

Global Trends and Drivers

This booklet describes some of the key global trends and drivers affecting society.

These are grouped according to the STEEP model:

Social

Technological

Economic

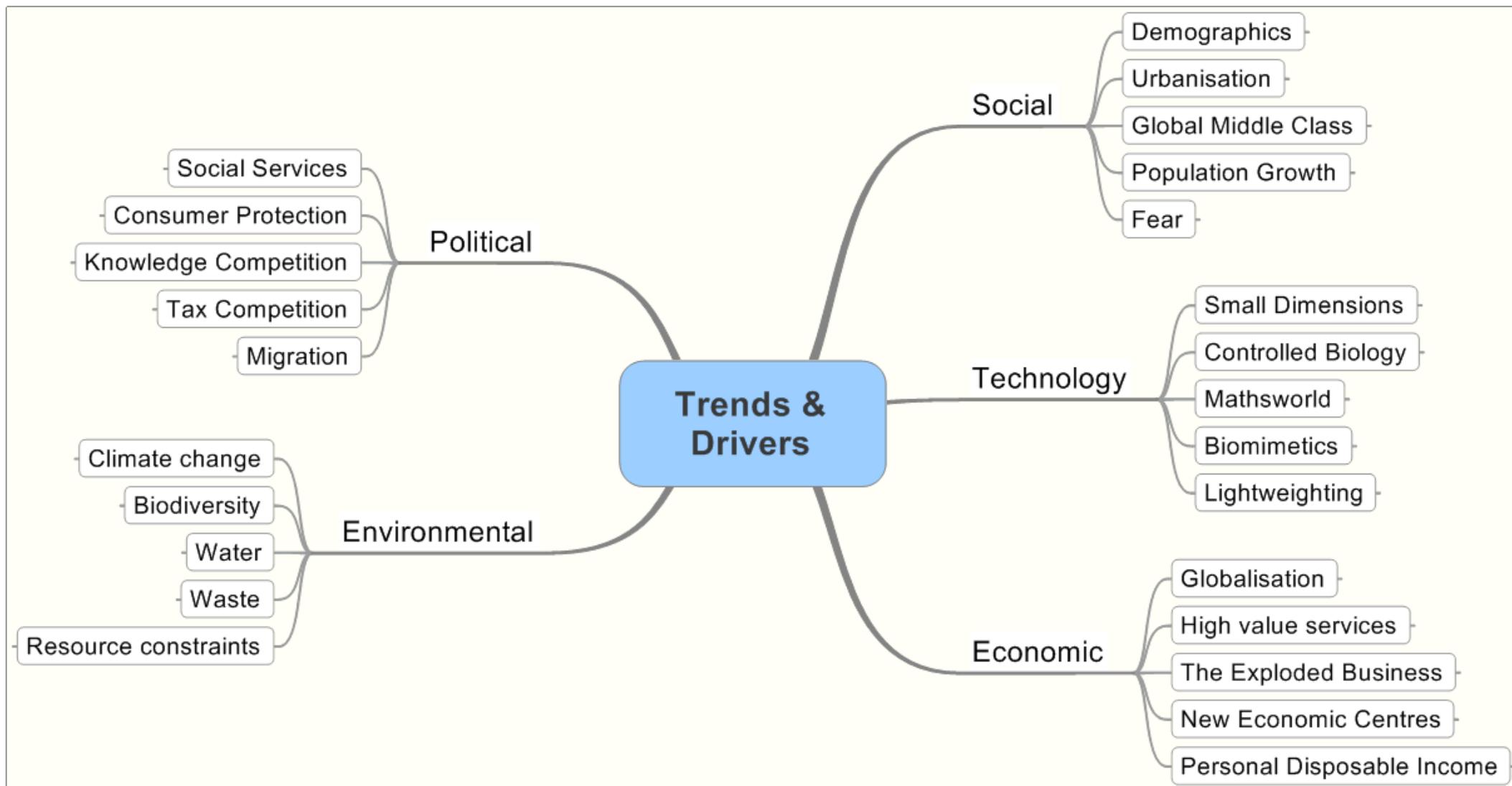
Environmental

Political and Legal

Five key trends or drivers are covered under each heading; including a definition, the impact on society and some of the questions it raises for the chemical and chemical using sectors of industry.

The trends and drivers have been gathered from several published sources including:

- Sustainable Technologies Roadmap, Chemistry Innovation, 2004 & 2008
- Science and Technology Perspectives 2005 – 2055, Institute for the Future, 2005
- Mapping the Global Future 2020, National Intelligence Council, 2004
- Drivers of Change 2006, Arup
- The UK Government Foresight Programme and Horizon Scanning Centre
- OECD, UN, World Economic Forum and World Business Council for Sustainable Development

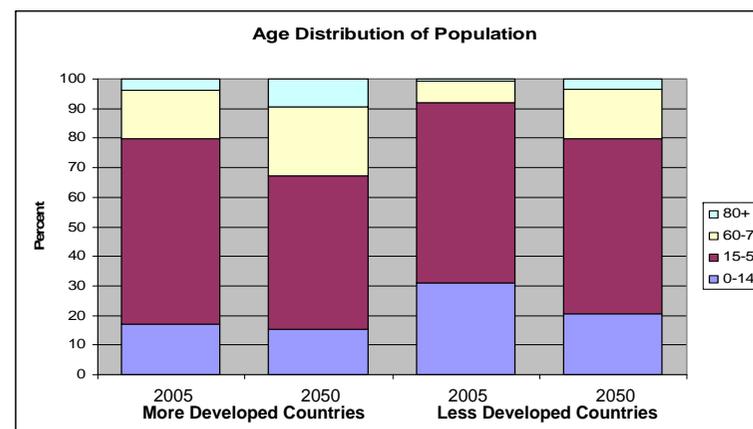


Social - Demographics



Developed countries have a rapidly aging population. By 2050 one third of the population will be over 60. At the same time the number of children and people of working age is also falling. Spanish birth rate is 1.07 children for each woman; the lowest in the world. The required rate for a stable population is 2.1

The less developed countries are following the same pattern but delayed. Children are about a third of the population and this number is still rising. In the least developed countries it is over 40%. By 2050 the proportion of children will start to fall and a significant older population will arrive.



Social - Demographics

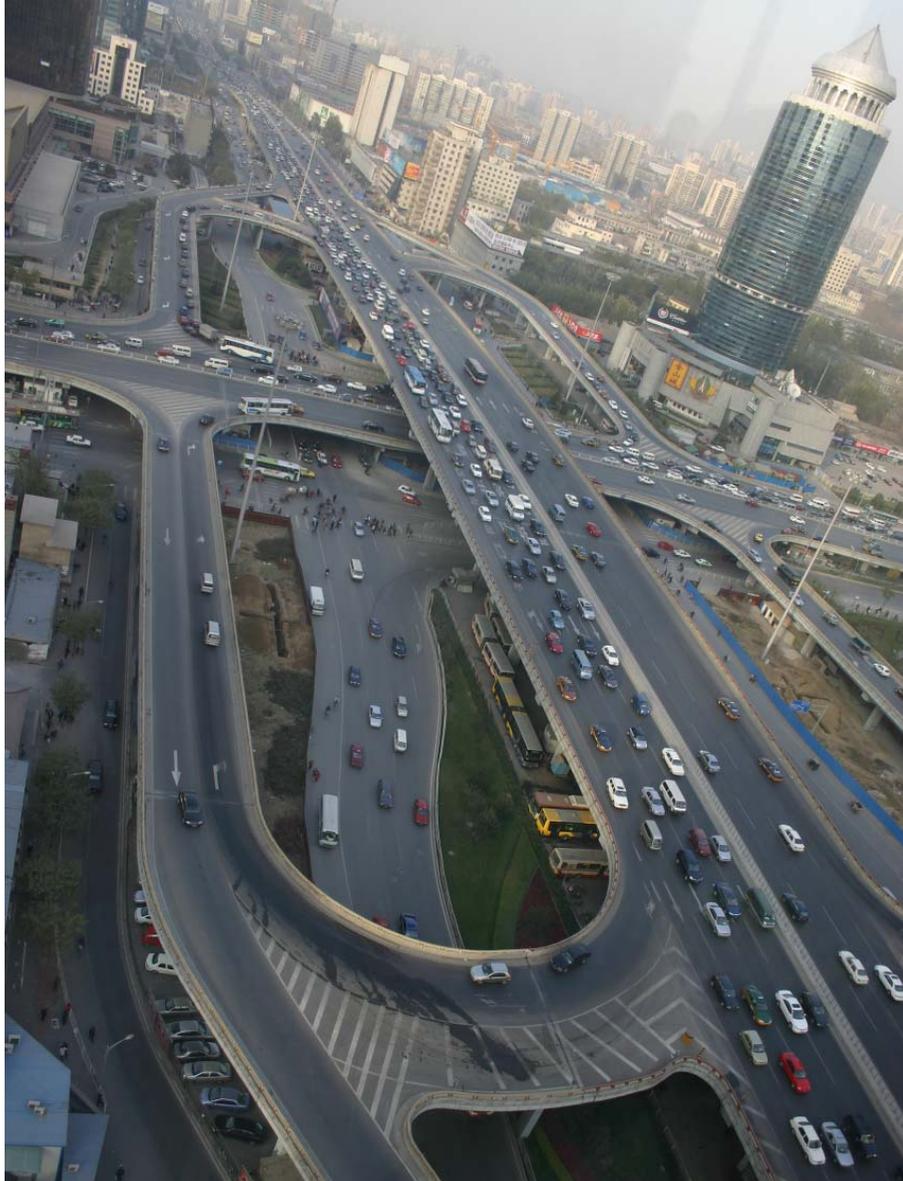
Challenges for Society

- Growth in workforce will slow everywhere and the workforce will shrink in the developed countries
- Migration will be essential to maintain working population in developed countries
- Number of workers per retiree will fall – leading to immense fiscal strains on society
- Older people in developed world cannot be supported in the way they are today – people will need to work longer and remain independent for longer
- In the least developed countries with the highest birth rate, there is a need to educate children and provide basic health care so that they can be economically active. Particularly a problem where children are frequently orphaned by disease (HIV) or by conflict.

