



# **The shape of jobs to come**

***Possible New Careers Emerging from Advances in  
Science and Technology (2010 – 2030)***

**Final Report**

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## **Executive Summary**

- 1. Introduction**
- 2. The World in 2030**
- 3. The Science and Technology Horizon**
- 4. The shape of jobs to come**
- 5. Global Survey Findings**
- 6. The shape of jobs to come – Key Implications**
- 7. Conclusions and Recommendations**

## **Appendices**

- 1 The World in 2030 Background Data**
- 2 The Science and Technology Horizon – Key Trends**
- 3 The Science and Technology Timeline 2010 - 2030**
- 4 The shape of jobs to come – Long List**
- 5 Geographic Breakdown of Survey Respondents**

## **Contributors**

## **Sources and References**

## **Report Authors**

# **The shape of jobs to come**

## **Executive Summary**

### **Purpose of the Study**

The purpose of this report is to highlight examples of the kinds of jobs, careers and professions that could result from advances in science and technology in the period from 2010 to 2030. The report was commissioned as part of the Science: [So what? So everything] campaign which aims to promote public interest in science and engineering and highlight their importance to the UK's future. Science: [So what? So everything] is funded by the Department for Business Innovation and Skills and supported by a wide range of individuals and organisations.

To help identify and understand the jobs of the future, the study has undertaken a short science and technology 'horizon scanning' exercise. The aim was to identify a sample of key science and technology trends and developments that could occur over the next twenty years and create a timeline highlighting when such developments may come to maturity.

### **An Era of Opportunity**

The study highlights that we are entering a new era for science and technology. The combination of rising public understanding of and trust in science, the benefits being felt across all aspects of our lives and the rapid pace of advances being made across a number of new disciplines are helping to raise prominence in the public domain. For the longer term, the centrality of science and technology in helping to tackle the most pressing planetary challenges from poverty to clean water, environment to human health, climate change to energy supply and housing to transport are ensuring that science and technology are at the heart of the sustainable development debate.

### **New Markets New Jobs**

Commercially, it is clear that science and technology can spur innovation, transform existing industries, create new business models and give birth to entire new sectors – underpinning the economic importance to developed and developing economies alike. The scale of potential impact has led to a massive increase in science funding from the public and private sector globally. This increased funding is fuelling the growth of opportunities to work in existing disciplines, in emerging sectors and in the jobs of the future which will result from developments on the horizon.

### **New Issues New Debates**

The scope of this study was focused on presenting a representative spectrum of future science and technology developments and highlighting the kinds of jobs that could emerge as a result. We recognise that many of these developments could be considered contentious. Naturally, serious consideration will be required of the broader societal implications of these developments. Lively public debate must take place around important areas of potential concern such as nano-technology, human enhancement and Genetically Modified (GM) foods. The report has not attempted to prejudge or deliver verdicts on such key issues - however the possible future jobs identified in this report do illustrate some aspects of the potential impact of science on our lives.

### ***The shape of jobs to come - Survey Findings***

A process of consultation was used to identify an initial long list of future jobs from which twenty were selected and profiled. These profiles formed the basis of an online survey. The survey focused on assessing the popularity, job impact, environmental impact, educational benefits, developing country benefits, financial rewards and attractiveness of the twenty jobs. The survey attracted 486 responses from 58 countries on 6 continents – including 104 from the UK – representing 21% of the total sample. The highlights of the survey are that:

- ‘Old Age Wellness Manager / Consultant’ was considered the most popular career choice both globally (41%) and amongst UK respondents (34%). This was the role expected to create the most jobs – being selected by 48% of global respondents and 49% from the UK
- ‘Quarantine Enforcer’ was considered the least popular career choice both globally (50%) and in the UK (48%)
- ‘Climate Change Reversal Specialist’ is expected to deliver the greatest environmental benefits both globally (71%) and by UK respondents (70%)
- The role expected to deliver the greatest benefit to human health and wellbeing was also ‘Old Age Wellness Manager / Consultant’ – gaining the support of 69% globally and 73% in the UK
- ‘Farmer of Genetically Engineered Crops and Livestock’ was considered the role most likely to deliver benefits to developing economies by global respondents (54%) and those from the UK (61%)
- ‘Alternative Vehicle Developers’ were expected to make the greatest contribution to driving commercial innovation and economic growth – gaining support from 52% globally and 51% of UK respondents
- The role considered likely to be the best paid globally was ‘Nano-Medic’ (45%), whilst in the UK the preferred option was ‘Virtual Lawyer’ (59%)
- ‘Space Pilots, Architects and Tour Guides’ were considered the most aspirational roles amongst respondent globally (48%) and in the UK (43%)
- When asked to select the role that would have the most impact on their domestic economy, the most popular choice both globally (37%) and in the UK (41%) was ‘Farmer of Genetically Engineered Crops and Livestock’.

The top five roles that respondents would most like to see materialise were:

- ‘Old Age Wellness Manager / Consultant’
- ‘Vertical Farmer’
- ‘Nano-Medic’
- ‘Climate Change Reversal Specialist’
- ‘New Scientists Ethicist’

The five roles that respondents would least like to see materialise were:

- ‘Quarantine Enforcer’
- ‘Personal Brander’
- ‘Farmer of Genetically Engineered Crops and Livestock’
- ‘Weather Modification Police’
- ‘Climate Change Reversal Specialist’.

The response to the global survey suggests these roles can individually and in various combinations make a significant contribution to tackling the care challenges of an ageing society, feeding a growing population and maintaining and enhancing our health. They are also seen as essential to giving us greener mobility solutions and reducing the impact of dangerous climate change. Finally they are expected to help us survive and thrive in the cyberworld, whether through legal protection, counselling or management of our virtual data and 'personal brand image'. As a result, the survey suggests that many of these roles will be popular, well-rewarded and aspirational.

