nations engaged with foreign states. A greater emphasis on the role of poverty and instability in the breeding of terrorism emerged. Governments began to put increasing pressure on international NGOs to assist in their strategic geo-political goals, a factor in the noticeable 'securitisation' of the international humanitarian agenda. A major dilemma for such organisations today, particularly during complex-emergencies, is how to effectively channel support to communities while maintaining an apolitical presence.

Humanitarian NGOs of major and minor international reputation face huge challenges when trying to uphold foundational principles of neutrality in the delivery of aid. The very concept of universal human rights is a product of a particular world view, and one that is not always welcomed by sovereign states – especially in cases where warfare is rooted in systemic discrimination against particular social, racial, religious or political groups. As such, humanitarian agencies are often unwilling players in the war for hearts and minds.

Moreover, governments shape the context and boundaries within which aid agencies work, sometimes making it difficult, or impossible, to deliver aid equitably. A notable example comes from Russia, who very recently introduced an NGO bill which requires NGOs receiving international assistance to articulate when their support is coming from 'foreign agents'. The government has suggested that those NGOs dependent on international funding may instead receive increased state support if their organisation is seen to provide a "useful and positive" contribution to the country. The Russian government has claimed that the bill is a necessary measure to protect internal politics from foreign influence. Yet others fear it is a tool to 'crush dissent' by controlling the focus, values and interests of communities and civil society, and forcing them to align with the priorities of powerful state institutions.

Local actors... provide access to the most vulnerable populations... and often continue operating long after international agencies have left

As we write, despite commitments from the international community to provide significant aid to the Syrian population, delivery of humanitarian aid within Syria continues to be severely limited and subject to restrictive conditions. The Syrian government's refusal to date to allow international assistance, unless an official Syrian body can control its delivery, has raised concerns that such aid will be manipulated by government forces to access opposition strongholds, or to deliberately deny the population in rebel-held areas access to humanitarian support.

In Sudan too, not far from the border carved out when South Sudan gained independence last year, for 14 months humanitarian access has been denied to conflict affected regions of South Kordofan and Blue Nile States where fighting and constant aerial bombardment has caused half a million people to be displaced. In Sudan's western Darfur region, a more subtle manipulation has been in play for years where international NGOs face shifting bureaucratic barriers that would have frustrated even Florence Nightingale.

Many organisations prefer aid to be delivered through an international agency, rather than through locally-based organisations, for fear of it being manipulated by political or criminal interests that they do not support. Yet attempts to remain entirely neutral are in vain. In such 'complex emergencies', allowing humanitarian access to communities affected by conflict can become little more than a political tool or negotiating chip in peace talks. The denial of humanitarian access, often in borderlands or ethnic minority areas, may be used to manipulate international actors and governments, or as a distraction from more long-term diplomatic efforts.

In situations like those in Sudan and Syria, local community actors may be left alone to single-handedly respond to a severe humanitarian crisis. This is a stark reminder that aid work is far from a technical endeavour that takes place in a social vacuum. Agencies are working *with people* – and the cultural, political and social context that comes with them.

Local Solutions

Looking to community-based organisations, including a range of actors operating at the local level, social networks, local organisations or charities, civil society organisations and religious or other groups, we ask what can they bring to the table?

Firstly, local organisations give communities the 'dignity of choice'.

"Why do organisations always come and tell us what they are going to do; why don't they ask? We know our priorities."

Community leader in Sudan asks Humanitarian Aid Relief Trust (HART).

It is not enough for local communities to be involved in the implementation of humanitarian support; they need responsibility for decision making and management too:

"First we lost our lives, then we lost our dignity – it seemed like international humanitarian agencies had their own agendas – they did not give attention to our own capacities to cope with the crisis."

Local NGO volunteer in Gaza (Overseas Development Institute, ODI).[3]

When persistent conflicts form the backdrop of entire lives, or generations, retaining identity requires that the stories within a community, and the perspectives that they represent, are preserved.

Community-based organisations have the potential to develop genuine conversation between international actors and local people. Aid agencies cannot easily understand the subtleties of the environment within which they work without the input of people whose lives are bound up in the conflict.

The Marol School in South Sudan is described as a 'Girls school, to which Boys may come!', emphasizing the need to increase female education. The academy caters for between 300-350 pupils, and is a locally run initiative supported by HART UK.

Secondly, community actors are often more efficient and effective in their use of funding, while also avoiding causing further instability in an already fragile local economy. In devolving decision-making they can help ensure resource distribution is fair and popularly accepted.

It is worth noting that in complex emergencies, the lines between 'aid' and 'development' blur, with an emphasis not just on saving lives but on the rehabilitation of the community to promote livelihoods and reduce vulnerability. Moreover, protracted emergencies often experience 'donor fatigue' and a reduction of funds which necessitates a move towards more sustainable and rehabilitative programs. Community-based organisations are often well-placed to respond to this shifting landscape.

Thirdly, local actors can operate in areas with significant security risks or where the government has denied access to NGOs. They provide access to the most vulnerable populations, who might not otherwise be reached, and often continue operating long after international agencies have left.

Finally, in cases of prolonged conflict, community-based organisations can play a unique role in promoting democratic ideals and enhancing civil capacity, building up local leadership structures, protecting cultural identities, and enhancing community cohesion. The Karen of eastern Burma (Myanmar) represent a striking example of this. Camps along the Thai-Burma border have become a breeding ground for civil society institutions that preserve strong cultural identities and promote local language.

Local Complexities

Working with community-based organisations in prolonged conflicts, however, is not always straightforward. Government aid departments and major international organisations can be reluctant to partner with such organisations as they are often small and limited in geographical reach (a key consideration that plays a primary role in international organisations looking to distribute millions of dollars with minimal administrative demands). Monitoring can be difficult, especially in the context of conflict, and this gives rise to concerns over impartiality of assistance. Moreover, community-based organisations may operate cross-border without the permission of the host government thus disregarding issues surrounding national sovereignty.

More generally, there are concerns surrounding funding of community-based initiatives that may support a malevolent power structure that bears responsibility for the conflict in question. For example, in Burma, community-based organisations are virtually the only vehicle of support for heavily persecuted ethnic minorities. Historically, some pro-democracy groups in Burma voiced concerns over the use of western funds for providing developmental assistance, including access to water, sanitation and medical care. They feared that such assistance would stop the military regime and international governments from recognising the devastating impact of a national budget that dedicates almost a quarter to military spending, leaving only 1.3% for healthcare and 4.1% for education.

The efficacy and survival of community organisations can also be threatened by disconnects within a donor nation's foreign policy and development strategy. The current emphasis on foreign investment to aid economic growth can undermine the impact of immediate humanitarian work. For example, until recently, plentiful oil, natural gas, and other resources of Burma had been sanctioned by most western states. Positive political changes in Burma have led to a major change in western policy, and today global businesses are scrambling to access these resource-rich regions. So far, however, rather than initiating a boom in local jobs and building the capacity of communities, local organisations are struggling to cope with escalating land-grabs and violence.

Local Conflict

The Local to Global Protection (L2GP) project at the Overseas Development Institute (ODI) observes that, in prolonged conflicts, the distinction between protecting 'human rights' and ensuring livelihoods can seem less relevant. States may engineer famine as a means of controlling a population. Individuals and families may have to balance the need for survival – through farming or migration – with risks from landmines, armed attacks, or trafficking.

The protection of communities and their livelihoods is a political minefield. A seemingly humanitarian act, such as building a camp for the displaced away from fighting, becomes an inherently political act. On the one hand, it creates a greater opportunity for international awareness and media reporting in an area that is relatively safe. At the same time, it may enhance the military strategy of one of the parties. This can enable governments to seize land, exploit natural resources, remove populations or change the ethnic or religious make-up of the population. For example, in the 1990s in Sudan, the creation of camps for the displaced in Bahr-El-Ghazel and the Nuba Mountains 'enabled the government to secure its military position… contributing to the government's consolidation of territory.'[4]

Local approaches to protection can also sit uncomfortably with international humanitarian ideals, but they allow community-based organisations to continue operating in places where international organisations have limited access, where communities resist displacement, or where the state is threatening vulnerable populations.[5] Such approaches may include paying power holders, temporary or permanent migration, providing labour or food to armed groups, or seeking assistance of local or religious leaders for behind-the-scenes advocacy with armed groups.

Local Peace

Community-based organisations can play a uniquely positive role in providing for vulnerable groups, enabling equitable opportunities and protecting or promoting human rights.