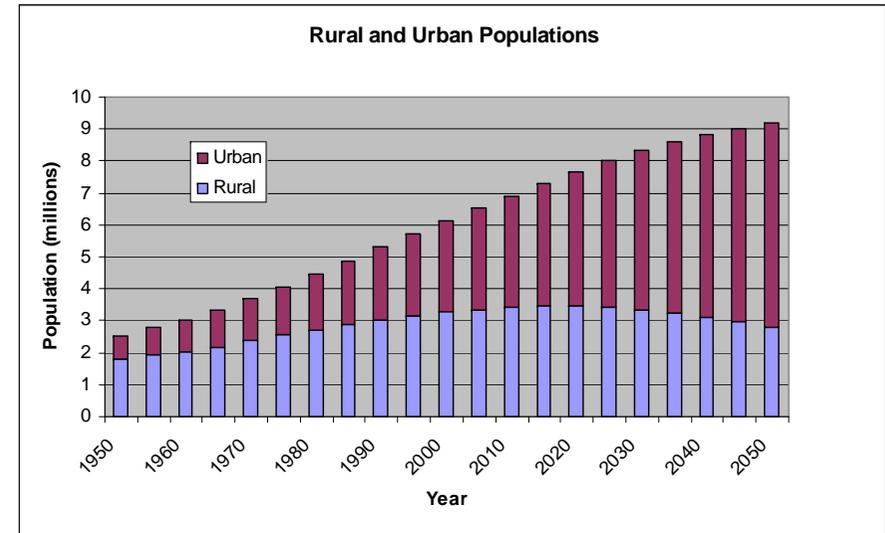
Issues for the Chemicals Sector

- Where will the future workforce come from?
 - Competition from other sectors
- How to retain knowledge base?
- Opportunities in assisted living for older population
 - In-home diagnostics
 - Nutritional supplements
 - Treatments for chronic conditions
 - Senior friendly products (inc. packaging)
- Age-profile of workforce

Social - Urbanisation



In 2008 for the first time in recorded history more people lived in cities than in the countryside.



Already 90% of the UK population is urban

Globally:

- 153 cities over 1 million
- 18 of the 27 megacities (pop > 10m) in Asia
- Of 11 current megacities, all except Tokyo exceed WHO air pollution limits by >100%

Social - Urbanisation

Challenges for Society

Urbanisation brings real benefits. Cities generate a higher proportion of goods and services than their population would suggest. They are centres of innovation and offer the best opportunities for individuals to lead a full life.

However, they also bring enormous problems; particularly in the megacities of Asia. They suffer from:

- Water shortages
- Traffic congestion
- Air pollution
- Damage to the surrounding hinterland
- High energy use and carbon emissions
- Slums, crime and breakdown of social structures

Countries are now trying to design low-footprint environmental cities such as Dongtang in China

Issues for the Chemicals Sector

- Technologies for decarbonising cities
- Reducing the impact of water treatment
- Clean chemical processes to reduce air pollution
- Low-pollution transport
- Developing low-pollution solutions for downstream chemical using industries
- Avoiding exporting pollution by re-locating industry
- Opportunities for innovation centres in developing megacities

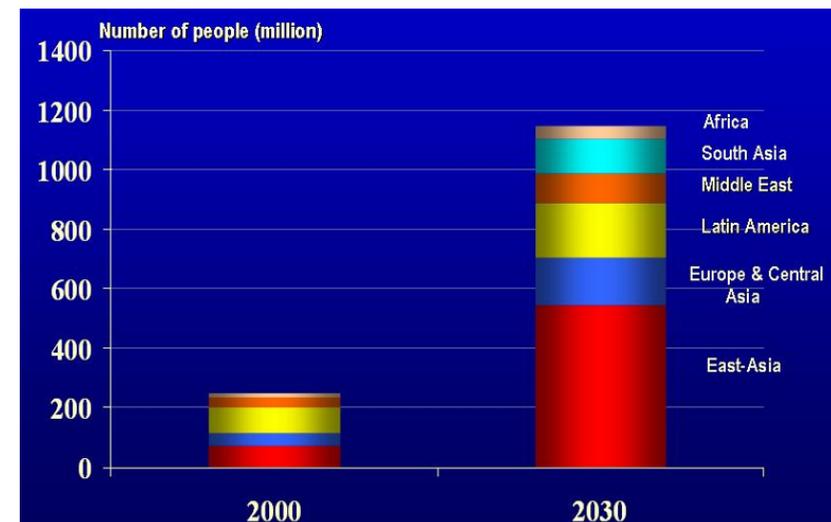


Social – Global Middle Class



By 2030 1.2 billion people in developing countries will belong to a global middle class – earning \$4,000 - \$17,000 per person. the largest growth will occur in India and China.

This global middle class will be part of the global economy, demanding world-class products and education, and with the power to purchase cars, consumer durables and overseas travel.



Social – Global Middle Class

Challenges for Society

- New consumers demand products and services previously only available in developed countries
- Globalisation pressures will increase
- Decreasing economic influence of OECD and growth in purchasing power of China and India
- Increased demand for healthcare and education strains resources of less developed nations
- Pressure on limited physical resources
- Increasing inequality in less developed nations

Issues for the Chemicals Sector

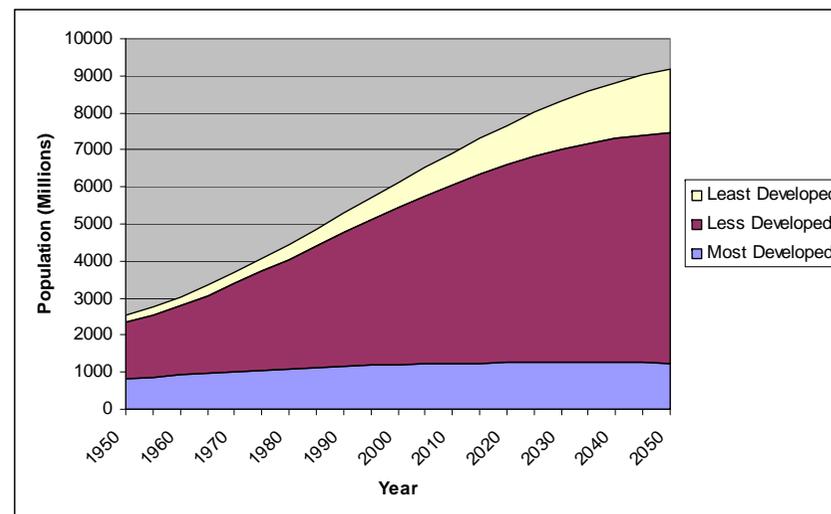
- Opportunities to expand markets for all kinds of consumer products
 - Pharmaceuticals
 - Processed foods
 - Cleaning and personal care products
 - Coatings, adhesives, sealants and elastomers
 - Electronic materials
 - ...
- Multinationals will have a much larger market in 2030
- Consumer needs and tastes will be increasingly defined by China, and to a smaller extent India
- Competition for scarce materials
- Delivering consumer expectations at radically lower environmental impact

Social – Population Growth



Current projections for world population show a growth from the current 6.7 bn to 9.2 bn by 2050. This growth is equal to the total world population in 1950. The bulk of the growth is in the less developed countries. Growth in the developed countries is negligible. Population in these countries is only sustained by migration.

Average births per woman ranges from 1.07 in Spain to 8.0 in Niger.



Social – Population Growth

Challenges for Society

- Providing the fundamentals of life to a much larger population
 - Food
 - Water
 - Shelter
 - Healthcare
- Pressure on physical resources
- Threat of conflict over access to land and water

Issues for the Chemicals Sector

- Need for a new 'green' revolution to meet growing food requirements
- Improved water purification and handling
- Improved sewage treatment
- Development of lower impact and lower input agriculture
- How to support development of drugs and treatments for the less developed world
 - Orphan diseases
 - Poor consumers
- Maintaining secure supply chains

Social – Fear



We live in an increasingly fearful society; especially in the developed world.

Fear of crime is often out of all proportion to the actual risk. Health scares, such as the MMR vaccine, provoke a reaction strong enough to seriously impact social policy.