### **Assessing the Implications**

A number of prominent futurists were invited to comment on the implications of these new roles for governments, businesses and society. The futurists emphasised the need to encourage a mindset shift and facilitate the change in all our thinking and in our education systems in particular to bring about such new roles. Equally important was recognition of the critical role of commercial viability in determining which areas of science and which careers will progress. Finally, specific fields which were expected drive significant job creation were the shift to a low carbon economy, artificial intelligence, augmented reality, social media, personalisation and the opening up of space as a commercial opportunity.

### **Conclusions**

We hope that this report acts as a useful stimulus for raising public interest in and discussion of the key role science and technology will play in shaping the world around us and in creating new jobs and career opportunities over the next twenty years. Target audiences for this material include students of all ages, parents, teachers and those who might want to retrain for a new career. The aim is to encourage children and young people in particular to research forthcoming science and technology developments, imagine the kinds of jobs they will create and explore how these developments could help tackle a number of the 'grand challenges' facing our planet.

# 1. Introduction and Objectives

The purpose of this report is to highlight examples of the kinds of jobs, careers and professions that could result from advances in science and technology in the period from 2010 to 2030. The report was commissioned as part of the Science: [So what? So everything] campaign which aims to promote public interest in science and engineering and highlight their importance to our future. The specific objectives were to:

- Conduct a brief 'horizon scan' to identify a sample of key advances in science and technology that are anticipated in the period from 2010 to 2030
- Develop a timeline indicating the timeframes in which these developments might come to maturity
- Identify a long list of 'jobs of the future' - highlighting 'Jobs that don't yet Exist' and current jobs that could become more prominent over the next two decades as a result of these advances
- Develop more detailed profiles of a representative sample of twenty jobs – highlighting what a 'day in the life' of these professions might involve
- Invite a global audience of future thinkers to assess the value, impact and attractiveness of these twenty roles using an online survey.

## 1.1 Report Structure

The report is presented in seven main sections and five appendices:

*Section 1 – Introduction and Objectives* - Here we outline the rationale for the report and explain the methodology adopted.

*Section 2 – The World in 2030* - Explores ten major patterns of change that will shape our world over the coming two decades, identifies some of the resulting opportunities and implications for science and technology and introduces a non-exhaustive list of 110 future jobs that could emerge as a result.

*Section 3 – The Science and Technology Horizon* - Provides a short introduction to the key areas of science and technology development that were examined to help identify '*The shape of jobs to come*'.

*Section 4 – The shape of jobs to come* - Explains how the list of 110 jobs was compiled and presents the profiles of a 'day in the life' of a representative sample of twenty jobs that highlight the range and nature of the opportunities that are emerging.

*Section 5 – Global Survey Findings* - Presents the findings of a global survey that was run to assess future thinkers' views on the impact and implications of the sample of twenty jobs.

*Section 6 – The shape of jobs to come – Key Implications* – Presents the views of a range of futurists from around the world on the implications of these developments and job opportunities and how best to prepare for the resulting changes we face in the coming decades.

*Section 7 - Conclusions* - Draws some brief conclusions from the study.

*Appendix 1 - The World in 2030 Background Data* - Provides short descriptions of the key underlying trends and developments for the ten patterns of change presented in section 2.

*Appendix 2 – The Science and Technology Horizon- Key Trends* - Presents a short overview of a representative selection of key trends in each of the areas of science and technology that were examined for this report.

*Appendix 3 – The Science and Technology Timeline 2010 – 2030* - Sets out a development timeline, showing the earliest point at which these fields of endeavour might reach maturity.

*Appendix 4 – The shape of jobs to come – Long List* - Presents short summaries of the 110 future jobs that were identified as part of this study.

*Appendix 5 – Survey Respondents* - Identifies the full list of countries that took part and the number of respondents by country.

## **1.2 Science and Technology for a World in Transition**

To some, the tail end of an economic downturn might seem like an odd time to be taking an imaginative look forward at *The shape of jobs to come* as a result of science and technology advances over the next two decades. However, an alternative view is that now is the perfect time to focus on the positive opportunities and developments that could lead us into recovery, create new professions and help shape a powerful vision of what can be achieved through investment in science and technology excellence in the coming decades.

As nations across the globe emerge from the economic crises, there is a growing focus on choosing the right levers to pull in order to restore confidence, restart economic growth and steer the planet on a path towards sustainable development. As a result, there has been a clear emphasis on the role of science and technology in shaping and sustaining the recovery. For example new monitoring systems and complexity management tools are seen as critical to establishing better regulatory control of the banking system.

Beyond fixing the causes of the current crisis, perhaps an even more important role is that envisaged for science and technology in facilitating growth by providing a stream of advances and innovations across every sector. These developments will lead to the transformation of many industries such as car manufacture and spawn new sectors such as nano-chemistry, quantum computing and integrative fields such as the much vaunted NBIC convergence (nanotechnology-biotechnology-information technology-cognitive science).

Perhaps most critical of all is the role science and technology is expected to play in solving the challenges facing an increasingly interconnected and co-dependent world. Governments globally are increasingly challenged by the issues of feeding a growing planet, educating our children, providing new housing solutions, delivering alternative clean energy sources, solving our need for efficient transport, ensuring our security and tackling dangerous climate change. Science and technology are seen as central to providing effective, affordable and sustainable solutions to all of these challenges and more.