While acting as crucial actors in assisting international organisations to respond to acute situtations, community-based groups have also been found to have a subtle impact on development and stability over the longer term.

While peace cannot be imposed, this type of development aid can focus on building a local capacity for peace, restoring dignity and promoting the resilience of communities that might otherwise be forgotten.

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Mental Health and the Military:
From the Crimea to the 21st Century

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Over the last ten years, two military campaigns have dominated the United Kingdom's (UK) foreign policy. The operations in Afghanistan and then Iraq, although contentious, have raised a number of important questions about the country's relationship with its armed forces. This debate has highlighted the apparent separation of the military from broader British society, between which there is increasingly little communication and consequent understanding.

One of the defining characteristics of these two conflicts, typified by the 2003 invasion of Iraq, has been the paucity of support, if not outright hostility, that the general public has shown. Arguments over whether this criticism extends beyond politicians to the military continues. The growing toll of military wounded and dead, while small in historical terms, has elicited growing questions about the function and utility of the UK's military in general. Never far from this media spotlight has been the mental health of those presently serving in the armed forces, those who have served (veterans), as well as the wider military community.

While combat and combat support units (such as infantry and artillery) form the majority of the media's depiction of war, supporting these offensive units are a large number of service personnel: from cooks to drivers, from mechanics to nurses. A diverse and heterogeneous population to study, the military are subject to many of the issues witnessed in society at large. Statistics suggesting high rates of homelessness, imprisonment, suicide or mental illness are frequently among the headlines. In particular, it is the diagnosis of post-traumatic stress disorder (PTSD) that has solicited considerable attention. The characteristic flashbacks and hyper-responsiveness (to the car engine that misfires) have been incorporated into the popular understanding of PTSD and the sequelae of conflict.

In this article, we give a brief background to military mental health, considering the history of post-conflict syndromes, before going on to consider the challenges posed to mental health in today's armed forces and among ex-service personnel. Finally, we briefly scan the horizon for future challenges to good mental health in tomorrow's military.

Historical Approaches to Military Mental Health

Many of us are familiar with the term 'Shell Shock' which, although initially considered a consequence of physical trauma or toxic munitions during World War I, later came to be recognised as a psychological response to combat. It was widespread; some estimates suggest that 'shell shock' accounted for 10% of all British battle casualties. Furthermore, both the War Office and printed press, champions of the 'stiff upper lip' public school mindset, were loathe to accept shell shock as an official condition.

Wherever there is conflict, there is likely to remain psychological sequelae

Edwardian society deemed nervous breakdown as a threat to both male authority and traditional sex roles.[1] Therefore, and not surprisingly, 'shell shock' is rarely mentioned as a consequence of World War II; but for this a relatively straightforward explanation exists – so severe were the social and political consequences of

The view from inside: a soldier dons protective chemical weapons clothing during Operation Desert Storm

'shell shock' following the Great War, British authorities simply banned the term. Instead, a similar constellation of symptoms were later described as 'Post-concussional syndrome'.[2]

World War I may have been a turning point in the history of warfare with increasing mechanisation, modern munitions and the horror of trench warfare. However, it was almost certainly not the first conflict to have psychological consequences for those who had fought. Since the inception of warfare it is reasonable to postulate that psychological sequelae have emerged albeit in various forms, though shaped and interpreted by the prevailing attitudes of contemporaneous medical (and more recently, psychiatric) practice.

The diagnosis of 'irritable heart' during the Crimean campaigns of the 1850s is among the first suggestions of medically unexplained symptoms as a consequence of warfare. Attributed to the heart, this maladie was inexplicable by contemporaneous investigation. By the time of the Boer Wars in the late nineteenth century, the diagnosis of 'disordered action of the heart' had become commonplace,[3] though opinion was split between those who considered it to be an unexplained organic disease and those who considered it a more 'constitutional' affliction. Therefore the question arises whether a post-conflict stress reaction is common to all wars, and whether the symptoms are constant in the presence of changing attitudes and diagnoses?

'Fast-forwarding' to the latter twentieth century, and the campaigns in Korea, and later Vietnam, the more modern view of post-traumatic stress disorder began to coalesce. Here, the term 'fast-forward' is used intentionally; it alludes to televisual techniques and modern media. On the basis that the flashback, so commonly used by cinematographers, was a symptom absent among those affected veterans up until the First World War,[4] the consistency of the post-conflict stress reaction has been called into question. Some have even suggested a cultural basis to today's PTSD, with flashbacks suggested as an effect of widespread access to television and cinema flashback sequences, in contrast with the assumption that these techniques merely reflect combatants' experiences.

Modern Warfare and Military Health

Flashbacks are a relatively frequent feature among those presenting and who served in the 1991 Gulf War. It was from this conflict that the notion of a Gulf War syndrome emerged and caught the public's attention.

Epidemiological studies in both US and UK service personnel failed to identify a unique constellation of symptoms, although deployed veterans appear to have reported symptoms of all types more frequently than similar service personnel who did not deploy to the Persian Gulf.[5] While not a syndrome, the morbidity exhibited by some has led to the limited acceptance of the diagnosis by the UK Ministry of Defence (MoD) for the payment of war pensions.

With these experiences still at the forefront of the military discourse, following the invasion of Iraq in 2003, the MoD funded a cohort study based at King's College London.

Designed as a prospective cohort for both surveillance and research, more than 10,000 personnel were enrolled into the cohort with subsequent additional enrolments since, most recently to include personnel serving in Afghanistan. Results so far have shown no discernible specific effects of the Iraq War beyond those experienced by personnel who did not deploy.[6] As such an Iraq or Afghanistan War Syndrome is deemed unlikely.

While much of the research historically has been on regular personnel, specific investigation into the risks that reserve personnel (those who have a principal occupation outside the armed forces) are exposed to has also been undertaken.

Despite the robust psychology of most reservists, research has identified specific issues to which reservists are less resilient than regular personnel. While PTSD is rare among reservists, the prevalence rises with deployment more markedly than among regular soldiers. In response, post-deployment mental health care, previously provided for regular personnel, has been extended to cover this group.

More broadly though, additional resources and mental health programmes have been instituted across the services, of which the Trauma and Risk Management (TRiM) programme is an example. Piloted in the Royal Marines and now adopted by a range of organisations (including the BBC), TRiM provides training for individuals throughout the organisation to recognise mental health problems among their peers following a traumatic incident, and signpost them onwards to mental health services if appropriate.

Prevalence of PTSD rises sharply amongst deployed reservists, perhaps unprepared for the realities of war

In line with the public's interest in PTSD, considerable efforts have been made both in the UK and US to establish the prevalence of PTSD in serving and ex-personnel. Despite frequent portrayals of PTSD as the stigmata of war-fighting, the estimated prevalence of PTSD among UK service personnel is between 4.0 and 7.0%, and varies, with higher prevalence among combat units than non-combat units. When this burden is compared against the general population this prevalence is high, however in the context of other common mental illnesses it remains relatively uncommon.

The burden of psychological disease in the military, like society more widely, is predominantly caused by neurotic disorders such as depression and anxiety.[7] In the apparent search for PTSD, studies have consistently identified a separate problem and one that could be considered as endemic in military culture: that of alcohol misuse. In an analysis of mental health diagnoses, alcohol misuse was almost as common as anxiety, depression and PTSD combined. It is likely that the widespread availability and low cost of alcohol in military establishments plays a part in what is a broadly cultural issue, though quite how one might go about addressing it remains unclear.

The Health of Veterans

The UK's military numbers some 230,000 regular personnel, supported by a further 175,000 reservists. However, the military covenant (the implicit agreement made between a nation and its military) extends in time beyond those currently in service. Defined as any individual who has served in the UK forces as a regular, reservist or national serviceman, there are approximately 4.6 million veterans, who with their dependents total some 9 million individuals. There are efforts underway to establish the effect of military service on this group, for whom the transition back into civilian society can be challenging.

Homelessness among veterans hit the headlines in 1994 when a report suggested that a quarter of homeless people in London had spent time in the armed forces. Disputed at the time, a more comprehensive study published by the University of York in 2008 estimated that veterans formed approximately 6% of the homeless in London, this group comprising individuals sleeping rough, but with the majority residing in temporary hostels. Accepting that further resources were needed for those exiting the services, and with re-settlement allowances being based on years of service, the MoD has made extra provision for leavers, and in particular for those who leave earlier.