Fear of unknown, unlikely or invisible risks is greater than familiar risks. For example fear of risks of nuclear power, compared to risks of driving.

We are moving to a risk averse society with powerful implications for the way that we live our lives, innovate and manage society

Social – Fear

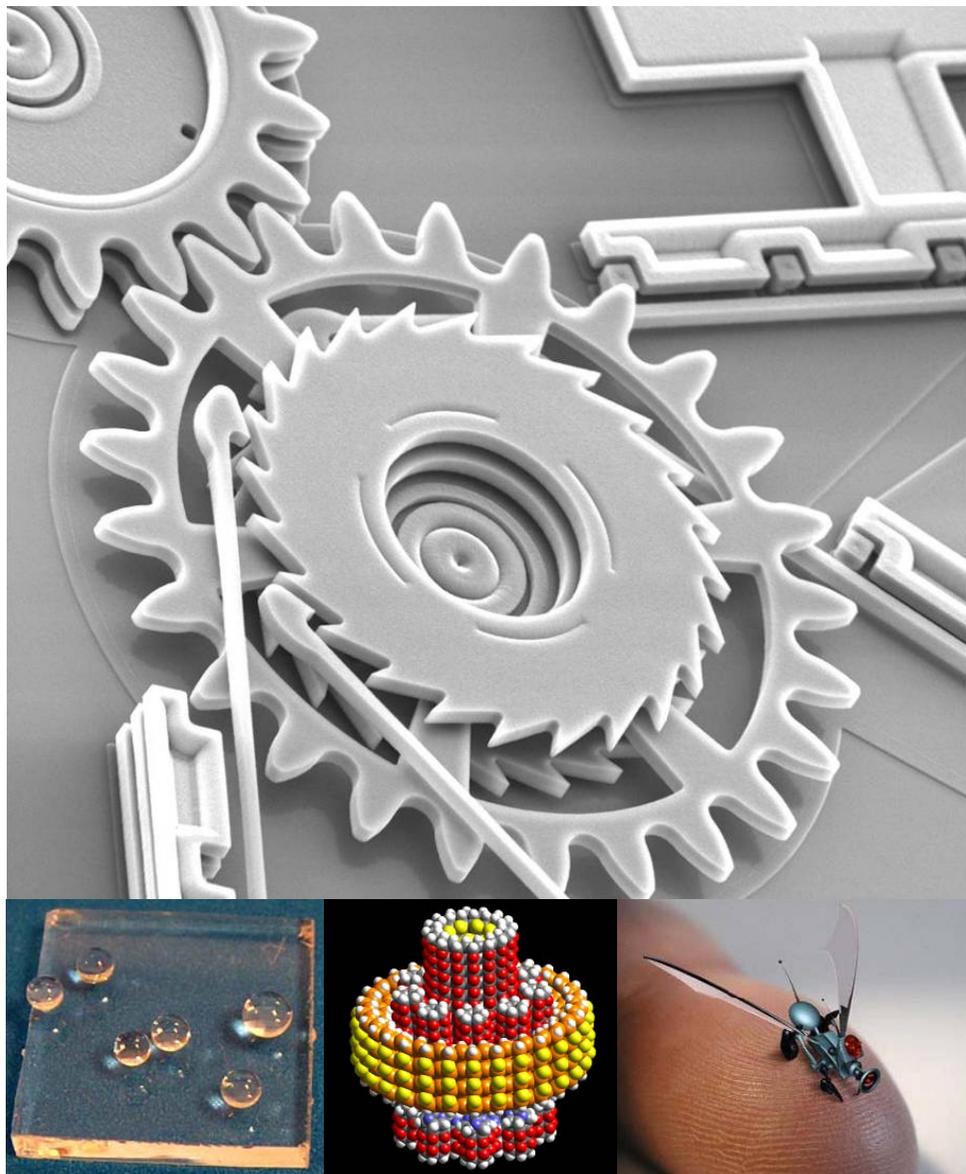
Challenges for Society

- Risk averse society ceases to innovate
- Suspicion of new things
- New technologies blocked, but existing tolerated whatever the impacts
- Suspicion of strangers, others
- Demand for absolute safety
- Children not allowed to develop properly
- Public health initiatives stifled by public concern
- Inability to react to global challenges such as climate change
- Suspicion of science
- Rise of non-rational decision making

Issues for the Chemicals Sector

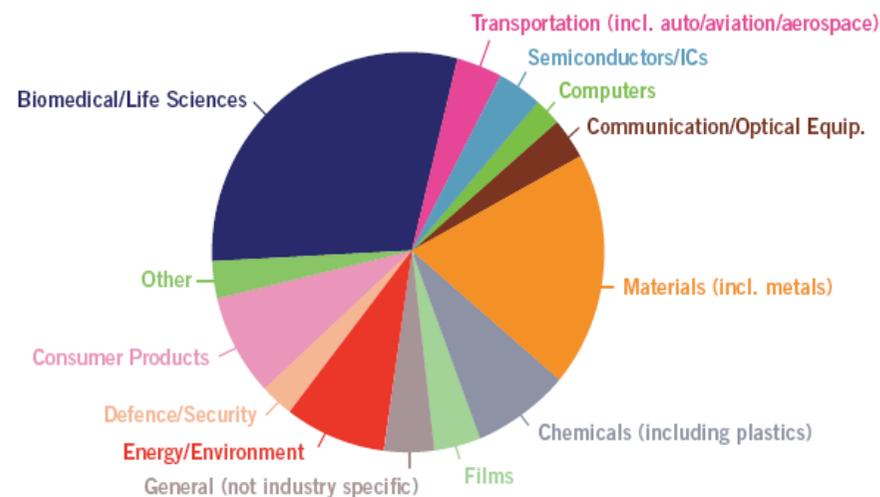
- Tackling 'chemophobia'
- Demonstrating social benefits of chemistry
- Improved ability to respond to 'scares'
- Traceability of all materials throughout life
- Making product stewardship real – lifetime responsibility for products
- Improved methods of recycling / disposal for chemicals
- Developing new testing procedures to give reliable safety data without use of animals
- Improved sensing and forensic methods
 - Analytical tools
 - Sensor technologies
 - Easily deployed field methods
- Lifestyle products for the 'worried well'

Technology – Small Dimensions



Nanotechnology has had all the hype, but in reality it is part of a much larger movement towards manipulating materials on very small scales.

This is not all about machines, but extreme efficiency, novel materials and novel fabrication techniques applied across a wide range of industries. Direct impact on the future of the chemical sector.



Target end use sectors for companies researching and using nanotechnology

Technology – Small Dimensions

Challenges for Society

- Opportunity to dramatically improve material efficiency of products
- Could reduce pressure on scarce resources
- Small-scale means potential for ubiquitous technology
- Public concern could threaten adoption – ‘grey-goo’ and images of robots in your blood-stream.
- Over-enthusiasm by promoters could hide problems
- Do we understand whether the risks of materials on a small scale are actually the same as the same materials in bulk?

Issues for the Chemicals Sector

- Game-changing technology with massive impacts:
 - Catalysts
 - New materials – particularly in electronics and biomedicine
 - New surface coatings and treatments
 - New delivery vehicles
- Will change many of our downstream user sectors:
 - Pharmaceuticals
 - Electronics
 - Personal care
- New ways to create nano-scale materials and effects
- Designing at a scale bigger than molecules and smaller than bulk
- Opportunity to leverage expertise in colloid science etc.
- Linking chemistry and biology

Technology – Controlled Biology



Somewhere between 3.5 bn and 4.5 bn years ago, life started on this planet. Since then it has evolved through random process to produce all the biodiversity current and extinct. Until now.

Developments in genomics, genetic engineering and computational biology are giving us unprecedented control over biological systems.

Re-engineering of existing life forms is now routine, if controversial. Synthetic biology will enable us to create new organisms based around re-usable 'bio-bricks'.