The good news is that governments are not simply stacking these challenges up at the laboratory door and walking away with hope as their only strategy for how to address them! Across the world, science and technology has been a major recipient of funding in government economic stimulus packages. Examples included 900M Euros (£831M) in Germany, 731M Euros (£675M) in France and 685M Euros (£632M) in Norway. A significant proportion of China's 10Tn Yuan (£0.9Tn, 1Tn Euros, US\$1.5Tn) stimulus package was also

channelled into science and technology investment.<sup>1</sup> 'Green' technologies and solutions have also received significant support – particularly from East Asian governments. Notable examples include South Korea, which is apparently allocating 81% of its recovery funds to green initiatives and China, which is setting aside 34% for eco-projects.<sup>2</sup> At the same time, Japan has targeted a doubling of the number of green sector jobs to 2.8 million over the period from 2008 to 2020.<sup>3</sup>

Governments, corporations and investors alike are recognising that science and technology innovation can drive growth, create new jobs and facilitate wealth creation. The investments being made are creating well funded facilities in research centres and laboratories around the world. Furthermore, technology itself is facilitating collaboration between scientists across the globe on an unprecedented scale. We are also entering an era where science and technology will assume far greater prominence in our lives and will play a more central role in everything we do. As a result, society's expectations will be raised as to how effectively and how quickly science and technology can meet our ever expanding needs and desires and tackle persistent problems for humanity and the environment.

The combination of global need, funding and societal expectations makes this a tremendous time to be considering a career in one of the many existing science and technology disciplines that exist today and those new professions that will emerge in the coming decades. This horizon scanning report seeks to provide initial insights into some of the domains of science and technology that will open up to those that want to go into the field. Equally importantly, the report tries to bring to life what these new roles might involve.

### **1.3. Study Methodology**

The project was conducted between mid-August and early October 2009. The first phase involved horizon scanning to identify potentially key science and technology trends and developments for the next two decades. The aim was to draw on a wide range of authoritative sources citing well referenced examples of science and technology developments on the horizon. As such, extensive use was made of the UK Government Horizon Scanning Centre (HSC)<sup>4</sup> outputs – most notably the Delta and Sigma horizon scans of emerging trends and developments. Other key sources used extensively included MIT's Technology Review<sup>5</sup>, the BT Technology Timeline<sup>6</sup> and TechCast<sup>7</sup> – an acknowledged resource pooling expert knowledge on science and technology forecasts.

This scan resulted in the list of trends and the timeline presented in appendices 2 and 3. In addition, an initial long list of 110 future jobs was identified and profiled in brief. A short list of ten jobs were then selected and shared for review with colleagues in the Association of Professional Futurists. The list was also presented to Fast Future's own global network. This comprises over 20,000 people from a variety of professions and sectors who have an interest in the trends and factors shaping our future. Both groups were asked to provide their comments on the list of ten jobs and identify additional jobs that might be created in future as a result of advances in science and technology.

The long list of future jobs was refined and expanded with the feedback received. A list of twenty jobs were then selected as being representative of the breadth, scope and impact of the jobs that would be created or become more prominent in the future. An online survey was then run from August 12<sup>th</sup>-21<sup>st</sup> 2009. The survey attracted 486 responses from 58 countries on 6 continents. Of these 65% were male and 35% female.



Survey respondents were asked to evaluate the attractiveness and impact in a variety of fields from human health to the environment. Survey participants were also asked to provide their views on what a day in the life of these roles might involve and to suggest additional roles they could see emerging in the coming two decades. The invitation to take part in the survey was distributed to Fast Future's global network and promoted via various social networks and to the mailing lists of a number of fellow futurists.

## 2. The World in 2030

To help set the context for this review of emerging science and technology developments, it is important to look at the range of trends, forces, developments and ideas that could shape our world in the period to 2030. In this section we identify ten major patterns of change which will have an important bearing on everything from governance systems to the food we eat. We explore the opportunities and implications for science and technology resulting from these patterns of change and introduce the jobs that could emerge as a result.

### 2.1. The Ten Patterns of Change

In a short study of this nature it was not possible or appropriate to conduct an original horizon scan of factors shaping the next two decades. Instead we chose to adopt an existing scanning framework which we use and keep updated on a continuous basis. This framework takes the key global trends and developments shaping our world and groups them under the following ten key patterns of change<sup>1</sup>:

1. Demographic Shifts
2. Economic Turbulence
3. Politics Gets Complex
4. Business 3.0 – An Expanding Agenda
5. Science and Technology go Mainstream
6. Generational Crossroads
7. Rethinking Talent, Education and Training
8. Global Expansion of Electronic Media
9. A Society in Transition
10. Natural Resource Challenges

A brief description of the key features of each pattern of change is presented in Table 1 below. A short summary of the key underlying trends is presented at Appendix 1. Each of these patterns of change, or ‘drivers’, is a strong and influential force in its own right. However, it is the interactions between them that generate both opportunity and challenge. For example, the rising living standards being achieved by Asia’s growing population is clearly something to be strived for. The challenge is the pressure this places on natural resources and the planet’s ability to service these demands. Investment in science and technology is seen a critical to achieving sustainable growth and development. When we layer in the economic, political and societal dimension, we see just how complex the interconnection is between the patterns of change.

Collectively, an analysis of these drivers tells us that the world in 2030 will see significant economic and political power shifts. Indeed, we can envisage many possible scenarios for exactly what the global economic, political, social, environmental and scientific landscape will be. However, whilst scenario development was beyond the scope of this study, we can posit a number of likely features of what might be considered the ‘central’ or expected scenario in 2030:

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<sup>1</sup> The ten patterns of change were developed on a project commissioned by the American Society of Association Executives and the Center for Association Leadership. The resulting book – *Designing your Future – Key Trends, Challenges and Choices for Association and Nonprofit Leaders* was published in August 2008.