Another persistent headline is that veterans fill up the criminal justice system, accounting for up to 10% of those imprisoned. Again these statistics are almost certainly an over-estimate, and more recent and robust statistics estimate that veterans form 3.5% of the prison population, which on a numbers basis would make veterans under-represented when compared to the general population. The picture is similar within the probation service. However, these statistics belie the fact that on a breakdown of offences, veterans are more likely to be convicted of violent and sexual crimes than the general population.

These comparisons must be expressed with a number of caveats. The fact that the military population draws frequently on less affluent communities might suggest that comparisons suggesting equivalence of outcome with the general population would underscore the benefits of military life. Whilst this may be the case for many, at a population level one must also consider the process of screening and selection that takes place at recruitment, along with assured access to employment, amenities and healthcare. As such, drawing direct comparisons between service personnel and the general population is always fraught with limitations.

These troubling statistics aside, for the vast majority of veterans military service is a very positive experience. For a small minority military life remains more than challenging, and for these individuals (frequently early service leavers) the transition back to civilian life can be daunting. It is this cohort of individuals for whom research is ongoing, and who appear to be at heightened risk for a range of poorer outcomes.

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The Future

The future represents a broad range of challenges for promoting, protecting and managing mental health within the military.

In the short-term, and while fatalities for on-going operations remain low (in historical terms), the low fatality rate masks a growing number who endure horrific injuries but who, due to advances in front-line and field-hospital trauma care, now survive.

Living with significant disability both physically and mentally adds recurring pressures to healthcare budgets. Avoiding the downgrading of the status of mental health services and funding in light of acute surgical and medical care will remain critical. Ensuring that mental health remains high on the political and military agenda is necessary. Furthermore, as early service leavers are increasingly recognised as at risk of a multitude of sociological problems, improving their preparation and resettlement is vital in preserving the military covenant.

Studies have consistently identified a separate problem and one that could be considered as endemic in military culture: that of alcohol misuse.

In the medium-term the increased frequency of deployment (or operational tempo) presents a challenge to mental health. While the evidence suggests that some variation in the length of tour has no major effects on mental health (providing that stand down periods are scheduled appropriately), the issue of over-stretch may present hazards as troops spend increasing proportion of service time in theatre. With operations in Iraq concluded, and a conclusion to the conflict in Afghanistan in sight, the recent interventions in what has become known as the Arab Spring demonstrate that conflict cannot be accurately anticipated. This, in the context of declining regular numbers, makes the operational tempo of the future highly uncertain, but unlikely to be relaxed.

Longer-term, the reduction in troop numbers also renders many military support services vulnerable as economies of scale are lost. The closure of the UK's last military hospital in 2007 is one example of how infrastructure can cease to be viable. While these changes offer the opportunity for the military to better integrate with civilian society, to what extent this may have been achieved is unclear.

Moreover, the consequences of a smaller military include the potential for further divergence of society from the military as fewer people have direct contact with those in service. Increasing the number of reservists who can bridge that gap effectively is an additional benefit of increasing reserves, but this in turn requires a reshaping of services to ensure that reservists have access both theoretically and practically to high quality mental health services which can effectively manage the consequences of conflict.

The military is famed for its technological innovation. The advent of unmanned aerial vehicles, frequently referred to as 'drones', herald a new era of technological warfare. The implications of this on mental health are unclear. The recent debate over whether pilots situated in a home base controlling drones in theatre should receive medals is an example of the changing nature of warfare that will no doubt in some way levy a psychological toll. The Millennium Cohort is a US cohort study aiming to assess some of these challenges over time, and which has so far recruited in excess of 250,000 personnel.[8]

The role and importance of good mental health in the armed forces and within the veterans' community has advanced tremendously since the early twentieth century, and even since the Gulf War of 1991. Wherever there is conflict, there is likely to remain psychological sequelae. Identifying and managing these in a non-stigmatising way in the future will remain central to ensuring a healthy navy, army and airforce, and a secure United Kingdom.

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Antibiotics in Decline:

The Rise of Multi Drug-Resistant Pathogens

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The incredible success of antibiotics in treating life threatening infections has carried a sting in its tail in the form of resistance. The majority of antibiotic use is in the community, however the impact of antibiotic resistance is felt most acutely when treating patients in healthcare settings.

The ready transmission of bacteria between healthcare staff and patients, and between the environment and patients, play a critical role in the acquisition of infections and antibiotic resistance in hospitals. The intensive use of broad spectrum antibiotics in hospitals results in selection pressure on the disease causing pathogens and promotes the emergence of multi drug-resistant bacteria.

Antibiotic resistance renders antibiotics ineffective and poses a serious threat to how infections are treated

Though many of the advanced healthcare systems now have initiated steps to control the use of antibiotics and the spread of infections in the healthcare environment, there are many parts of the world where there continues to be a lack of control over the use of antibiotics. With mass mobilisation of the human population, and the opening of geographical borders, it is essential to put the risk of antibiotic resistance into a global context and move towards a global strategy to monitor antibiotic usage.

The accidental discovery of penicillin by Alexander Fleming, in what is now Imperial College London, changed the course of modern medicine. Fleming stumbled across a substance that he called penicilllin in 1928, but it wasn't until 1941 in the throes of World War II that the mass production of this naturally occurring substance for medical purposes took hold.

Penicillin became the 'wonder drug' of the war and saved the lives of thousands of wounded soldiers. With this drug, doctors were suddenly able to treat previously incurable and fatal infections. With the success of penicillin the search was on for discovering similar agents and the term antibiotic was first coined by John C. Sheehan in 1957, following his success in developing synthetic penicillin.

Antibiotics did, and still do, continue to save millions of lives but it wasn't long though before this class of 'wonder' drug began to lose its luster due to the emergence of resistance. Success came at a cost and antibiotic usage requires careful consideration.

Infections occur as a result of the body being invaded by pathogens. The symptoms of infection are a manifestation of the host's immune response to eradicating the pathogen. Thus the target of action for antibiotics is not the host but the invading pathogen; this creates a unique medical scenario and sets antibiotics apart from other classes of drugs. They target the invading bacteria and cause minimum damage to the host.

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Bacteria, when exposed to antibiotics, can develop resistance and withstand the destructive mechanisms antibiotics use to destroy them. This acquisition of resistance is detrimental to the long-term efficacy of antibiotics and results in collateral damage. Antibiotic resistance renders antibiotics ineffective and poses a serious threat to how infections are treated not only in individual patients but also long-term in populations.

This is of particular concern and poses long-term adverse effects for patient safety as there are not many new agents in the pipeline.[1] Unlike, for example, antihypertensive or diabetes medicines where all the drugs in the class can be relied on to have the required effect on diseases outcomes, antibiotics have spectra of activity.

This variation is due to the myriad of different bacteria capable of causing serious infections in humans. The characteristics of these different species of bacteria mean that not all antibiotic drugs can cure all pathogens. Currently in the UK there are 52 licensed anti-infectives with varying spectrum of activity against disease causing bacteria.

Pharmaceutical companies need a financial incentive if they are to invest in research into finding new antibacterial agents. However the increasing focus on using targeted and justified antibiotic therapy, and the reservation of broad spectrum agents, act as a disincentive for big pharma to invest in new agents.

The growing threat of antibiotic resistance and the lack of new drugs pose a serious public health threat when put in the context of emergence of Tuberculosis and serious hospital acquired infections that are now treatable with only a handful of drugs.[2] This growing public health concern was highlighted in a recent World Health Organisation (WHO) report earlier this year urging organisations and nations to put into place measures to streamline antibiotic stewardship strategies to tackle the rising tide of resistance.

Antibiotic Exposure

The majority of antibiotic usage is in the community (over 80% of all prescriptions), however, the usage of antibiotics in hospital settings continues to receive a lot of attention, primarily due to hospital acquired infections.

Healthcare acquired infections (HCAI) are defined as infections acquired as a result of 'healthcare interventions such as medical or surgical treatment, or from being in contact with a healthcare setting'.[3] A host of different pathogens are implicated in development of HCAI with the most prevalent pathogens associated with HCAIs being meticillin-resistant Staphylococcus aureus (MRSA), meticillin-sensitive Staphylococcus aureus (MSSA), *Clostridium difficile* (*C.diff*) and *Escherichia coli* (*E. coli*).[3] HCAIs pose a serious threat to the health and wellbeing of patients, staff and carers and their prevention and treatment is a top priority for the National Health Service (NHS).

The hospital environment too plays an important role in the threat of antibiotic resistance and HCAIs. In healthcare settings the transmission of bacteria between patients and staff, and between the contaminated healthcare environment and patients results in higher risks of infection.