Technology – Controlled Biology

Challenges for Society

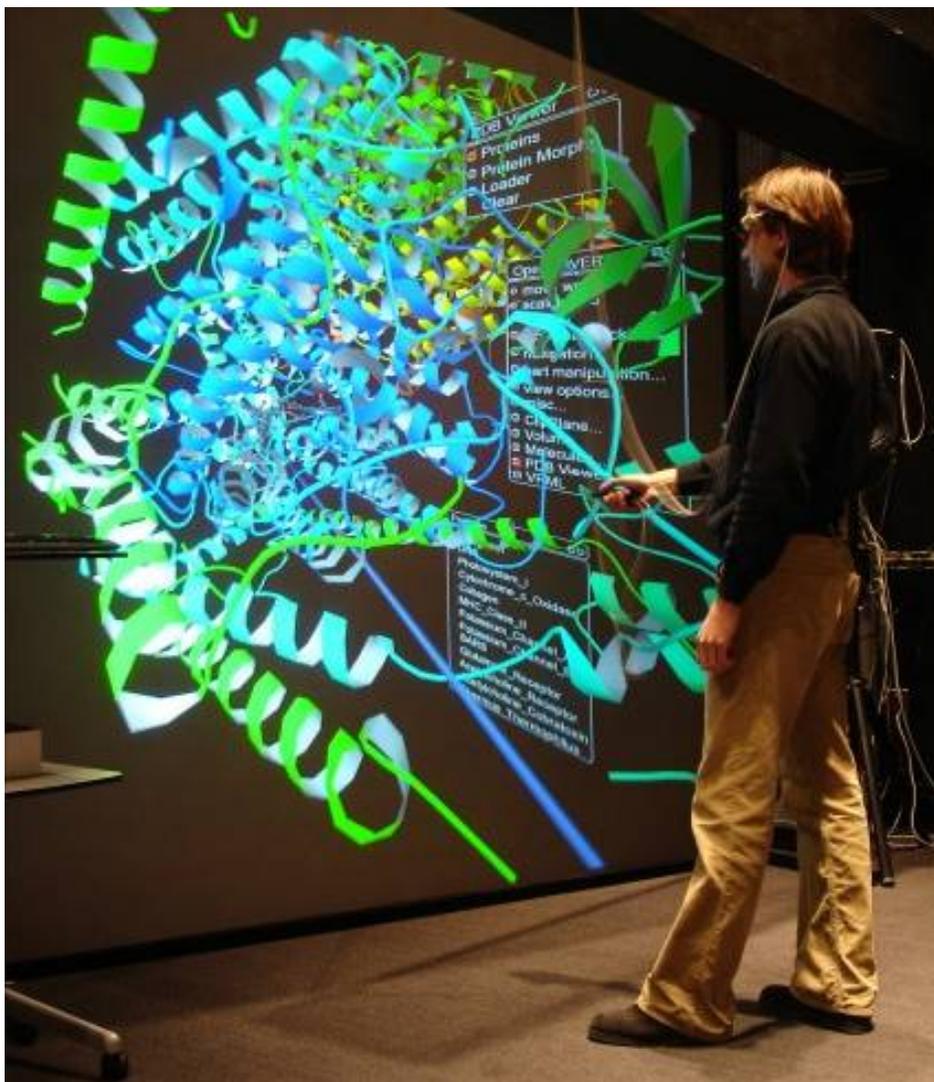
- Ethics of controlled biology (see below a genetically engineered fluorescent rabbit conceived as an art work)
- Consumer fear (GM food in Europe)
- Uncertainty over how to carry out risk analysis for synthetic biology organisms
- Usefulness in solving big problems – particularly in agriculture, food and healthcare



Issues for the Chemicals Sector

- New catalysts
- New production systems
- Combining biology and chemistry on one process system
- Access to difficult transformations
 - Fermentation of biomass to fuel and platform chemicals
 - Chiral reactions
 - Glycosylation of drugs

Technology - Mathsworld



Growth in computing and communications power will enable a further transformation of science and technology. From the ability to collect and understand enormous data sets to modelling of very complex systems we will continue to make rapid progress. But this is an extension of what we have today. Computing and communication embedded in everyday objects will create distributed networks capable of interacting with the world in new ways.

Mathematics will become 'invisible' and therefore more widely used as statistical and modelling tools become accessible and usable by all.

Life sciences and social sciences will become increasingly mathematical.

People will increasingly use the power of models to communicate and argue in a mathematical language that was inaccessible.

Technology - Mathsworld

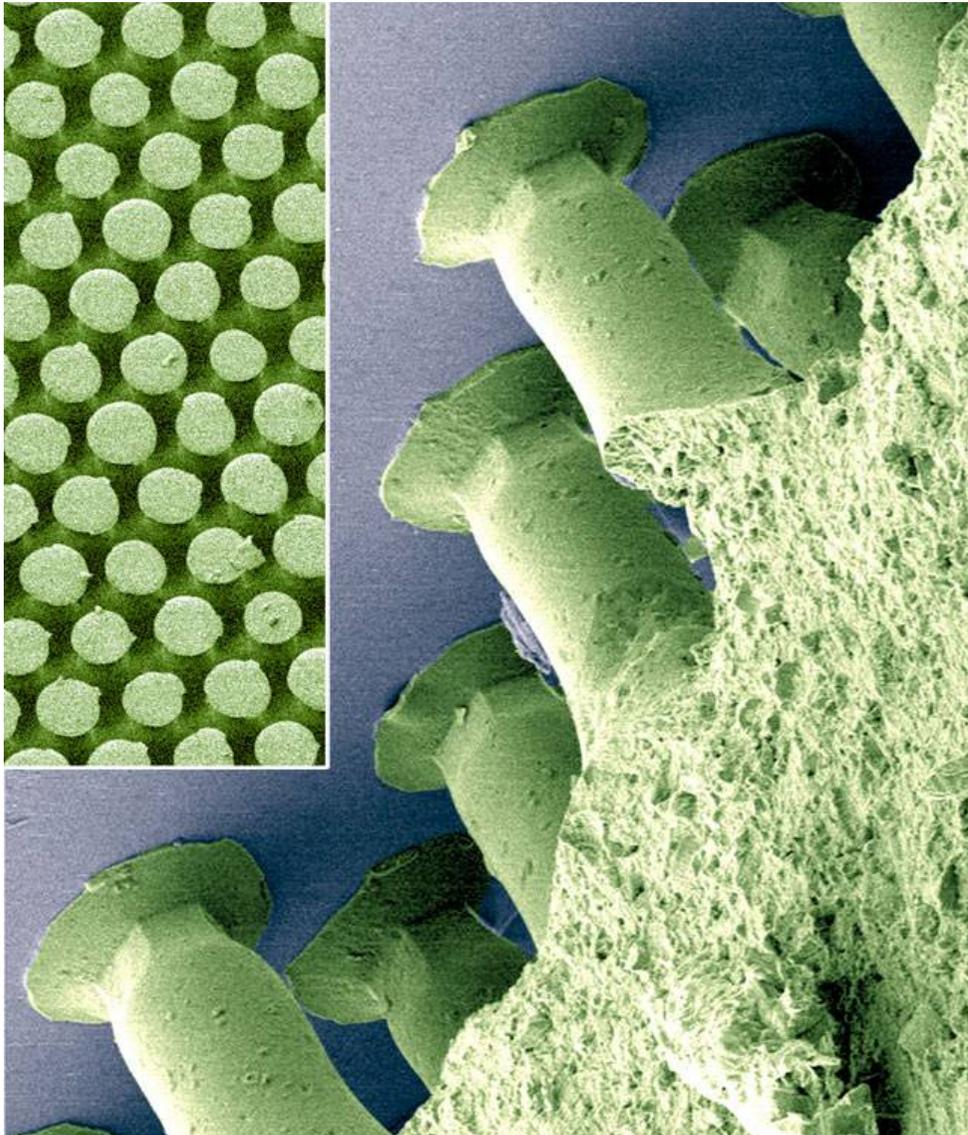
Challenges for Society

- Privacy in a wired world
- Identity – proving who you are in cyberspace
- Avoiding the growth of a digital elite – conflict between the digital haves and have nots
- Rise of cyber-terrorism
- Network security – when your economic system is based on a global network of computers, and all your key services are run by these computers, what do you have to do to feel secure?

Issues for the Chemicals Sector

- Developing the skills in the sector to take advantage of these technologies – financial services and the creative industries can probably pay more
- Re-thinking the innovation process completely
- Becoming much more efficient in the use of resources
- Finding ways to demonstrate product safety more quickly and cheaply without animal experiments.
- Being able to do real life cycle design
- Developing intelligent products that provide information on status
- Developing low-cost, low-energy, flexible plastic electronics materials

Technology - Biomimetics

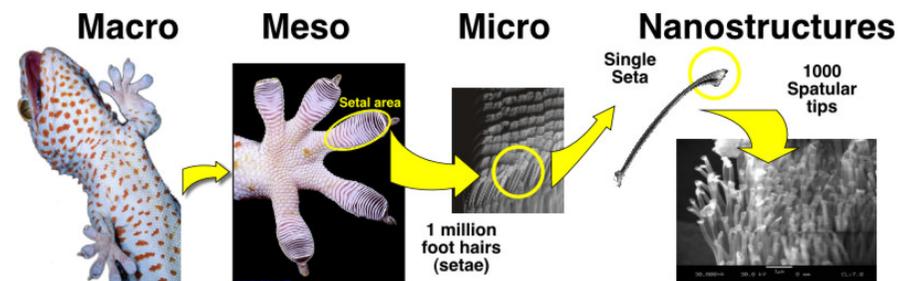


Evolution has solved many complex problems over millions of years, and living systems can deliver amazing functionality.

We can use these living systems as models to suggest new approaches to industrial products and processes. From novel catalysts to termite mound inspired air-conditioning systems. From guidance systems for autonomous vehicles to new optical systems we can learn from biology.