### *Economic*

- Further economic turbulence and potential downturns between 2010 – 2020, followed by a more stable period to 2030 as excessive risks have been removed from the financial markets and most economies have repaired their finances
- Sustainable growth is still the dominant driver for most economies
- China could be the biggest global economy and India the fourth largest
- Public sector debt has been a major issue until at least 2020 for developed economies in particular
- Globalisation and interconnectivity between companies and value chains will continue to increase
- Major new industry sectors emerge as a result of advances in science and technology

### *Political*

- No major new multi-nation global conflicts
- National geographic boundaries of the current G20 economies are largely similar to today
- Global institutions such as the UN, IMF and World Bank still carry influence – although other strong institutions now exist on a regional basis in Asia, Africa the Middle East and Latin America
- Security, environment and sustainability challenges remain prominent concerns

### *Socio-Demographic*

- A global population of 8.3 billion, with 723 million in Europe and 68 million in the UK<sup>8</sup>
- Global social challenges remain around poverty, hunger, health and education

### *Environmental*

- Alternative (non-nuclear) energy sources will be common in vehicles, homes and businesses – supplying 20-40% of all demand in most developed economies
- Demand for food and energy are expected to jump 50% compared with 2009 levels<sup>9</sup>
- Fresh water demand could rise 30% on 2009 levels<sup>10</sup>
- Without adaptation to the impacts of climate change, Southern Africa could see declines in production of 15% for wheat and 27% for maize<sup>11</sup>

### *Science and Technology*

- Advances in flight technology have shortened travel times
- Scientific progress and new technological advances continue to accelerate (e.g. biotechnology, nanotechnology, next generation computers).
- Advances in experiential technologies will lead to widespread use of developments such as virtual worlds, holograms, 3D projection, 3D television, virtual reality and interactive surfaces.

The implication of these projected developments and trends is that the demands on science and technology are only like to increase over the period. For those working in these fields, the expectation should be for more public scrutiny of their work, greater accountability and a constant need to demonstrate the economic and social benefits of the particular field of science and technology being pursued.

## **2.2. Identifying the Opportunities – Implications for Science and Technology**

For each of these patterns of change, there are a range of opportunities which can be addressed through science and technology advances and a number of resulting implications for scientists, technologists and society as a whole. Some examples of these key opportunities and implications are highlighted in the second column of Table 1 below. Column three sets out an attempt to map the long list of 110 future jobs from Appendix 4 to the ten patterns of change, and the resulting opportunities and implications. A source reference and explanation is provided for all of these roles in Appendix 4. Clearly each job could be mapped against more than one of the opportunity and implication clusters.

**Table 1 – Global Change Drivers Mapped to Science and Technology opportunities and Implications and Possible Future Jobs**

Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
<b>Demographic Shifts</b> <ul style="list-style-type: none"> <li>• Global population growth</li> <li>• Increasing life expectancy</li> <li>• Increasing urbanization</li> <li>• Ageing societies</li> <li>• More ethnically diverse populations</li> </ul>	<ul style="list-style-type: none"> <li>• Addressing basic needs of a growing planet – e.g. feeding, health, housing, education, energy, water, sanitation and transport</li> <li>• Serving specific needs of an ageing population – health monitoring, joint and organ replacement, wellness and mobility</li> <li>• Potential to extend human lifespans and support people working past retirement (e.g. nutritional supplements, prosthetic replacements, memory enhancement)</li> <li>• Understanding of human genome opening up potential for targeted cures and personalised medicine</li> </ul>	<ul style="list-style-type: none"> <li>• Genomics Developer / Architect / Baby Designer</li> <li>• Body Part Maker</li> <li>• Farmer of Genetically Engineered Crops and Livestock</li> <li>• Old Age Wellness Manager/Consultant Specialists</li> <li>• Personal Body Weight / Obesity Consultant</li> <li>• Longevity Providers</li> <li>• Cryonics Technicians</li> <li>• Insect-Based Food Developers, Chefs, Nutritionists</li> <li>• Population Status Manager</li> <li>• Monorail Designer</li> <li>• Socialization/Culturalization Therapists</li> <li>• End-of-Life Planner</li> </ul>
<b>Economic Turbulence</b> <ul style="list-style-type: none"> <li>• Legacy of economic downturn – decade of turbulence</li> <li>• Closer integration of global economy</li> <li>• New economic powers emerging</li> <li>• Redistribution of wealth around the planet</li> </ul>	<ul style="list-style-type: none"> <li>• Higher S&amp;T funding to stimulate economic growth</li> <li>• Funding for and creation of new S&amp;T based industries and businesses</li> <li>• Facilitate country transformation through S&amp;T (e.g. Singapore, Ireland, UAE)</li> <li>• Major investment required in infrastructure – transport, power, water, sanitation, distribution. Requires S&amp;T innovation to reduce construction and operating costs, accelerate implementation, improve lifetime performance and increase</li> </ul>	<ul style="list-style-type: none"> <li>• Bioinformationists</li> <li>• Genetic Hacker</li> <li>• Weather Modification Police</li> <li>• Knowledge Broker</li> <li>• Virtual Police</li> <li>• Holographer</li> <li>• Teleportation Specialists</li> <li>• Water Traders</li> <li>• Desert Land Rights Trader</li> <li>• Currency Designer</li> </ul>

Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
	resilience <ul style="list-style-type: none"> <li>• Harnessing of S&amp;T innovation to drive opportunity for world's poorest – generation of micro-businesses and micro-payment systems</li> <li>• Application of S&amp;T to enable growth without harmful environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>• Unconditional Basic Income (UBI) manager</li> </ul>
<b>Politics Gets Complex</b> <ul style="list-style-type: none"> <li>• Rising number of global issues requiring co-ordinated global solutions – social, environmental, financial, security</li> <li>• Increasingly complex domestic agendas</li> <li>• Pressure on public funding</li> </ul>	<ul style="list-style-type: none"> <li>• Requires decision support systems to facilitate global issue scanning and monitoring, comparative assessment of risks, solutions, costs and benefits</li> <li>• Opportunity for collaborative decision making support systems to aid co-ordinated choice making and action planning across governments</li> <li>• Growing roles for smart sensors to monitor environments, infrastructure, battlefields</li> <li>• Counter-terrorism and surveillance</li> <li>• Post-conflict clean up (e.g. clearance of land mines, cluster bombs and toxic debris)</li> <li>• Border monitoring</li> <li>• Development of conflict alternatives (e.g. simulations, war games)</li> </ul>	<ul style="list-style-type: none"> <li>• Quarantine Enforcer</li> <li>• Climate Change Compliance Auditor</li> <li>• Business Consultant for Climate Change Compliance</li> <li>• In-House Simplicity Experts</li> <li>• Complex Security Integrators</li> <li>• Mind Reading Specialist</li> <li>• Virtual Police</li> <li>• Infrastructure Specialists</li> <li>• Societal Systems Designer</li> <li>• Currency Designer</li> <li>• Non-military Defence Specialists</li> <li>• Privacy Protection Consultants</li> </ul>
<b>Business 3.0 – An Expanding Agenda</b> <ul style="list-style-type: none"> <li>• Increasingly global opportunities and competition</li> <li>• Pressure to address 'triple bottom line' of people, planet, profits</li> </ul>	<ul style="list-style-type: none"> <li>• Creation of new business sectors and opportunities within them (e.g. nano-medicine)</li> <li>• Opens up entirely markets (e.g. space exploration)</li> <li>• Overthrows industry assumptions and practices (e.g. vertical farming, hypersonic travel)</li> <li>• S&amp;T drives business model innovation</li> <li>• Greater need for S&amp;T 'horizon scanning' in every</li> </ul>	<ul style="list-style-type: none"> <li>• Complexity Analyst / Gaianologist</li> <li>• Chief In-Company Health Enhancement Officer</li> <li>• In-Company Gene Screener</li> <li>• In-Company Sustainability Coordinator</li> <li>• Recycling Analyst</li> <li>• Social Network Analysts</li> <li>• Global Work Process Coordinators</li> <li>• Chief Networking Officer</li> </ul>

Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
<ul style="list-style-type: none"> <li>• Ever-widening technology choices</li> <li>• Increasing role of networks and partnerships</li> <li>• Disruptive business models</li> </ul>	<ul style="list-style-type: none"> <li>• sector</li> <li>• Demands 'open innovation' approaches to accelerate and diversify idea generation and solution development</li> <li>• Patents can be rendered obsolete more rapidly by breakthrough developments</li> </ul>	<ul style="list-style-type: none"> <li>• Spaceline Pilots</li> <li>• Spaceport Designers</li> <li>• Space Tour Guides</li> <li>• Terraformer of the Moon and Other Planets</li> <li>• Space Architect</li> <li>• Astrogeologists, Astrophysiologists and Astrobiologists</li> <li>• Director of Responsible Investment</li> <li>• Executive VP Foresight, Oversight and Governance</li> </ul>
<p><b>Science and Technology go Mainstream</b></p> <ul style="list-style-type: none"> <li>• Nations competing on innovation</li> <li>• Major stimulus package investments in S&amp;T</li> <li>• 'Advanced' science increasingly permeating our daily lives</li> <li>• Technology becoming central to middle class lifestyles</li> </ul>	<ul style="list-style-type: none"> <li>• Increased funding broadens research base, increases opportunities for researchers and drives innovation</li> <li>• Greater emphasis on S&amp;T in national economic strategies</li> <li>• Countries seeking to develop excellence in key S&amp;T niches – increases competition, encourages innovation and drives up standards</li> <li>• Greater demands placed on S&amp;T to provide a return on the investment and solve key challenges for society and business</li> <li>• Increased public awareness raises societal expectations of what S&amp;T will deliver</li> <li>• New products and solutions will be developed to problems that were previously intractable</li> <li>• S&amp;T advances generate their own needs (e.g. use of virtual worlds and virtual reality to teach nanochemistry)</li> <li>• Risk of over-reliance on S&amp;T in place of human</li> </ul>	<ul style="list-style-type: none"> <li>• Personal Enhancement Advisors</li> <li>• Nano-Medic</li> <li>• Telemedicine Technician</li> <li>• Biometric Identification Specialist</li> <li>• Experimental Petrologist</li> <li>• Machine Linguist</li> <li>• Quantum Computing specialist</li> <li>• Professional VR Citizen</li> <li>• Robot Designers / Trainers</li> <li>• Robot Mechanic</li> <li>• Robot Counsellors</li> <li>• Synthetic Life Designer / Scientist / Engineer</li> </ul>

Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
<b>Generational Crossroads</b> <ul style="list-style-type: none"> <li>Increasing lifespans require people to work past retirement age</li> <li>Five generations in the workforce for the first time</li> <li>Marked differences across generations - needs, expectations, communications styles, technology preferences, values and world views</li> <li>Challenge of managing multi-generational workforces</li> <li>Talent gap posed by retirement of Baby Boomers (born 1946 – 64)</li> </ul>	<p>judgement</p> <ul style="list-style-type: none"> <li>S&amp;T may provide solutions to facilitate improved cross-generational working</li> <li>Tools required to help and support people working past retirement (e.g. translators to help interpret language of younger colleagues)</li> <li>Science can provide better understanding of physiological and chemical differences between brain functions and thought patterns of different generations</li> <li>Virtual world simulations could help in training staff to work with different generations</li> </ul>	<ul style="list-style-type: none"> <li>Personal Enhancement Advisors</li> <li>Memory Augmentation Surgeon</li> <li>Mind Reading Specialist</li> <li>Intelligent Agent Designers and Managers</li> <li>Virtual Personal Shopper/Shopping Assistant</li> <li>Social 'Networking' Worker</li> <li>Socialization/Culturalization Therapists</li> </ul>
<b>Rethinking Talent, Education and Training</b> <ul style="list-style-type: none"> <li>Growing talent gap</li> <li>Education a critical priority for developing nations</li> <li>Rising concerns over educational performance in some countries</li> <li>Increasing importance of</li> </ul>	<ul style="list-style-type: none"> <li>Major growth in numbers of S&amp;T teachers, lecturers and researchers required</li> <li>New insights in how we learn will drive development of accelerated learning solutions and enable far greater personalisation of learning – particularly online</li> <li>ICT seen as critical to closing educational gap for developing economies and providing access to learning in remote areas</li> <li>Virtual worlds and simulations seen as critical to</li> </ul>	<ul style="list-style-type: none"> <li>Avatar Manager / Devotees</li> <li>Human to Machine Interface Controller</li> <li>I Knowledge Guide</li> <li>Cybrarians</li> <li>Personal Learning Programmer</li> <li>Enhanced Games Specialist</li> <li>Memetics Manager/Analyst/Trader/Generator</li> </ul>



Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
<ul style="list-style-type: none"> <li>lifelong learning</li> <li>Better understanding of how we learn driving breakthroughs in accelerated learning</li> <li>Rapid growth in take up of online learning</li> </ul>	<ul style="list-style-type: none"> <li>experiential learning from medicine to ship repair</li> </ul>	
<b>Global Expansion of Electronic Media</b> <ul style="list-style-type: none"> <li>More global users</li> <li>More connected</li> <li>More devices</li> <li>More functionality</li> <li>Mobile phone becoming 'remote control for life'</li> </ul>	<ul style="list-style-type: none"> <li>Enables increasing proportion of the global population to access the digital world</li> <li>Advances in Internet and Web 2.0 facilitate innovation services, business processes, business models, and conduct of government</li> <li>Internet is enabling creation of new industries and reinvention of old ones</li> <li>Spawning massive employment opportunities for developers of web tools and applications, hardware designers and engineers, and those working in web-based businesses – e.g. customer service, marketing, finance and business development</li> </ul>	<ul style="list-style-type: none"> <li>Personal Entertainment Programmers</li> <li>Psycho-Customizer</li> <li>Human to Machine Interface Controller</li> <li>Narrowcasters</li> <li>Data Miner</li> <li>Waste Data Handler</li> <li>Privacy Protection Consultants</li> <li>Virtual Clutter Organizer</li> <li>Off-the-Grid/off-the-Net Facilitator</li> <li>Designer of Advanced Interfaces for Ambient Intelligence Systems</li> <li>Network Relationship Counsellors</li> <li>Virtual-Reality Actors</li> <li>Ghost Experience Assistant</li> <li></li> </ul>
<b>A Society in Transition</b> <ul style="list-style-type: none"> <li>Entering era of greater responsibility and accountability</li> <li>Evolving societal norms and</li> </ul>	<ul style="list-style-type: none"> <li>High levels of trust placed in science and scientists</li> <li>Rising expectations of S&amp;T to provide solutions to persistent societal problems (hunger, education, environment)</li> <li>Technology enables even the most marginalised</li> </ul>	<ul style="list-style-type: none"> <li>New Science' Ethicist</li> <li>Experimental Therapy Experts</li> <li>Resource Use Consultant</li> <li>Virtual Property / Home Owners' Association (HOA) Managers</li> <li>Vertical Farmers</li> </ul>

Global Change Driver / Description	High Impact Opportunities and Implications for Science and Technology (S&T)	Possible Future Jobs
<ul style="list-style-type: none"> <li>expectations</li> <li>• Pressure to serve the greater good</li> <li>• Expectation of high ethical standards</li> <li>• Declining trust in key institutions</li> </ul>	<ul style="list-style-type: none"> <li>to find a voice (e.g. Twitter in Iran)</li> <li>• Desire for IT to provide tools to ensure transparency and accountability – particularly for holders of public office</li> <li>• Technology providing opportunities to create and connect communities and give them a voice</li> <li>• Web enables individuals to find volunteer opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Media Ethicist</li> <li>• Computer Sex Worker / Therapist / Designer</li> <li>• Time Broker / Time Bank Trader</li> <li>• Black Swan Life Advisory</li> <li>• Authorised Narcotics Salesman</li> <li>• Personal Branders</li> <li>• Intelligent Clothing Designer / Engineers</li> </ul>
<p><b>Natural Resource Challenges</b></p> <ul style="list-style-type: none"> <li>• Growing resource pressures</li> <li>• Escalating energy demand</li> <li>• Increasing risk and cost of dangerous climate change</li> <li>• Ecosystems under threat</li> <li>• Rising long term commodity prices</li> <li>• Energy and environment as dominant global agenda items</li> </ul>	<ul style="list-style-type: none"> <li>• Major potential for clean fuels and alternative energy sources</li> <li>• Central role for S&amp;T in environmental protection, monitoring, analysis, modelling, damage repair and cleanup</li> <li>• S&amp;T generating new materials to resolve resource challenges</li> <li>• High expectation from citizens, businesses and governments that S&amp;T will ‘fix the environment’ and ensure sustainability</li> </ul>	<ul style="list-style-type: none"> <li>• Wind Farmer</li> <li>• Farmer of Genetically Engineered Crops and Livestock</li> <li>• Climate Change Reversal Specialist</li> <li>• Drowned City Specialist</li> <li>• Consumer Energy Analysts</li> <li>• Geomicrobiologists</li> <li>• Biorefinery Operative</li> <li>• Battery Technician</li> <li>• Chlorophyll Technician</li> <li>• Fusion Engineers</li> <li>• Vertical Farmers</li> <li>• Water Traders</li> <li>• Desert Land Rights Trader</li> <li>• Hydrogen Fuel Station Manager</li> <li>• Dirigible Pilot</li> <li>• Alternative Vehicle Developers</li> <li>• Scarce Metal Tracer</li> <li>• Solar Flight Specialists</li> </ul>

### 3. The Science and Technology Horizon

#### 3.1. Scope of Science and Technology Horizon Scanning

The horizon scanning undertaken for this study focused on identifying examples of key trends and of the kinds of developments taking place across a number of dimensions of the science and technology spectrum. In addition key contextual trends were scanned to get a sense of key changes happening in the world in which these advances are taking place. The horizon scanned trends and developments are presented in Appendix 1. Clearly there are a wide range of domains that could have been covered. Given the short duration of the study we chose to focus on the following areas - trends related to science policy, medicine, biology and biogenetics, energy, the environment, nanotechnology, manufacturing, information and communications technology, internet and the virtual world, artificial intelligence, robotics, transportation, space, demographics, culture and leisure and politics, economic and commerce.