In addition, the exposure of bacteria to broad spectrum antibiotics used to treat patients and the opportunity of genetic transfer between different bacteria can bring about resistance through selection pressure on the bacteria.[4] Patient morbidity and mortality is higher amongst patients infected with resistant bacteria.

The cornerstone of antimicrobial stewardship initiatives is evidence-based policies to guide the prescription by doctors, the surveillance of antibiotic usage and resistance and a change in the culture of antibiotic usage

The direct link between antibiotic usage and emergence of antimicrobial resistance is well established.[5,6] To combat the rise of HCAI and antibiotic resistance, over the last 10 years, healthcare organisations across the globe have been implementing infection prevention and control and antimicrobial stewardship initiatives.[7,8] These initiatives have had varying success and the threat of antibiotic resistance still remains as a major public health threat, as detailed in the WHO report.[2]

The successes observed in healthcare institutions in some regions of the world for particular infections such as *C. diff* is offset by the growing concern over emergence of 'superbugs' such as *E. coli* strains reported as being resistant to all but one antibiotic.[1]

One approach that needs to be considered is whether the fight to conserve the efficacy of antibiotics is extended to all nations and not restricted to those which have advanced health systems and infrastructure to implement local interventions.

Antibiotic Stewardship

Antibiotic stewardship is an umbrella term for a host of different activities undertaken to promote prudent use of antibiotics in healthcare settings. It involves a multidisciplinary collaboration between doctors, pharmacists, nurses, patients and researchers to streamline policies on prescribing of antibiotics and conduct surveillance on the use of antibiotics and the emergence of resistance.

The cornerstone of antimicrobial stewardship initiatives is evidence-based policies to guide prescription by doctors, surveillance of antibiotic usage and resistance and a change in the culture of antibiotic usage. These initiatives are relevant and important to the health and wellbeing of patients and can help contribute to efforts to promote judicious use of antibiotics and containment of antibiotic resistance.

Although only 20% of antibiotic usage occurs in hospital settings, it is essential to conduct surveillance of antibiotic use and emergence of resistance in hospitals due to the higher risk of acquiring infections amongst the hospitalised patient population and the greater use of broad spectrum antibiotics in this population.

Furthermore antibiotics used in hospitals are often intravenously administered and are prescribed for longer. The need to get the right therapy for infections in hospital settings means that often antibiotics are started blindly or empirically without any laboratory data to confirm the causative organism.

Increasing reports of multi drug-resistant *E.coli* strains emerging from healthcare settings and their rapid global spread has created a global public health threat.[9] The mass mobilisation of the human population and increases in travel and exposure of people to different healthcare settings means that the term HCAI is no longer to be used in the local context. People can act as the vectors for the global spread of infectious diseases much more rapidly than they could a century or even 50 years ago.

Antibiotic usage remains not well-regulated in the majority of the world, and there needs to be an increased global focus on mechanisms to promote prudent use of antibiotics. We live today in a 'global village' and healthcare organisations and governments need to acknowledge this when setting agendas for antibiotic stewardship strategies.

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ANTIBIOTICS IN DECLINE

Multi Drug-Resistant Tuberculosis

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Tuberculosis, or TB, an airborne infectious disease, remains one of man's great adversaries. It is estimated that one third of the world's population is infected. Although huge strides have been made in reducing the global burden of this disease, a new threat has emerged. Multi and Extensively Drug resistant TB are rewriting the rules.

In 2010, 8.8 million people fell ill with TB and 1.4 million died from it. 95% of these deaths were in the developing world. TB is closely linked with poverty as well as reduced immunity, which is most strikingly seen in the form of increased rates of HIV infection.

Here we examine why drug resistant TB has come into existence, how it can be categorized, what treatment options are available and how the global health community plans to combat this growing threat. We will also look more closely at India, one country particularly bearing the brunt of this emerging challenge.

In India, reports of Totally Drug Resistant (TDR) TB, or Extremely Drug Resistant TB (XXDR) TB have emerged and present a deadly new threat... the WHO, however, does not yet officially recognise this resistance category

MDR, XDR, TDR, or XXDR?

Drug resistant TB can be divided into 3 categories: Monoresistant, Multi Drug-Resistant (MDR) and Extensively Drug Resistant (XDR) TB. There are currently thought to be 650,000 cases of MDR TB worldwide. Of these, 9% are thought to be XDR cases.

There are 27 MDR TB high burden countries as defined by the WHO (World Health Organisation). Those that bear the highest burdens are India and China. Within these regions 73 from every 1000 cases of TB are thought to be multi drug-resistant. At last count, in 2011, 77 countries worldwide had reported at least one case of XDR TB. In the UK, between 2005 and 2010 there were 16 cases of XDR TB.

In India, reports of Totally Drug Resistant (TDR) TB, or Extremely Drug Resistant TB (XXDR) TB have emerged and present a deadly new threat. In January 2012, there were at least 4 cases of possible TDR TB reported by Hinduja Hospital, Mumbai. The WHO, however, does not yet officially recognise this resistance category because drug susceptibility testing of second line TB drugs is not yet standardized: what might be resistant in one lab in India could be susceptible elsewhere, and hence the reluctance to use the label definitively.

Therapy and Resistance

First Line drugs (FDLs) are classically used for treatment of naïve patients where no TB drug resistance has been found. Alternatively, Second Line Drugs (SDLs) are used once drug resistance is suspected or confirmed.

TB physicians are well versed in the uses of first line drugs to treat TB. The efficacy and side effect profile of second line drugs are much less clear, encompassing a wide a range of classes of drugs including aminoglycosides, polypeptides, fluoroquinolones and thiodamides. There are many others that have sometimes been used in desperation, particularly in XDR TB cases. Inadequate drug treatment can result in spontaneous genetic mutations in Mycobacterium Tuberculosis (MTB) primarily via the selection of resistant strains. Mutations in one gene, enabling resistance to one drug, might also have a knock-on effect, conferring resistance to other drugs.

Hence, drug resistance can occur where TB drugs are of poor quality, where regimes are unsupervised and not properly completed; or where, quite plainly, the wrong drugs have been given.

In India, first line drugs are available without a prescription. There is availability of second line drugs, but stock regularly runs out at both a central and peripheral level, making the supply erratic. As misuse of first line drugs has been the main cause of rising MDR TB in high burden countries, stewardship of second line drugs is a key priority.

Directly Observed Therapy – short term (DOTS) is the cornerstone of treatment of drug sensitive TB and has contributed to significantly to its decline. This is a strategy where, at its heart, patients are observed taking their TB treatment by a trained healthcare worker. DOTS relies on a regular drug supply and simply cannot work if there are no drugs available in the first instance.

Stop TB

The Stop TB Strategy was launched in 2006 by the Stop TB partnership, an international body comprising a variety of partners including the WHO. The Global Plan to Stop TB, also launched in 2006, comprises the nitty gritty of how countries should actually go about doing this, and was updated in 2010 to reflect the growing importance of MDR TB as a very real issue.

A plan for combatting drug resistant TB, therefore, is built into TB frameworks that are already in existence. However, specific policies and strategies aimed at tackling drug resistant TB are now gaining traction. The New Global Framework to support expansion of MDR-TB services and care was launched in 2011.

DOTS services are nation-wide in India, and plans are underway to offer treatment at 'DOTS-Plus' sites to those with MDR TB. The DOTS-Plus programme follows international guidelines on the management of MDR TB, pioneered by WHO agencies. The target is to scale-up these services so that they are country-wide by 2012. The Global Drug Facility, an initiative of the Stop TB Partnership, aims to expand access to, and availability of, high quality TB drugs to facilitate DOTS expansion. It uses innovative strategies to procure TB drugs for countries in need of its services. It is evident that more potent, reliable and affordable drug combinations are needed to treat drug resistant TB.

TB can be difficult to diagnose for any one of a variety of factors whether they be human, lab or operator dependent. As part of the Global Plan to Stop TB, the WHO aims to have at least one functioning TB diagnostic lab per 5 million people world-wide.