Recently the way geckos can cling to smooth surfaces has been duplicated using polyurethane micro-fibres

Gecko adhesive system



Technology - Biomimetics

Challenges for Society

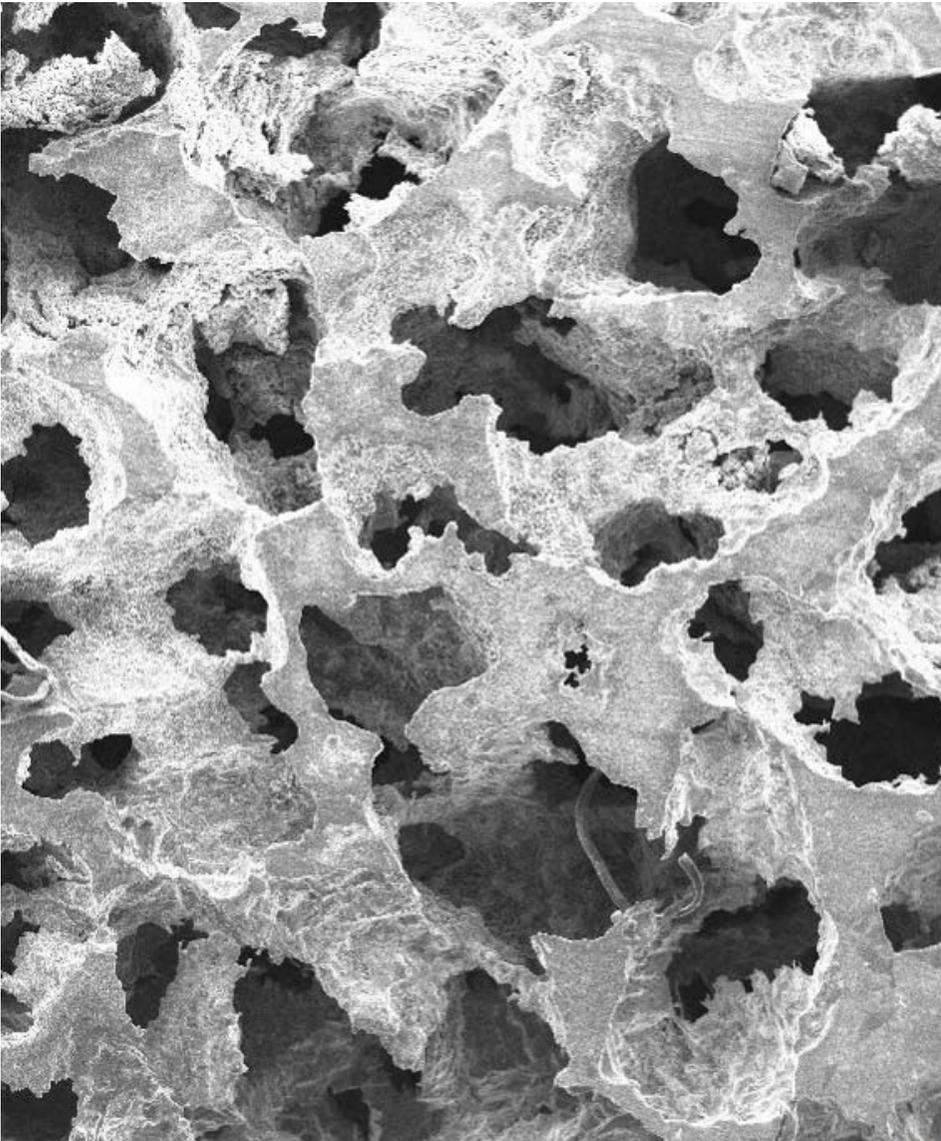
- Profound source of new ideas for innovation
- Loss in biodiversity could reduce examples
- Potential for products based on simpler materials and milder chemistry and processing
- Links into ideas of industrial ecology



Issues for the Chemicals Sector

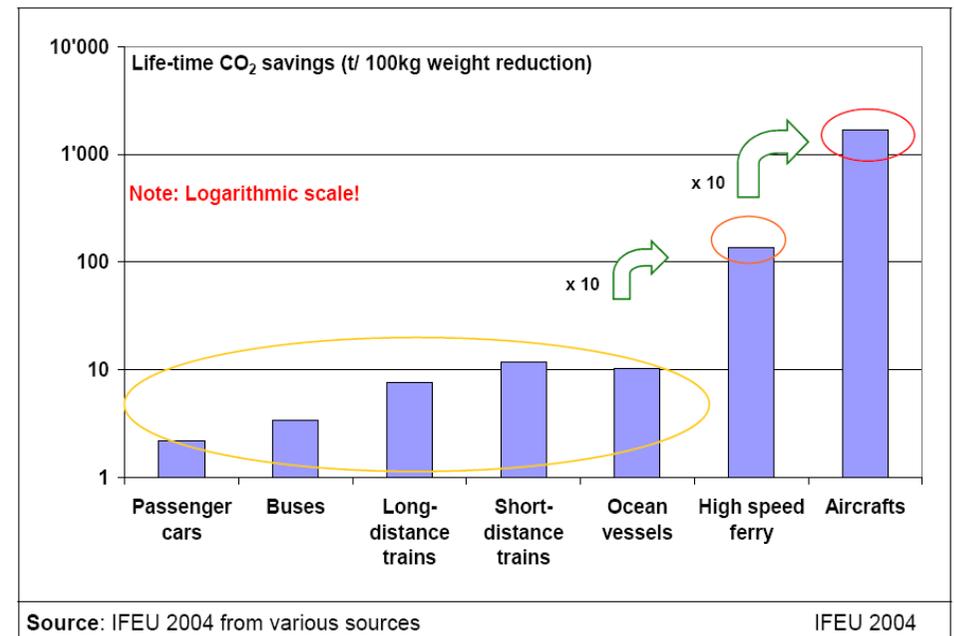
- Linking Biomimetics to the Small Dimensions and nanotechnology theme
- Providing the training to industrial R&D chemists to be able to find the connections and develop new product and service concepts
- Rethinking surfaces – including appearance
- New catalyst opportunities
- New milder processes
- Thinking about evolutionary design in chemistry – linked to Mathsworld

Technology - Lightweighting



Lightweighting – producing the required results with less and less material is having a powerful effect. In transport alone the carbon savings from lightweight structures is enormous, and carbon savings equal lower fuel costs.

Lightweighting offers lower raw material costs, lower in-use costs and lower disposal costs across a wide range of products.



Technology - Lightweighting

Challenges for Society

- Lightweighting without using rare and non-renewable materials
- Understanding full life-cycle impact. What is the trade-off between the 'cost' of manufacture and the 'cost' of use?
- Building more 'intelligence' into products

Issues for the Chemicals Sector

- Developing new materials
- Developing new joining techniques
- Eliminating waste
- Designing in new ways
- Thinking about lifecycle impact of our ingredients and materials on final product
- Identifying opportunities to solve problems for customers

Economic – Globalisation



Globalisation has been a powerful driver of the world economy from the last quarter of the 20th century.

It has led to increased growth and prosperity for many parts of the world, although the benefits have been unevenly distributed across countries and within societies.

Export focused industrialisation has fuelled the growth of many economies, particularly in Asia. In 2004 one container vessel arrived every 3 minutes at the port of Hong Kong.

Globalisation has led to trans-national economic systems where countries are mutually dependent. Through investment, many developed countries are extending their economy to include parts of the economy of other countries. This is particularly true of the offshoring of manufacturing by the US and EU.