The material used is drawn from a wide range of authoritative sources which in turn cite well referenced examples of science and technology developments on the horizon. As such, extensive use was made of the UK Government Horizon Scanning Centre (HSC) outputs – most notably the Delta and Sigma horizon scans of emerging trends and developments. Other key sources used extensively included MIT's Technology Review, the BT Technology Timeline and TechCast – an acknowledged resource pooling expert knowledge on science and technology forecasts. Where possible we have tried to republish and remain true to the source definition of the trend or development – except where we feel further clarification, paraphrasing or expansion is required.

Summarised in Table 2 below are the fields of endeavour we focused on and the range of topics considered in the scanning.

**Table 2 – Key Fields Addressed through Horizon Scanning**

<b>Field</b>	<b>Topics Explored</b>
<b>Science Policy, Strategy and Funding</b>	<ul style="list-style-type: none"><li>• Growing prominence and diffusion of science</li><li>• Globalisation of science funding and standards</li><li>• Convergence on a 'Theory of Everything'</li></ul>
<b>Medicine, Biology and Biogenetics</b>	<ul style="list-style-type: none"><li>• Personalised medicine and human enhancement</li><li>• NBIC convergence</li><li>• Synthetic biology, biological machines, systems biology and synthetic chemistry</li><li>• Gene therapy and stem cells</li><li>• Biomechatronics, neuroprosthetics and bionics</li><li>• Electronic health management</li><li>• Virtual reality education</li><li>• Health risks</li></ul>
<b>Energy</b>	<ul style="list-style-type: none"><li>• Demand, supply and investment forecasts</li><li>• Alternative energy sources</li><li>• Smart Grids and decentralised energy systems</li><li>• New Battery technologies</li></ul>
<b>Environment</b>	<ul style="list-style-type: none"><li>• Consumption and urbanisation trends</li><li>• Food demand and GM food</li></ul>

Field	Topics Explored
	<ul style="list-style-type: none"> <li>• Climate change</li> <li>• Water scarcity</li> <li>• Soil degradation</li> </ul>
<b>Nanotechnology</b>	<ul style="list-style-type: none"> <li>• Nano spending and investment forecasts</li> <li>• Nano applications</li> <li>• Nanosensors</li> <li>• Nanohealth</li> <li>• Nanomaterials and nanofibres</li> </ul>
<b>Manufacturing</b>	<ul style="list-style-type: none"> <li>• Green Manufacturing</li> <li>• Manufacturing techniques</li> <li>• 3D manufacturing and personal fabricators</li> </ul>
<b>Information and Communications Technology</b>	<ul style="list-style-type: none"> <li>• Digital Convergence</li> <li>• Greening I.T</li> <li>• Software platforms and techniques</li> <li>• Hardware components and devices</li> <li>• Mobile communications</li> <li>• Technology threats</li> </ul>
<b>Internet and Virtual World</b>	<ul style="list-style-type: none"> <li>• Usage forecasts</li> <li>• Web 2.0 and social media</li> <li>• Immersivity, virtual reality and augmented reality</li> <li>• Interfaces</li> </ul>
<b>Artificial Intelligence</b>	<ul style="list-style-type: none"> <li>• AI applications</li> <li>• Self-teaching AI</li> <li>• Self-replication</li> </ul>
<b>Robotics</b>	<ul style="list-style-type: none"> <li>• Market forecasts</li> <li>• Applications</li> </ul>
<b>Transportation</b>	<ul style="list-style-type: none"> <li>• Market forecasts</li> <li>• Maglev trains</li> <li>• Hypersonic jets</li> <li>• Hybrid vehicles</li> <li>• New fuels</li> </ul>
<b>Space</b>	<ul style="list-style-type: none"> <li>• Market forecasts</li> <li>• Missions and destinations</li> <li>• Space tourism</li> <li>• Mining, terraforming and astrobiology</li> </ul>
<b>Demographics</b>	<ul style="list-style-type: none"> <li>• Population growth</li> <li>• Ageing and life expectancy</li> <li>• Generational trends</li> </ul>
<b>Culture and Leisure</b>	<ul style="list-style-type: none"> <li>• Embedding of science in society</li> <li>• Public attitudes to and participation in science</li> </ul>
<b>Politics, Economics and Commerce</b>	<ul style="list-style-type: none"> <li>• Trust</li> <li>• Political instability and multilateralism</li> <li>• E-government and e-law</li> <li>• Economic power shifts</li> <li>• Talent shortages</li> </ul>

#### **4. *The shape of jobs to come***

As explained in section 1.3. above, desk research was carried out to identify an initial long list of future jobs and current jobs that might grow in prominence. These were reviewed with members of the Association of Professional Futurists and Fast Future's global network. As a result, the long list was extended and number of job profiles refined. A representative list of twenty jobs was then agreed with the client. These were selected on the basis of being representative of the breadth, scope and impact of the jobs that would be created or become more prominent in the future.

An online survey was then run to evaluate the attractiveness and value of these jobs (see section 5 for survey findings). Participants also provided input that was used to help develop the 'day in the life' summary for each of the jobs presented below. For each job, the following information is presented:

- A short description
- An assessment as to when it might possibly emerge and be 'accepted' as a recognised profession (e.g. have its own association or section within an existing body), and
- A day in the life of that professional.

For each job we have also provided a reference indicating where the original title was sourced from or the individual who proposed it.

The twenty jobs were selected to cover a range of activities from pure science driven roles such as a 'nano-medic' through to those which help us deal with the impact of technology on our lives such as a 'virtual clutter organiser'. The roles also cover a range of discipliners from healthcare to farming, personal services to environment protection and policing to education. The twenty jobs are listed below and described on the following pages.