Only 16/27 MDR high burden countries have achieved this to date. Very encouragingly, however, all 27 have a lab network capable of testing first line drug

Drug Resistance	Definition
Monoresistant TB	Resistance to only 1 of the first line TB drugs e.g. isonizid
Multi Drug-Resistant TB (MDR)	Resistant to both isonizid and rifampicin, two of the commonest first line drugs classically used to treat TB
Extensively Drug resistant TB (XDR)	MDR TB resistance plus resistance to any fluoroquinolone (a class of second line drugs) plus resistance to at least one of the injectable second line drugs. XDR TB was first famously documented in Africa in 2006

First Line TB Drugs (FLDs)	Second Line TB Drugs (SLDs)
Rifampicin	**Aminoglycosides:** Amikacin Kanamycin
Isonizid	**Polypeptides:** Capreomycin
Ethambutol	**Fluoroquinolones:** Ciprofloxacin Levofloxacin Moxifloxacin Gatifloxacin
Pyrazinamide	**Thiodamides:** Ethionamide Prothionamide

susceptibility. India, for example, has improved lab capacity and quality assurance, but limitations remain on the diagnosis and follow up of MDR TB patients. This is currently, however, at the heart of plans to scale-up services. An affordable, rapid, point-of-care diagnostic tool for TB infection remains the holy grail of TB control. A new tool was rolled out in 2010 by the WHO. The Xpert MTB/Rif test is a NAAT (Nucleic Acid Amplification Testing) for TB case detection and rifampicin resistance, and could revolutionize TB diagnostics.

Drug resistance occurs when TB drugs are of poor quality, or where regimes are unsupervised and not properly completed; or where, quite plainly, the wrong drugs have been given

Efforts are also underway to develop new drugs. In July 2012, results were released from a randomized prospective study conducted in South Africa that could herald a significant breakthrough in the treatment of TB. A combination named PA-824-moxifloxacin-pyrazinamide was found to be very effective for both drug-sensitive and drug-resistant TB, and is potentially a bright hope for the future.

Money Matters

Both human and financial resources are inadequate when it comes to fighting MDR/XDR TB. It is estimated that in 2011, $0.7 billion was needed for the high burden countries alone, but that there was a shortfall of $0.2 billion in funding.

Currently funding for these activities comes from the Global Fund and other international donors such as UNITAID for many MDR high burden countries. In fact the most recent WHO progress report cites the Global Fund as providing over 90% of financial support for combatting TB resistance in 10 of the MDR high burden countries.

It remains a major challenge to stimulate funding from domestic sources, which is rarely achieved. In India, however, the majority of funding is from the Government of India (with World Bank credit) with funds from other international agencies such as DFID, the Global Fund and USAID.

One of the most resounding of the Millennium Development Goals is to eliminate TB as a public health problem by 2050. In the form of resistance, TB has found a new way to perplex and challenge us, yet it is only in the last few years that a roadmap for tackling increasing levels of TB resistance has emerged. This is certainly an ongoing challenge that we cannot afford to ignore.

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How to Plan a Successful Biopharma Product Rollout

Jürgen Lücke, Judith Wallenstein, Torsten Kurth, and Caroline Teichmann, The Boston Consulting Group

In the film business, opening weekend is the critical barometer: a movie's receipts from the first couple of days typically predict how popular it will be at the box office. That dynamic holds true in the biopharma industry as well. A product's performance during its launch often indicates how successful it will be during its life cycle.

Effectively launching a new biopharma product, however, has never been more challenging. In addition to a litany of regulatory issues, companies face high stakeholder expectations, numerous market-access hurdles, and stiff competition, all of which are made more formidable by the business realities of the industry: pipelines are boasting fewer promising candidates than they did only a few years ago, and many are not true breakthroughs.

In the past, companies had an abundance of potential therapies in R&D, and they could count on a continuous flow of new products. Some were revolutionary drugs, but all were virtually guaranteed market access. This is not the case today. Pipelines are thinner, and blockbusters are fewer. In addition, facing both an explosion in medical costs and constrained budgets, national payers in most European countries, and a host of private insurers in the U.S., are increasingly unwilling to pay for marginal innovation in categories that are well served by existing products. More often, market access is coming with heightened reimbursement restrictions.

In this uncertain environment, companies are increasingly focusing on their launch strategy. Typically, launch managers use their estimates of peak sales to determine investment levels, resource allocations, and manufacturing plans. Yet the industry has a poor track record of predicting a product's performance. We followed the sales development of a group of products that were launched from 1994 through 1997 and found that company estimates of peak sales at launch were not predictive of peak sales reached during the products' life cycles.

In fact, the correlation between estimated and realized peak sales was close to zero. In addition, we analyzed data from EvaluatePharma and discovered that the peak sales for new treatments introduced from 2001 through 2005 averaged $950 million per year; however, this number dropped to $570 million in the second half of the decade. Specifically for drugs launched in 2008, only 33 percent were expected to achieve peak annual sales of more than $1 billion. And looking ahead to 2013, no forthcoming drugs are projected to post peak sales in excess of $750 million.

Pipelines are thinner, and blockbusters are fewer

Still, company valuations are highly dependent on the potential of the product pipeline. Therefore, the cost of failing to successfully launch a product is high. Clearly, companies cannot continue to roll out therapies as they have done in the past. Not only is the environment more complex but also the traditional guidelines no longer apply. With fewer therapies under development, realizing the full potential of every product is critical to a company's health and, in some cases, its survival. Therefore, it is more important than ever for companies to pursue a more sophisticated launch strategy.

Traditionally, companies have built launches almost solely around promoting a product's efficacy and safety to physicians. But this is no longer enough. Rather, companies must take a comprehensive approach—one that includes more precisely differentiating the product from the competition, devising an effective strategy for winning market access, performing timely market research, and mobilizing the company around the effort. Because all these tasks are interconnected, and the marketing environment is complex and shifting, planning is often what distinguishes the successes from the failures. Much of the groundwork for a successful launch must be laid 24 months or more before the therapy receives approval. So to assist companies in their planning, we have identified six levers that launch managers should pull to create a winning rollout.

War-gaming can be an effective tool to identify possible market disruptions, study the probability of various competitive actions and estimate their impact

Create a Winning Playbook

Much like an athlete or a coach, launch managers need to think strategically if they are going to lead their team to victory. This is a critical departure from the more static approach, which takes into account market conditions, how much companies have spent to support a competing product, and how they have positioned their product – at a particular point in time. Considering only competitors' past actions leaves managers ill-prepared to react to changes in rivals' tactics. Instead, launch managers must plan for the "game" that lies ahead – anticipating the successive moves that competitors might make in the face of a new market entrant.

War-gaming can be an effective tool to identify possible market disruptions, study the probability of various competitive actions and estimate their impact, and design an appropriate response.

It can also be used to prepare for rivals' product launches. For example, The Boston Consulting Group used war-gaming to help a company with an injectable biologic product prepare for the launch of competing products. Among the key unknowns were the products' pricing and labeling. We created four possible scenarios on the basis of these unknowns and had teams play out how they would respond in each situation. This exercise identified important vulnerabilities and led to a plan for addressing them, which is expected to protect about $100 million in annual revenue from sales of the biologic product.

Put Market Access Front and Center

For many in the industry, winning in the marketplace has been achieved by having sales representatives continually communicating information about a product's efficacy and safety directly to physicians. In today's world, biopharma companies need to effectively make the case for their product to a host of payers and health technology assessment (HTA) agencies, which are now operating in most markets. In discussions with BCG, industry experts revealed that payers and HTA agencies have the most influence over a product's performance in the market, sometimes being responsible for as much as 70 percent of a product's success. And yet, companies generally spend only 2 to 10 percent of their total marketing budget on these stakeholders.

Certainly many companies have a market access team, but it rarely includes individuals from across the organization. To have a constructive conversation with payers, companies must create a cross-functional market-access team comprised of individuals from R&D, sales and marketing, and medical affairs. This team should begin a dialogue with payers and HTA agencies early and then keep them apprised of the decisions made throughout the R&D process. The team should especially communicate the type of patient populations that are being targeted and the expected benefits. Such a dialogue will also give payers and HTA agencies the opportunity to provide guidance on the kind of efficacy and safety data they would be looking for, which would help companies define more targeted clinical studies.

Change the Game with Innovative Pricing

Price increases have been a major driver of growth for pharmaceutical companies, accounting for 65 percent of industry growth worldwide and even more in the US But although the industry has relied heavily on price increases, it has not used pricing as a tool for gaining competitive advantage. Rather, pharmaceutical companies have typically established a price range for a new product, and only if payers pushed back, or if competitive pressure forced a reevaluation, did companies get creative.

Nowadays, companies should study innovative pricing strategies during product development and make pricing a core pillar of the product's profile.

Innovative pricing is often critical to gaining market access and receiving reimbursement. Increasingly, payers are worried about the size and the predictability of their budgets. They are more likely to approve reimbursement if a therapy can guarantee certain treatment successes or outcomes. Evidence-based pricing agreements, which may offer a payer rebate or a patient refund, are still low in volume but growing. In 2010, they accounted for 8 percent of total pharmaceutical sales in the UK, but they are growing at an annual rate of 15 percent worldwide. Even higher rates are seen in certain therapeutic areas, such as oncology and immunology. Payers look favorably on these agreements because they discourage excessive or off-label usage.