Economic - Globalisation

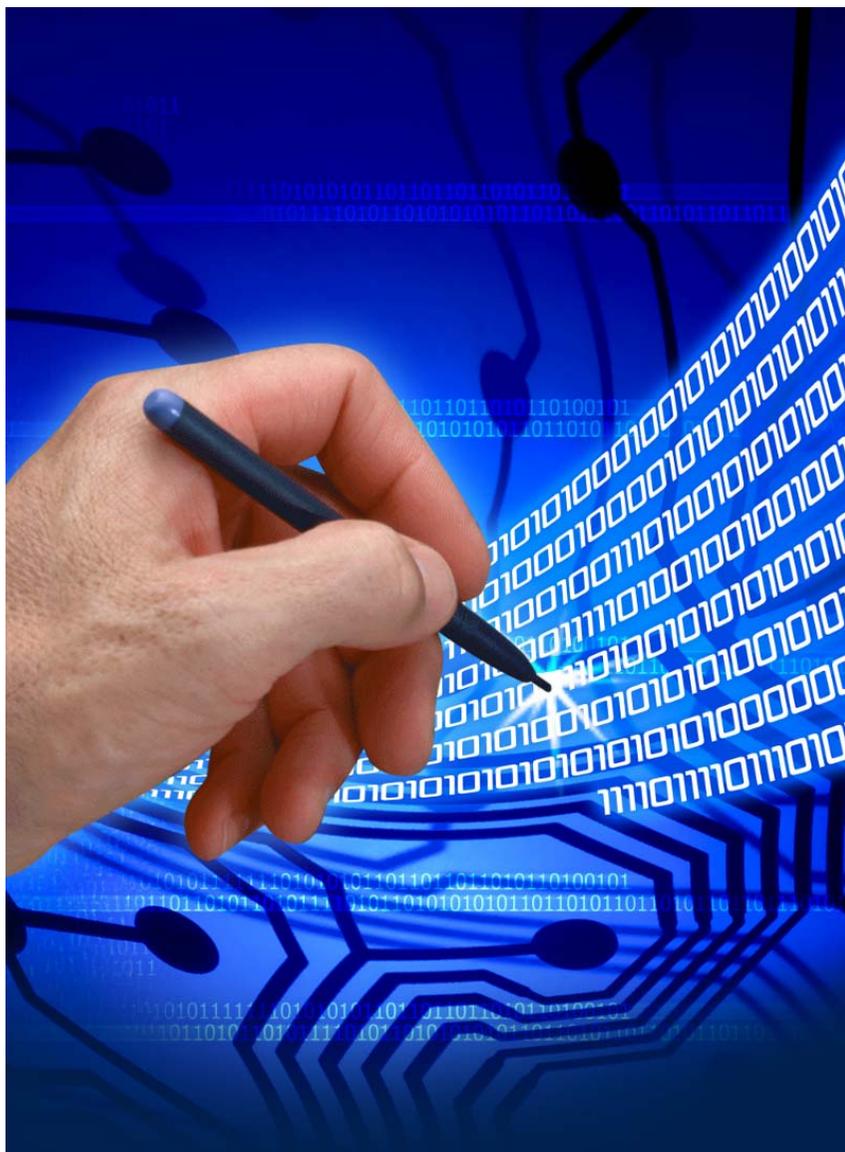
Challenges for Society

- Preventing uneven distribution of benefits
- Avoiding a race to the bottom on standards of all kinds
- Preventing exploitation of vulnerable populations
- Preventing the export of environmental degradation
- Using new industrialisation to raise quality of life
- Encouraging developing countries to invest in services as well as raw materials and manufacturing
- Enabling industrialised countries to cope with the offshoring of manufacturing

Issues for the Chemicals Sector

- Recognising that globalisation provides massive new markets, but markets that are different
- Exploiting the opportunities for off-shore manufacturing to control costs and reach new markets
- Working out what to do in the high wage economies
 - R&D?
 - Marketing?
- Leakage of intellectual property when manufacturing offshore
- Recognising that commodity manufacturing will move close to the feedstocks and developing business models that can adapt to this
- Downstream integration with you customers; wherever they are

Economic – High Value Services



There has been a shift away from manufacturing towards service industries in the developed world. High value services include those where the cost of delivery is low compared to the market value. These include R&D, design, law and the creative industries. Services form an increasing part of the global economy.

- Around 41% of the UK's national income was generated by knowledge based industries in 2002
- UK has one of the highest shares of employment in knowledge-based industries in the EU.
- Between 1995 and 2005 most new jobs in the UK were in knowledge industry services.

Traditionally this sector has been seen as the way that developed countries will cope with manufacturing moving offshore to lower wage economies. However, the OECD points out that 20% of the OECD economies are in service sectors that do not require face-to-face contact and are ICT enabled. These can easily be outsourced to other countries

Economic – High Value Services

Challenges for Society

- Providing the education and skills for high-value services
- Understanding how much of the current 'knowledge economy' can move offshore and preparing for it
- Constantly innovating

Issues for the Chemicals Sector

- Turning the European chemical sector into a high value service
- Learning from success stories like architecture, design, financial services and computer games
- Building on the strengths that we have in process design
- Finding downstream services that cannot easily be replicated offshore. IBM used to be primarily a manufacturer of computers. Now it is primarily a software and services company. Cisco provides the bulk of the switches, routers and other hardware for the internet, but makes almost none of it. It coordinates the process of meeting the customers needs

Economic – The Exploded Business



When Henry Ford set up the River Rouge plant in 1928, it converted cowhide, wood, steel and rubber directly into vehicles in the largest integrated factory in the world. The complex was 1 mile long by 1.5 miles wide, with 100 miles of internal railway track. It employed 100,000 people.

At the time this was the simplest way to work. The cost and complexity of working with many suppliers made centralised and integrated factories the most cost effective.

Now the reverse is happening. Computers, communications and globalisation mean that it is better to farm out different aspect of manufacture to specialist companies – “as the cost of transactions tends to zero, so does the size of the firm”. Today it is possible for a company to have a branded product it does not design, does not make, does not deal with supply chain, order fulfilment, customer service, or repair and maintenance.

Economic – The Exploded Business

Challenges for Society

- Opportunity to bring economic benefit to less active locations
- Avoiding over-specialisation
- Using ICT to enable developing countries to enter this part of the economy
- Avoiding protectionism, particularly in services
- Providing people with the skills to operate in this kind of economy
- Making sure the ICT infrastructure is available and robust
- Modifying models of tax, social care and pensions to fit changing business patterns

Issues for the Chemicals Sector

- Use open innovation effectively
- Form value networks to provide superior customer service
- Focus on the benefits you can provide to the customer not on the products you make
- Outsource everything that does not help you serve the customer
- Use outsourcing to improve flexibility and speed of response
- Become less technical and more market focused
- Seek and work with the best people wherever they are

Economic – New Economic Centres



The balance of the world economy is changing rapidly. Key new economic centres are the BRIC countries; Brazil, Russia, India and China. All have relatively recently embraced capitalism, and have experienced rapid growth. The economies of Brazil and Russia are based on export of raw materials, and on manufacturing in India and China.

Goldman-Sachs predict future size of economies will be:

2007		2050	
Country	GDP US\$ mlns	Country	GDP US\$ mlns
United States	13,843,825	China	78,000,000
Japan	4,282,762	United States	38,500,000
Germany	3,322,147	India	37,600,000
China	3,250.827	Brazil	11,300,000
UK	2,772,570	Russia	9,340,000
France	2,560,255	Mexico	8,580,000

Economic – New Economic Centres

Challenges for Society

- Encouraging growth without instability
- Managing social upheaval of high growth
- Managing changes in the balance of economic power in the developed economies
- Avoiding conflict over access to key raw materials
- Managing migration as people move to new strong economies
- Avoiding environmental degradation in new strong economies
- Managing rapid urbanisation – social, economic and environmental impacts

Issues for the Chemicals Sector

- Identifying new economic centres – as customers for your products and as manufacturing locations
- If other countries are the best place to manufacture and the best place to source raw materials, what are we going to offer?
- These centres will define user requirements for much of the global economy. They will demand the best, but the best for them. Market analysis is critical
- Developing the skills to operate with these new economies – social, language and technical
- Very large pool of new aspirational consumers

Economic – Personal Disposable Income



Driven by high growth rates in the rapidly developing economies, personal disposable income will grow over the next few years.

McKinsey estimate that in India alone, the middle classes (earning between 200k and 1,000k rupees p.a.) will increase from 50 million households today to 583 million by 2025 (a larger market than the EU or the US).

These consumers aspire to the best that the global economy can provide.

Similar patterns are found in all rapidly growing economies across the world.

Despite the current personal debt crisis in many developed economies, personal disposable income continues to grow.

Economic – Personal Disposable Income

Challenges for Society

- How to fund social care?
- How to keep the savings ratio high enough to support growth?
- Avoiding dangerous fragmentation of society through large wealth gaps
- How to meet the aspirations of the population for goods and services whilst delivering a sustainable economy

Issues for the Chemicals Sector

- Global growing market for processed foods, ready meals and fast food.
- Growing global market for healthcare products and services
- Growing global market for education and entertainment
- Having satisfied basic needs, consumers are looking for more emotional benefits from products and services. The chemical sector should have more involvement in branded products, high-quality products and high-touch / high-concept products
- Finding ways to take a share of the growing global middle class by providing aspirational products adapted to cultural preferences
- Helping your customers to innovate in ways that differentiate them from their competition

Environmental – Climate Change



Anthropogenic climate change is now accepted as a reality by the consensus of scientists. According to the IPCC this is probably leading to: increased surface temperatures, rising sea-levels, reduced snow-fall, retreat of the ice-caps and significant shifts in rainfall patterns.

We need to take action to reduce emissions of greenhouse gases to attempt to prevent the climate reaching a 'tipping point'.

We also need to take action to adapt to the climate changes that are already happening. These will affect where and how people live and our ability to feed the global population. They are likely to lead to climate refugees and conflicts. We will need to adapt our infrastructure.