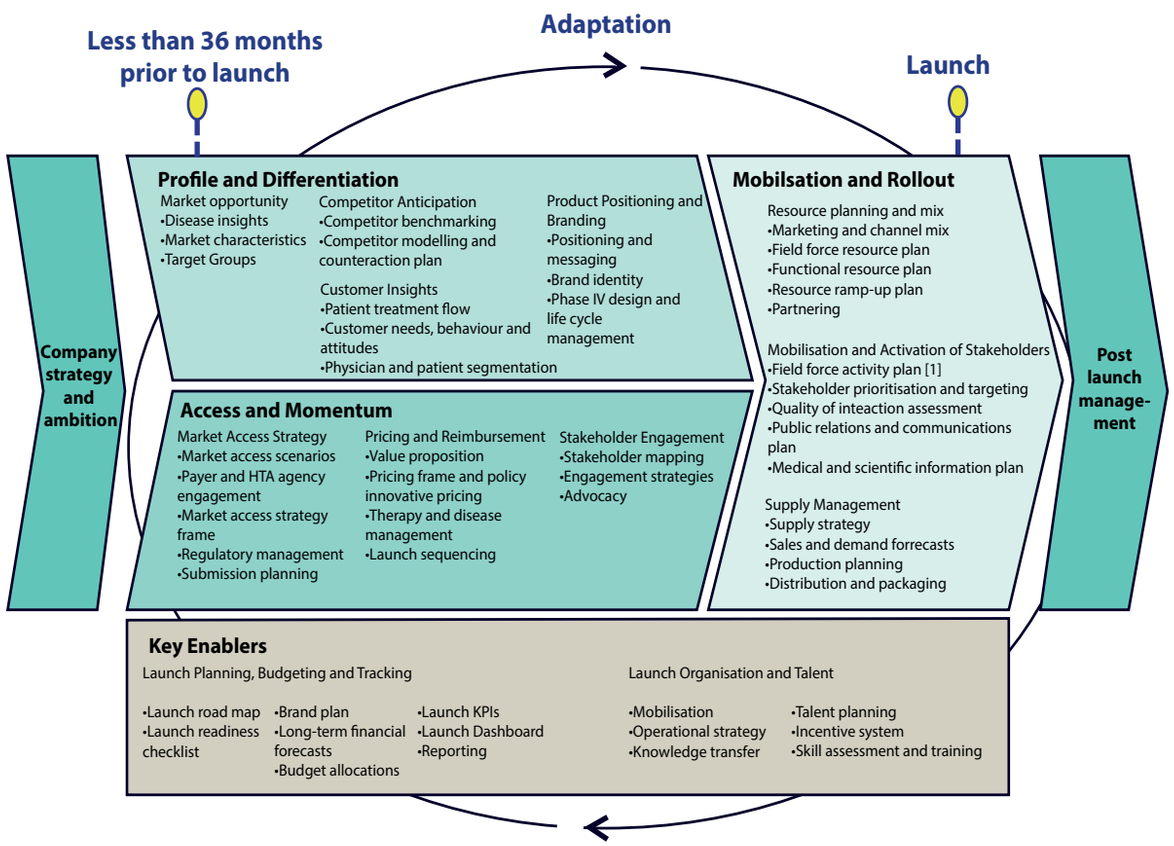
Engage and Connect with All Stakeholders

The traditional pharmaceutical selling model focused on a single channel: the physician. That narrow focus no longer makes sense in a world where myriad stakeholders exert significant influence over prescribing decisions.

Although many companies have expanded their customer-facing team to include medical science liaisons (MSLs), key account managers (KAMs), field-based access teams, and sales reps, most still struggle to maximize the value of this more complex market investment.

A consistent challenge is getting a comprehensive view of which stakeholders matter the most, who is connected to whom, and who has influence across the stakeholder network. BCG has successfully deployed social-network

BCG's Battle-Tested Launch Excellence Framework



Source: BCG analysis
[1] Includes medical science liasons, key account managers, field-based access teams and sales reps.

analysis to visualize stakeholder networks and define the most effective ways to engage with the key players. Social-network analysis helps companies answer questions such as, which institutions or individuals – for example, key opinion leaders, payers, HTA agencies, guideline committees, or physician and patient groups – are the most influential across stakeholder groups? How does information flow in the stakeholder network? And what are the most effective ways of conveying messages to the stakeholder network given the patterns of influence and communication?

Sticking to one strategy is a sure-fire way for getting outmaneuvered

When the most influential or connected stakeholders are identified, a cross-functional stakeholder-engagement plan is developed that defines the deployment of resources, outlines the roles of the various customer-facing functions, sets forth a concrete program of actions for approaching the stakeholders in a coordinated way, and details a way to measure the impact of key messages.

Measure, Measure, Measure

Collecting the right information and harnessing it is critical at every step of a product's launch. Sophisticated analysis is required to help teams figure out what is working and what is not. Currently, most companies collect launch data in an uncoordinated fashion, analyze KPIs that track past events and actions, and then take several months to compile the data. This approach makes rapid response to the current market impossible. Instead, launch teams need to create a comprehensive system that tracks KPIs in real time, enabling companies to understand what is happening in the marketplace and to make necessary adjustments quickly and effectively.

Biopharma companies could learn a thing or two from consumer products companies. These organizations have measured with great accuracy the impact that various marketing tools – such as promotions, coupons, and advertisements – have on their business. By contrast, pharmaceutical companies gather much detail on the recruitment, training, and effectiveness of sales reps.

Companies have failed to dig deeper and analyze the extent to which other elements of their marketing efforts—such as collateral materials, medical education, disease management programs, and conventions – are effectively communicating their message. Analyzing the impact of these elements is complex and challenging. But if it is done well, it can help companies create the optimal mix of tools and reduce spending overall – a savings that can be reinvested in activities that more effectively drive future success.

Prepare to Pursue Alternate Routes

In the past, investment levels for a new launch were more predictable. The rule was to spend aggressively for the launch and for a few years after and then to let spending decline as a product aged. In an environment where it is difficult for companies to predict whether they will gain market access and be approved for reimbursement, and where competitors are responding to new market entrants much more quickly, sticking to one strategy is a sure-fire way for getting out-maneuvered. Having a plan B that's only a slight variation is no better. Rather, investment strategies need to be dynamic and adapt to the realities of the marketplace. When it is apparent plan A is not working, companies need to shift gears and quickly pursue previously mapped out alternate routes.

The new reality of the pharmaceutical marketplace is one of increasing complexity, mounting uncertainty, and intense competition. These challenges stem from a host of pressures, including declining R&D productivity, increasingly crowded markets, and high market-access and reimbursement hurdles. As a result, a new product's success or failure hinges on the effectiveness of the launch and is judged by the market more quickly than ever before. Therefore, it is imperative that pharmaceutical companies employ a comprehensive launch strategy: one that coordinates all functions across the organization and drives decisions from the preparation phase through rollout.

These new tactics can reduce the budget for marketing a big film and more effectively build a movie's fan base well ahead of opening weekend. Certainly the stakes are much higher when it comes to life-saving medical treatments. But like their Hollywood counterparts, pharmaceutical launch managers must rewrite their go-to-market rules one launch at a time.

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Spending the Money Wisely:

Challenges of Health System Financing

Prof. Peter Smith, Imperial College Business School and Centre for Health Policy

Health services have enormous potential for mitigating many of the global health problems that afflict much of the world's population. However, it is a sad fact that all the heroic ambitions for improving global health must confront the prosaic reality of finding the necessary financial resources. The remorseless logic of accountancy requires that the funds needed to provide services must be raised somehow, and there are regrettably few alternatives as to how that can be achieved.

Yet some countries do seem to be able to finance their health services far more painlessly than others. So there are many lessons to be learned about how best to fund health services, especially in low income settings.

As well as providing the necessary resources, many of the decisions made about financing are a key determinant of the nature and performance of any health system. The sort of questions to be addressed by finance policymakers include:

- Who should pay for health services?
- How much should they pay?
- What services should be subsidized?
- How should the providers of those health services be reimbursed?

The answers to these questions will in very large part determine the scope and nature of services that are provided, who receives those services, and the extent to which poor or sick people are exposed to impoverishing health-related payments. In short, financing is a key determinant of the efficiency and fairness of the health system.

Health Spending and National Income

It is first worth noting the magnitude of the financing task. Health expenditure per annum amounts to just $27 per person in low income countries, compared to $4,879 in high income settings. This underlines the most basic difficulty confronting any efforts to address global health concerns: the profound scarcity of resources in low income settings. And resources available even in middle income countries are pitiful when compared with the high income countries. Of course one reason for this is the relatively low proportion of national income committed to health services in low and middle countries - see column two of the table.

Paradoxically, for many countries it is only as national income increases that it is possible to increase the proportion of the economy devoted to health, even though the most pressing health needs are clearly at low income levels. A number of reasons account for the inability of low income countries to prioritize health, such as the presence of even more pressing spending priorities, the reluctance of health service providers to operate in low income settings, and concerns about the quality and efficiency of services.

It can be argued that protection from health-related financial catastrophe is one of the great triumphs of twentieth century social policy in developed nations

Columns three and four demonstrate another clear trend: as national income increases, the proportion of health expenditure funded from public sources (such as taxation or mandatory social insurance) increases, and the reliance on out-of-pocket spending declines. Indeed it can be argued that protection from health-related financial catastrophe is one of the great triumphs of twentieth century social policy in developed nations.

Reducing the reliance on direct user charges for health services yields enormous benefits for citizens, in particular the very poorest. First there is the immediate benefit that households are protected from the financial hardship (and sometimes catastrophe) associated with paying for healthcare. But the reduced financial barriers to access to care have also been shown to yield major benefits in terms of population health, worker productivity and the broader prosperity of society.

As a result, development of improved protection from the financial consequences of illness has become a policy priority for many countries. It is noteworthy that the topic chosen for the World Health Report 2010 was 'universal health coverage': the notion that citizens should have access to needed health services of sufficient quality to be effective, without entailing financial hardship.

Universal Health Coverage

In general, with the notable exception (so far) of the United States, citizens in developed countries enjoy very high levels of coverage. Access to most needed services is readily available, and the associated fees are generally modest. This is achieved through systems of universal health insurance, such as the mandatory social health insurance used in countries like the Netherlands and Germany, or state funded health insurance of the sort provided in Scandinavia and the United Kingdom.

These insurance arrangements secure affordable coverage by charging citizens according to their ability to pay (usually income levels), rather than their levels of sickness. They therefore implicitly make a very large financial redistribution from the major financial contributors (the rich, the young and the healthy) to the major recipients of care (the poor, the old and the sick).

Of course low income countries do not have the capacity to purchase a full range of health services for the whole population, and they therefore tend to provide lower levels of coverage than their richer counterparts.

WHO characterize the level of coverage as a box in which the 'breadth' of coverage indicates the proportion of the population enjoying insurance protection from public insurance funds, the 'depth' of coverage indicates the range of services covered (how comprehensive is the benefits package?), and the 'height' of coverage indicates the degree of protection from user fees (because even if a service is nominally funded by the insurance arrangements, the patient might still have to pay a charge).

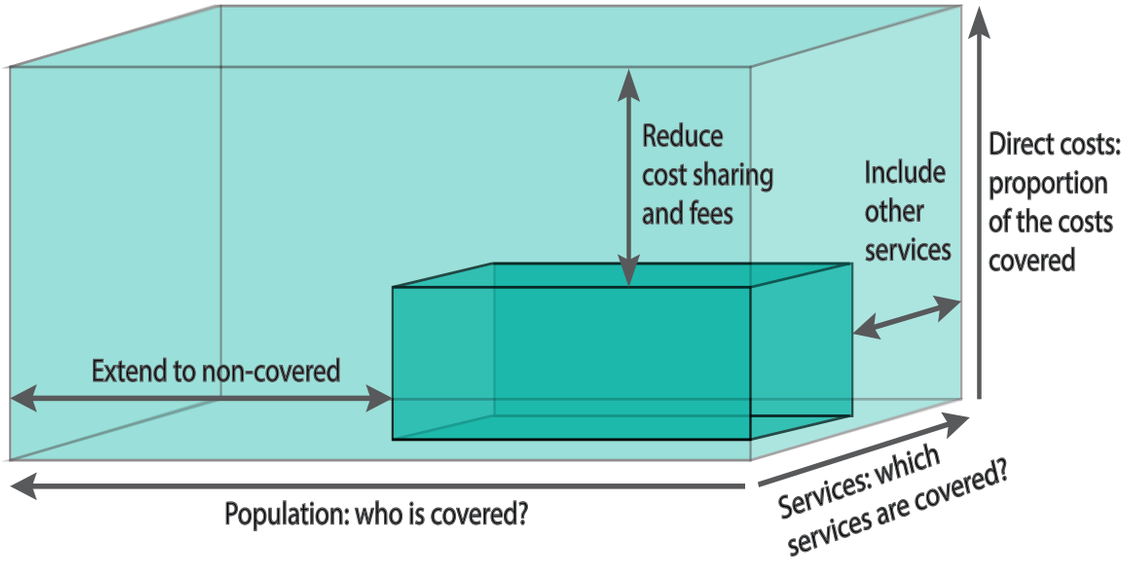
The size of the blue box indicates schematically the level of coverage enjoyed by the population; to attain a higher level of coverage requires either higher levels of funding or improved levels of efficiency.

Having secured a certain level of 'pooled' funding for health funding, policymakers must then decide which people to insure, which services to include in the national 'benefits package', and how much to charge people for access to those services. Of course, many would like to see all citizens being insured for all services, with no charges for securing access.

However, this position ignores the harsh reality that the size of the blue box in the figure shown overleaf is decidedly finite. Simple arithmetic makes it infeasible

Health expenditure per annum amounts to just $27 per person in low income countries (World Bank HNP data).

Country Type	Health Expenditure per capita	Health Expenditure, total	Health Expenditure, public	Out-of-Pocket Health Expenditure	External Resources for Health
	(current US$)	(% of GDP)	(% of total health expenditure)	(% of total expenditure on health)	(% of total expenditure on health)
Low Income	27	5.3	38.7	18.1	25.9
Lower Middle Income	71	1.2	10.2	52.3	2.8
Upper Middle Income	382	6.1	51.3	33.1	0.2
High Income	4879	12.7	65.1	13.7	0.0



A graphical model illustrates the level of healthcare coverage based on population, services provided and fees (WHO)

for all people to be insured for all services with zero price for access. In short, the policy problem is to make the difficult financing choices illustrated above.

Taxation for Health

One strategy for improving coverage is to increase the volume of pooled funding for health services (the size of the blue box). A number of approaches can be envisaged to this end, but perhaps the most fundamental is to develop trusted insurance arrangements.

Contributors to the health insurance pools can then feel confident that they and their dependants will be able to secure access to needed services when they suffer ill-health in the future. Such trust is a fundamental requirement for the efficient operation of any insurance arrangement, whether run by governments, non-governmental organizations, or the private sector.

It has been become evident that – to be effective – health insurance arrangements must be mandatory, covering a large population, with contributions graduated so as to reflect ability to pay. In effect they must take the form of taxation. A small number of low and middle income countries, such as South Africa and Uruguay, have historically placed a high reliance on voluntary private health insurance, at least for higher income citizens.

This protects those who can afford such insurance from health-related income shocks. In the same way, experiments with small-scale 'community based insurance' can be useful in demonstrating in low income settings the benefits of insurance (relative to user fees).

However, if enrolment is voluntary, voluntary community based schemes tend to attract sicker citizens, and will therefore not be financially sustainable unless they can make a transition to a universal system of mandatory health insurance. Furthermore, of course, such voluntary insurance is much more readily accessible to richer citizens. In short, to achieve the goals of health improvement, financial protection and equity, universal health coverage requires a move towards some form of tax-based funding.

Yet there is obviously a shortage of the necessary taxable capacity to fund health services in low income settings. The table underlines the heavy reliance of low income health systems on 'external' funds, in the form of foreign aid. Since 1990 the volume of health aid has increased from $6 billion to $28 billion (at constant 2009 prices), and it now accounts for 25% of all health expenditure in low income countries, from sources such as individual donor countries, non-governmental organizations and foundations including the Bill and Melinda Gates Foundation, and international agencies such as the Global Fund, the World Bank and the WHO.

Whilst these funds are a welcome supplement to the country's own resources, they often create added complication for policymakers, especially when (as is usual) they are tied to specific health programmes, rather than a general supplement to a country's own financial resources.