Environmental – Climate Change

Challenges for Society

- Dealing with rising sea-levels when so many people traditionally live close to existing sea-levels
- Managing the shift of agriculture from current high-yield areas to new high-yield areas
- Managing climate induced migration
- Dealing with increasing levels of extreme weather events in densely populated areas
- Managing rising populations at the same time
- Adapting the infrastructure to the new conditions
- Switching the world economy to a low-carbon model

Issues for the Chemicals Sector

- Participating in the switch to a low carbon economy
- Using biomass as a key feedstock instead of petroleum
- Developing low-carbon energy sources and products
- Developing materials for a low-carbon future
- Developing carbon capture and storage
- Increasing overall energy efficiency of the sector
- Reducing energy cost of feedstocks
- Enabling low-carbon agriculture

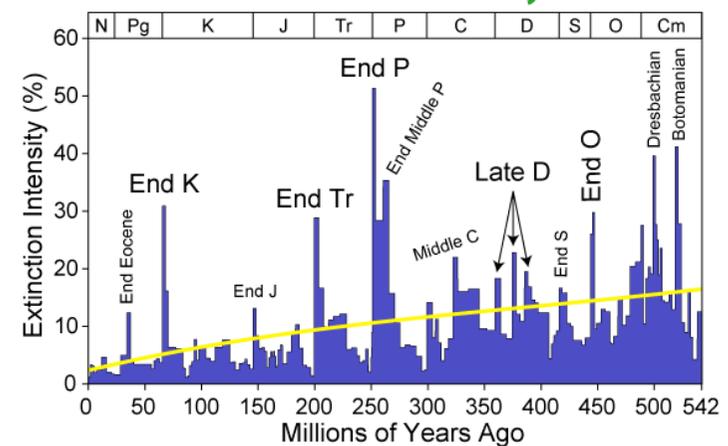
Environmental - Biodiversity



Yangtze River Dolphin – declared extinct August 2007

440 million years ago, 85% of marine animal species were wiped out in the earth's first known mass extinction. 367 million years ago, 70% of marine invertebrates perished. 245 million years ago, 95% of all animals were lost. 208 million years ago, another mass extinction occurred, and 65 million years ago, three quarters of all species vanished. Today, we may be in the 6th great extinction. A man-made one. The average extinction rate is now 1,000 to 10,000 times faster than the rate recorded over the last 60 million years.

Marine Genus Biodiversity: Extinction Intensity



Environmental - Biodiversity

Challenges for Society

- 70% of drugs used today have their origin in natural plant products found in areas of high biodiversity such as rain-forest.
- New therapies are being developed from chemicals found in marine organisms, such as sponges. We have only described and screened a tiny percentage of marine organisms.
- When ecosystems lose biological richness they also lose resilience. They become susceptible to the effects of climate change, invasions of alien species, etc.
- Weak ecosystems will not be able to provide the environmental services we require, such as clean water.
- Lost biodiversity makes our intensive agricultural system vulnerable. Almost all commercial bananas are a single clone.

Issues for the Chemicals Sector

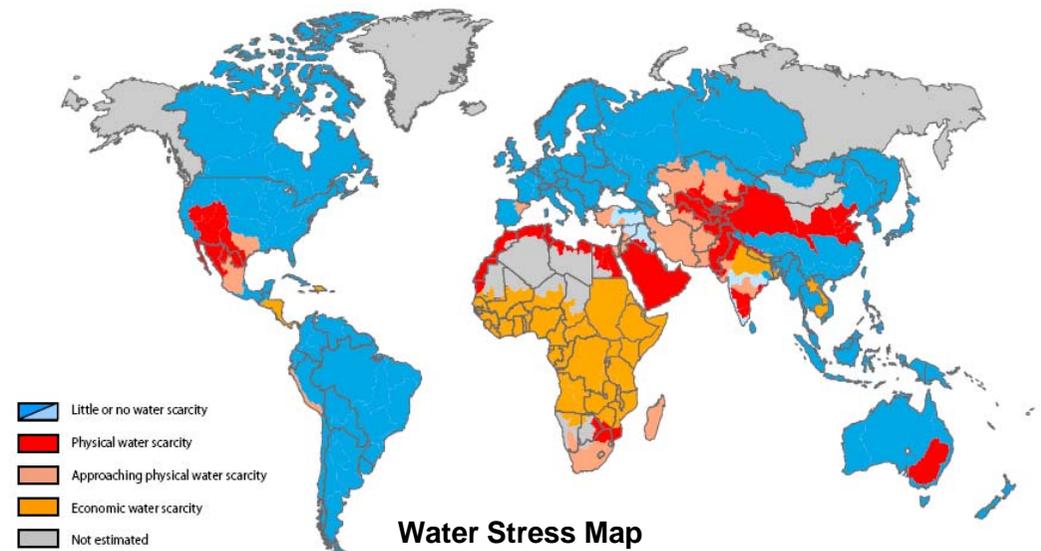
- Developing products and services with low environmental impact.
- Enabling society to reduce its footprint.
- Reducing demand for land and other resources.
- Capturing the diversity of chemicals and materials from the living world before it is lost.
- Rapid screening tools to help identify commercially important resources.
- Methods for preserving genetic information.

Environmental - Water



The amount of water available on the planet does not change significantly. However, it is not always available when it is wanted, where it is wanted and with sufficient quality.

Intensive agriculture is a major problem, abstracting vast amounts of water for irrigation, and polluting water systems. The Aral Sea was once the world's 4th largest freshwater lake. It is now less than 10% of its original size in the 1960's due to diversion of water for crops.



Environmental - Water

Challenges for Society

- Lack of water threatens many key agricultural areas – e.g. the Murray-Darling basin in Australia
- Urbanisation intensifies water demand and creates local water stress. Purification of water is energy and chemical intensive
- Affluence is associated with greater water use
- Growing population demands more water, for food, drinking and other uses
- Water resources spread across national boundaries, leading to conflict over access and use
- Abstraction from many key river systems and aquifers is unsustainable
- Pollution reduces the amount of water resources available for use
- Climate change will probably radically alter patterns of rainfall

Issues for the Chemicals Sector

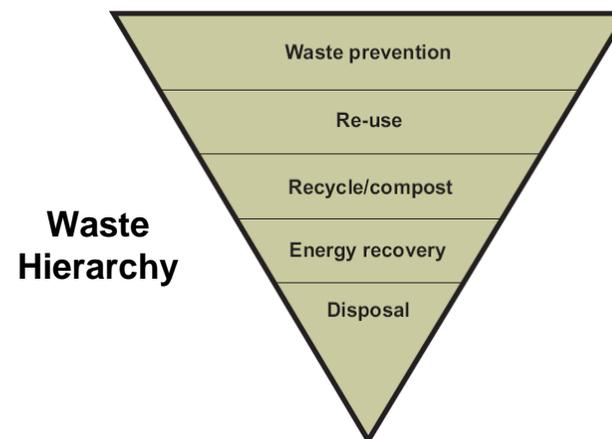
- New low-impact methods for purifying water
- Improved effluent treatment systems to avoid pollution of water systems
- Development of low water methods of cultivation for agriculture
- Development of no-water/low-water processes, or closed loop recycling systems
- Development of no-water/low-water consumer products for cleaning, food processing etc.

Environmental - Waste



Waste presents a problem on many levels:

- Nowhere to dispose of it, and environmental and economic cost of disposal
- Environmental and economic costs of lost raw materials
- Inefficiency in manufacture and use
- Loss of hard to obtain materials
- Ecosystem degradation through overwhelming carrying capacity.



Environmental - Waste

Challenges for Society

- Society is consuming resources at an unsustainable rate
- Consumers want convenience, but must learn to recycle
- We would need the resources of at least three planets to provide the lifestyle of North-Americans to the population of the planet. Need to move to One Planet Living
- UK generates about 100 Mt of waste each year, the bulk of which goes into landfill
- Methane from landfill accounts for 40% of UK's total methane emissions and 3% of GHG in CO₂e
- Critical strategic metals and minerals are dispersed through waste. We need to keep them above ground and in use as long as possible.
- The energy, waste and pollution impacts of producing virgin raw materials are typically much larger than the impacts of recycling

Issues for the Chemicals Sector

- More efficient processes
- Products designed for re-use, re-manufacture and recycling
- New chemicals and materials to ease recycling
- New processes and new business models to extend post-consumer recycling and improve efficiency
- New ways to win metals and minerals from less concentrated sources; including waste
- Lightweighting and improving mass efficiency
- Improving atom efficiency throughout the chemical industry
- New processes that produce high quality products from recycled materials
- Substituting materials to produce less waste, and less hazardous waste

Environmental – Resource Constraints



We are rapidly depleting many key resources that drive our industrial society.

Oil is the most obvious at the moment. Each gallon of gasoline required 98 tonnes of prehistoric biomass, equivalent to the season's growth from 40 acres. 'Peak oil' is the point when production starts to inexorably decline as we fail to find new reserves and what remains gets harder to extract. That point may have already been reached, or it may not arrive until 2050, but it will arrive.

But there are other resources in trouble. Many rarer elements are critical to today's society, but we are rapidly exhausting them. There is a higher concentration of platinum in the dust on the streets of London than in the South African mines it came from, and if we tried to give each Chinese person the same amount of copper to support their lifestyle that is used by Americans, there is not enough copper on the planet.

Environmental – Resource Constraints

Challenges for Society

- We need to reduce dependence on oil. Unexploited reserves are harder to extract and create massive environmental problems (eg oil-shales)
- Control of critical resources gives political power that can be used against other states
- Wars are fought over control of critical minerals. Coltan (columbite-tantalite) has driven the war in the Congo that has led to over 5 million deaths.
- Some of our more environmentally friendly solutions are making us more dependent on limited mineral resources. LCD displays use less energy than CRTs, but based on current reserves we only have about 13 yrs supply of indium left.
- Increased population and the growth of the global middle class will drive higher levels of consumption

Issues for the Chemicals Sector

- Switching from a hydrocarbon to a carbohydrate economy – sourcing key platform chemicals from biomass, either by the fermentation route through sugars, or by pyrolysis to synthesis gas
- Greater energy and material efficiency in products and processes
- Improved methods for recycling strategic metals, and winning from lower concentration reserves
- Beware of solving one environmental impact problem by shifting to a material at risk
- Find base metal catalysts
- Use organic materials instead of metals in products and processes. E.g. plastic electronics

Political – Social Services



The ageing population in much of the developed world is creating a crisis in social services and social care. Most developed economies recognise that they face some sort of pensions crisis as the number of people of working age falls compared to retirees.

There is also the problem of caring for older people. Current models are broken. It has been estimated that to continue to care for older people in the UK the way we do currently, by 2030 every 18-year old would have to be a nurse or a carer.

This leads to an interest in 'assisted living' where services are re-structured to enable older people to live independent lives for much longer

Political – Social Services

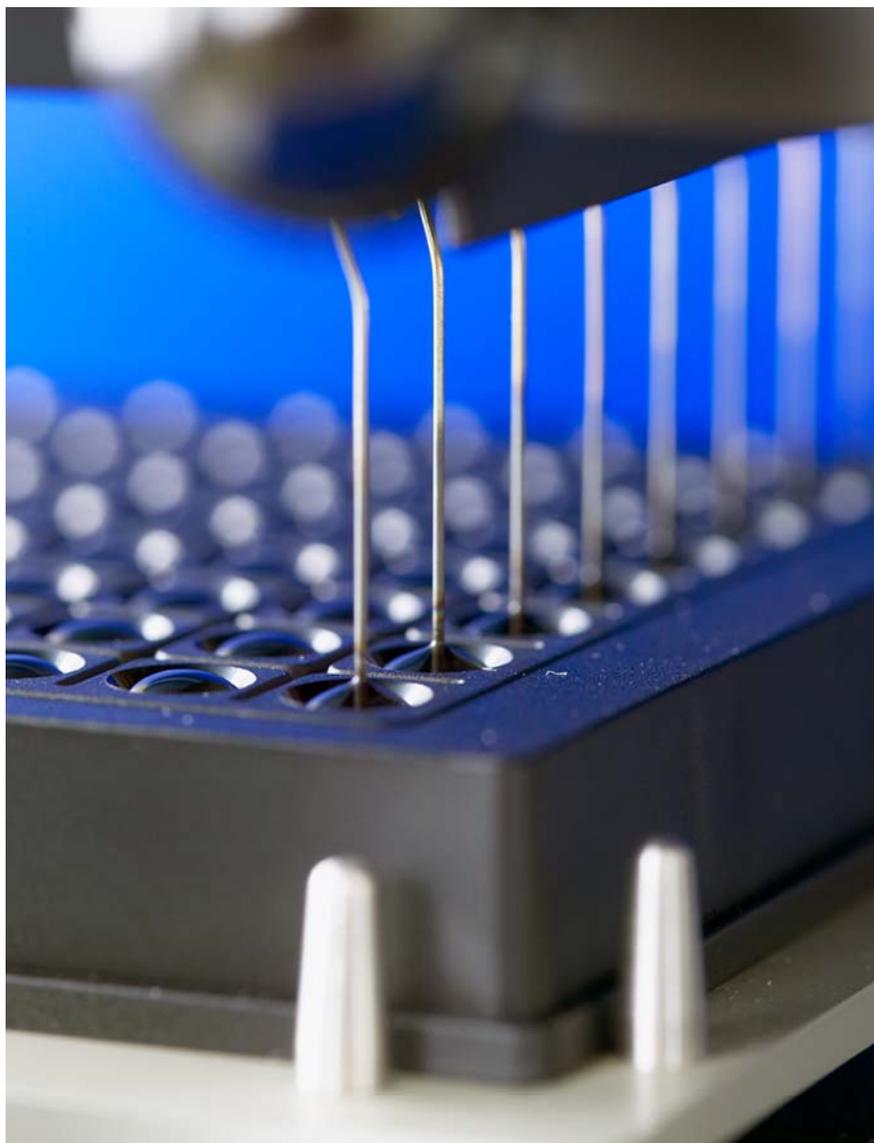
Challenges for Society

- How to meet pension expectations of older people without taxing the young to the point where they move elsewhere
- How to encourage a much higher savings to earnings ratio in a world used to functioning on debt
- How to keep older people independent for longer through 'assisted living'
- Migration to keep the population in balance between workers and retirees

Issues for the Chemicals Sector

- There is a big opportunity for the chemical and chemical using sectors in assisted living. It implies that most of the routine tests currently conducted in hospital, clinic or GP's surgery will have to be conducted in the home. That means opportunities for:
 - Sensors
 - Non-invasive measurement techniques
 - Field test kits
- New drugs and treatments for chronic diseases
- Improved drug delivery systems for safe self-administration
- Nutritional testing and diet supplements

Political - Consumer Protection



Consumers are increasingly risk-averse in many aspects of their lives. They will take risks themselves – bungy jumping and other extreme sports - but will not tolerate people imposing risks on them if they do not see the benefit – GM and pollution.

This results in increased pressure on Governments to provide a safe environment and a population increasingly willing to sue. In the UK, NHS medical negligence claims rose from £1m in 1974 to £477m in 2003. The equivalent of 22,700 extra nurses.

Governments respond by providing ever more stringent legislation to formalise product safety and liability issues to provide consumer protection

Political – Consumer Protection

Challenges for Society

- How to protect the consumer without stifling innovation?
- The proper balance of rights and responsibilities between supplier and user
- Creating legal frameworks that work in a globalised world
- Unintended consequences of well meaning legislation

Issues for the Chemicals Sector

- Emergence of strict liability models
- More stringent safety legislation – e.g. REACH – will continue to develop
- Need to develop new ways to demonstrate safety more quickly, at lower cost and without so much animal testing
- Development of traceability of materials and products to ensure compliance
- Risks arising from counterfeiting
- Opportunities in invisible tagging of products
- Improvement of supply chain management and packaging to prevent loss of containment in transit

Political – Knowledge Competition



World leaders believe that their countries will compete on the skills, level of education and knowledge base of their workforce.

Routinely quoted statistics say that the U.S. is producing 70,000 engineers a year vs. 350,000 from India and 600,000 from China, with a similar pattern in other skill areas. This has been challenged as there is no effective international comparison of qualification standards.

However, it is clear that many of the rapidly developing economies are ramping up education and training to enable them to compete more effectively.

The combination of currently lower salaries and good skills is enabling these countries to move from low-skill manufacturing under the direction of foreigners to a fully fledged knowledge economy. The thing that was supposed to protect the developed world from outsourcing

Political – Knowledge Competition

Challenges for Society

- Particularly for older industrialised nations, there is a major challenge to persuade the population of the value of high levels of education and skill. After all they did not need it in the past!
- Developing large numbers of people who are not merely well-trained, but also good creative thinkers and problems solvers.
- Persuading the people who have been expensively educated to remain in the host economy
- In the developed world to produce people of such a high level of skill that they can outperform competitor nations at much higher cost of employment

Issues for the Chemicals Sector

- Being seen as an attractive career option for the well educated
- Migration as a solution to skill shortages
- Allowing people to work in the sector until later in life to benefit from their experience

Political – Tax Competition



Countries compete with tax rates and concessions to attract business and inward investment. The UK claims to be a low corporate and personal tax environment, but has been under pressure from multinational threatening to move to another jurisdiction where they can get lower rates. A current example is Ireland (see below)

Country	Tax Rate
Japan	40.69%
USA	40.00%
Germany	38.36%
Italy	37.25%
Canada	36.10%
India	33.99%
Belgium	33.99%
France	33.33%
China	33.00%
Spain	32.50%
Australia	30.00%
UK	30.00%
Luxembourg	29.63%
Denmark	28.00%
Sweden	28.00%
Netherlands	25.50%
Austria	25.00%
Ireland	12.50%

Political – Tax Competition

Challenges for Society

- Keeping the tax rate low enough to be attractive
- Keeping the tax rate high enough to meet the needs / requirements of the population
- Being seen to be fair between large and small corporations and between corporations and individuals.

Issues for the Chemicals Sector

- If the effective tax rate in the UK shifts too far from the expectations of multinationals, it may trigger significant shifts in activity in the UK. For the chemical sector this has historically not been too severe a problem as headquarters may shift without moving either manufacturing or R&D. However, there are also many cases in mergers and acquisitions where R&D has moved to be with the head office functions, and those departments closer to the decision making processes tend to be more successful.

Political - Migration



Migration is a major political issue. Developed countries with their ageing populations and low birth rates need migration to maintain their economic performance. And many people want to migrate to better opportunities. However, it is proving difficult to persuade the indigenous populations of these countries of the benefits.

At the same time, population pressures, conflict and climate change are increasing the numbers of refugees and migrants moving around the world. Most of these refugees only move as far as necessary to feel safe. However, even the few that make it to the EU and US are seen as part of a flood of humanity

Political - Migration

Challenges for Society

- Reassuring the indigenous population
- Making the case for economic benefit
- Providing the additional social services that migrants require
- Dealing with language issues and integration into society

Issues for the Chemicals Sector

- Source of additional workforce to overcome labour shortages and skill shortages in the UK economy

Produced for Chemistry Innovation
by
Miller-Klein Associates Ltd
2008



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