Also, researchers are becoming concerned that donor funds may to some extent displace funds for health services that would otherwise have been raised by the country itself, rather than to supplement planned health spending. For example, one effect of donor funds may be to allow a country to spend its own health resources on other sectors, such as government education programmes or even reduced taxation.

Health insurance arrangements must be mandatory, covering a large population, with contributions graduated so as to reflect ability to pay.

Another way to increase the effective size of the blue box is to increase the efficiency of the health services that it funds. There are manifest inefficiencies in almost all settings, so in principle this should offer a fruitful way of making pooled funds go further. There is increasing recognition that health system inefficiency is immoral, because it wastes money and therefore denies treatment for people in need.

There are some hopeful signs, such as the increased use of telemedicine and better information on provider performance. However, there is no simple solution to driving out inefficiency, with a few percentage points a year likely to be the best that can be achieved in most situations. The reduction of waste will therefore usually require a long term commitment of energy and leadership.

Although increased revenue and enhanced efficiency can yield some leeway for policy makers, it is likely that – in most settings – the hard choices will remain of who will receive coverage, for what services, and at what level of price. Economists have traditionally championed cost-effectiveness analysis as the basis for making many of those choices. The idea of cost-effectiveness analysis is that the services to be covered should offer the biggest health gains for the limited money available.

This gives rise to some tough solutions, and may have to be adapted somewhat to protect the poorest people. However it is difficult to envisage a fairer or more transparent way of spending the limited health budget, and it is reassuring to see adoption of such methods in global initiatives such as WHO CHOICE (CHOosing Interventions that are Cost Effective) and the Disease Control Priorities Project.

Governance, Transparency and Accountability

The financing of health services is a basic pillar of every health system, and there is increasing recognition that it has a fundamental influence on the health of the population and their broader prosperity.

There are some very hopeful signs, such as moves towards genuinely universal coverage in countries such as Thailand and China, and careful specification of the benefits package in line with a nation's ability to pay, as in Chile. Approaches towards improved efficiency are less well developed, but there are some hints of success, such as Rwanda's success in implementing a system of paying providers in line with performance.

In summary, financing arrangements are a key determinant of health system performance. Future priorities will always include the following:

- The creation of trusted agencies to oversee the collection and spending of pooled health service funds;
- Clear statements of what services are to be funded from the pooled funds;
- Development of incentives for providers and citizens to encourage appropriate utilization and greater efficiency;
- The active measurement of performance so that insurers, providers, clinicians and governments can all be properly held to account for the results achieved.

There are active debates about how these are to be best achieved. For example, some promote the merits of provider competition, whilst others champion a public service ethos. No approach towards health system design has been shown to be unambiguously superior, so it is likely that the emphasis will to some extent depend on local circumstances. However, any system of finance will fail without the universal requirements of good governance, transparency, and proper accountability.

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On the Benefits of Competition in Healthcare

Prof. Carol Propper, Imperial College Business School

Governments faced with rising costs and growing demand are constantly searching for methods of delivering better healthcare. Reforms which promote competition are currently very much in vogue: within the OECD alone, The Netherlands, Switzerland, Germany, the UK and the USA all have introduced such reforms. Yet while the political appeal is simple – in the rest of the economy competition drives up standards and drives out poor quality suppliers – critics argue that the features of healthcare make the use of competition inappropriate. Is this really the case?

The arguments against the use of competition range from the rather unsophisticated to the deep. An example at the unsophisticated end is the debate that raged in the UK in 2011 when critics of the (not very coherent) pro-market reforms of the former UK Secretary of State for Health, Andrew Lansley, conflated private delivery of services with a removal of tax finance for healthcare and predicted a total collapse of the NHS and the equity goals which underpin it. Of course, in healthcare, scare-mongering is not confined to those who oppose competition: witness the debate in the USA against Obama reforms in which high profile politicians suggested that in the NHS older people were threatened with euthanasia to reduce the costs to the tax payer.

More sophisticated criticisms focus on the role of information and motivation. With respect to information, it is argued that healthcare is an area where there are informational asymmetries: providers of healthcare always have better information than users. This will give providers monopoly power (think snake oil salesmen in the nineteenth century). A variant of this argument is that information is just too complex for users so competition will either not occur or arise around irrelevant features of healthcare. Similar arguments are often advanced in the context of complex financial products. The motivational argument states that providers of healthcare are driven by intrinsic motivation and that the introduction of extrinsic rewards which often accompany competition will drive out intrinsic motivation.

Whether – and under what circumstances – these arguments are correct is, in fact, an empirical matter. And a key issue in the use of competition in healthcare is that the evidence base from which they draw is limited. Further, what evidence there historically has been is from the USA, which is an outlier both in terms of what it spends and in the complexity of its healthcare system. Fortunately, for policy makers there is growing evidence on the use of competition in healthcare from a very different OECD system: the UK National Health Service.

Competition and Choice in the NHS

The UK NHS is a tax financed system where all individuals are insured against the direct costs of healthcare. This means the UK has not experimented with competition in health insurance. But it has introduced a range of reforms intended to increase the amount of choice users have of providers of healthcare. And a cool look at the evidence from the UK gives a positive picture of potential gains from choice and competition.

First, there is the evidence from the 'Choose and Book' reforms of the Tony Blair, Labour, administration. Implemented in 2006, these mandated that patients be allowed to choose from up to 5 hospitals for their treatment, and so introduced competition between healthcare providers. Previous to that date, most patients had little choice of provider.

The evidence from these choice reforms broadly suggests the following. Not all patients were offered choice, wanted it or took it up when offered. But three years after the reforms around half of patients recalled being offered a choice. Hospitals rated as better – both in terms of some measures of clinical quality and in terms of having lower waiting times – before the policy reform attracted more patients, and patients from further away after the reform. This suggests that the choice agenda had some effect on the selection of hospitals: more patients chose – with the help of their GPs – to go to better hospitals. Fears that patients would only choose on the basis of car parking or factors unrelated to clinical quality also appear to be unfounded.

Hospitals in competitive markets increased their quality without increasing total operating costs or shedding staff

But did this movement of patients have any effect on outcomes for patients? Hospitals located in areas where patients had more choice had greater improvements in clinical quality (measured by lower death rates following admissions) and greater reductions in lengths of stay post policy than hospitals located in less competitive areas. What's more, the hospitals in competitive markets increased their quality without increasing total operating costs or shedding staff. While reductions in death rates are a pretty crude indicator of quality and are contested, they are also used by healthcare regulators in many countries as a measure of hospital performance. Further, these changes appear to have benefitted patients from deprived areas as much as those from better off areas. So these reforms appeared to have brought gains to patients.

Second, there is evidence that hospital consolidation and mergers did not improve outcomes for patients. Whilst outcomes in specialist departments such as care for critically ill babies or heart attack patients may improve when services are consolidated, a study of mergers and consolidation in UK hospitals in the late 1990s suggested that mergers promised much before the event but delivered much less after the event. As mergers tend to reduce the potential for competition in a local market, these findings also suggest that there are benefits from competition in an NHS type system.

Third, from a rather different perspective, researchers looking at the quality of management of hospitals in the NHS have found that better management is associated with better outcomes and that management tends to be better where hospitals compete with each other.

Finally, from elsewhere in Europe there is also evidence which broadly supports competition. The Netherlands has had a mixed system of provision for many years and has slowly introduced competition. There is no evidence that this has massively harmed equity and is thought to have led to improvements in service delivery.

In sum, the arguments may be more nuanced than many politicians (and perhaps health commentators) would like. But there is no evidence from recent experiments in the UK that allowing patients more choice and exposing poorly performing hospitals to the threat of their patients choosing another provider has led to poorer outcomes for patients and large equity issues. On the contrary, the evidence we have suggests that competition and choice – as in the rest of the economy – has the power to improve outcomes for patients.

For further reading:

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17 Oct 2012

Lecture Theatre G16, Sir Alexander Fleming Building, South Kensington Campus

The cyber threat represents one of the most complex, most novel, and most serious disruptive threats to security in the past sixty years. As these threats to cyber space become increasingly more sophisticated, as bad actors turn to the internet to wreak havoc, and as cyber networks continue to act as the backbone of global commerce and government, it is imperative that policymakers develop strong strategies for dealing with the cyber domain.

Doing so effectively will require societies to answer key legal and ethical questions. When is a cyber attack a genuine act of war? What is the line between the development of offensive versus defensive cyber capabilities? How can law enforcement most effectively combat cyber crime and cyber terrorism while maintaining civil liberties and privacy?

A drinks reception will follow the talk. Register for your free place by email to **securityscience@imperial.ac.uk**

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