- |  |  |
|--|--|
| 1. Body Part Maker                                       | 10. Quarantine Enforcer                          |
| 2. Nano-Medic  | 11. Weather Modification Police                  |
| 3. Pharmer of Genetically Engineered Crops and Livestock | 12. Virtual Lawyer                               |
| 4. Old Age Wellness Manager / Consultant Specialists     | 13. Avatar Manager / Devotees - Virtual Teachers |
| 5. Memory Augmentation Surgeon                           | 14. Alternative Vehicle Developers               |
| 6. 'New Science' Ethicist                                | 15. Narrowcasters                                |
| 7. Space Pilots, Architects and Tour Guides              | 16. Waste Data Handler                           |
| 8. Vertical Farmers                                      | 17. Virtual Clutter Organizer                    |
| 9. Climate Change Reversal Specialist                    | 18. Time Broker / Time Bank Trader               |
|  | 19. Social 'Networking' Worker                   |
|  | 20. Personal Branders                            |

## **1. Body Part Maker<sup>12</sup>**

Due to the huge advances being made in bio-tissues, robotics and plastics, the creation of high performing body parts - from organs to limbs - will soon be possible, requiring body part makers, body part stores and body part repair shops.

### **Possible Emergence as a Profession: 2020**

#### **A Day in the Life**

A day would typically start with scanning the most critical or urgent new requests for repairs and complete body parts, and checking on component deliveries to help schedule the day's work plan. Requests would be reviewed to determine whether entire limbs or organs were required or just component subsystems (e.g. a new kneecap) and where multiple copies were required e.g. for athletes and soldiers returning to combat. A visit to the incubator would follow to check on the progress of body parts currently being 'grown' and to perform staged quality control tests of all existing growth culture batches. Starting new growth batches would be the next priority.

The body part maker works with computer aided design, including online DNA modelling and biomechanical simulations, DNA encoding and DNA modification. A core skill is the selection and combination of biological materials to grow organ parts on "scaffolding", which is also modelled by the body part maker, based on computer-generated templates. While a typical organ such as a liver or kidney might be grown, other parts such as an arm would involve the complex integration of a nano-engineered skeleton, high performance robotic joints, fibre-optic nerves, artificially grown skin, synthetic flesh and muscles.

Much of the day would be spent working at the laboratory bench designing and assembling body parts and testing their performance under various conditions as specified by the owner. Throughout the day the body part maker would be engaged in video conferences with surgeons around the world to discuss their requirements, provide advice on appropriate body part design and review the results of past body part replacement surgeries. Dedicated time would also be set aside to review the latest information on new techniques and research provided by the body part maker's professional association.

## **2. Nano-Medic<sup>13</sup>**

Advances in nanotechnology offer the potential for a range of sub-atomic 'nanoscale' devices, inserts and procedures that could transform personal healthcare. A new range of nano-medicine specialists will be required to administer these treatments.

### **Possible Emergence as a Profession: 2025**

#### **A Day in the Life**

Applications for nanomedicine range from body part replacement through to tissue repair and gene therapy. A typical day for a skilled nanomedic might include patient consultation, time in surgery, ward rounds, review of past surgeries, complex modelling to devise appropriate nano-solutions, work in the laboratory to grow and engineer suitable nanomaterials, teaching and continuous professional development. A Nano-medic would typically work as part of team on rotating shifts, and be on call. Training is extensive and involves study of the human physiology, traditional medicine, the science underpinning nanotechnology, and the effects of nano materials in humans.

Because of the range of emerging applications of nano techniques and technologies, Nano-medics would need a deep understanding of the biological, chemical, electrical, magnetic, mechanical and optical properties of nanomaterials and of the human body. This would need to be coupled with a deep understanding of information processing and cognitive mechanisms in the human body. This multi-disciplinary expertise will be critical to engineering nano-medical solutions that perform as well or better than the organs or body parts being repaired.

Typically, a Nano-medic might be part of an expert team in one of a handful of specialist nanomedicine centres around the country. Individual team members might specialise in particular areas such as nano materials and tissues, cancer diagnostics and treatment, drug delivery or computational modelling of nano-medical interventions. Patient conferences on nanomedical interventions might typically involve specialists joining in via video link from a range of remote locations.

### **3. Pharmer of Genetically Engineered Crops and Livestock<sup>14</sup>**

Pharmers are the next generation of farmers who will raise crops and livestock that have been genetically engineered to improve food yields and 'grow' therapeutic proteins, pharmaceuticals and chemicals.

#### **Possible Emergence as a Profession: 2015**

##### **A Day in the Life**

The day begins with supervising the changeover of the security teams from the night shift, scrutinising the CCTV monitoring systems and the automated event and monitoring logs, which record the status of each crop or group of livestock. Each crop or animal would then be evaluated for progress against the relevant supply contract and treatments would be adjusted accordingly. Data is fed back automatically on each "crop" or animal to the food processor, abattoir, distributor, pharmaceutical company or chemical firm who will be the next step in the value chain.

Sophisticated computer models that draw information on temperature, atmospheric conditions and plant health from an array of biosensors will be used to determine harvesting of crops. This morning, we see that the GM "cancer cure" sunflowers have made good progress and our models suggest they are on track for harvest and processing tomorrow - quality and quarantine processes need to be implemented today in preparation.

Pharmers may come from a variety of backgrounds including chemical sciences, pharmaceuticals, medicine, and even traditional farmers who have retrained in the relevant scientific disciplines.



#### **4. Old Age Wellness Manager / Consultant Specialists<sup>15</sup>**

Drawing on a range of medical, pharmaceutical, prosthetic, psychiatric, and natural fitness solutions to help manage the various health and personal needs of the aging population.

#### **Emergence as a Profession: 2010**

##### **A Day in the Life**

The wellness manager will bridge the clients' needs for medical care, housing, transport, training, skills development and social care, as well as managing quality of life and providing financial advice. In order to stay up to date, our wellness specialist dedicates up to 20% of their time to researching and learning about all the latest developments that could benefit their practice. These could encompass new pensions legislation, exercise and diet regimes, medical advances and new psychotherapeutic interventions. A typical day might start with video and telephone conversations with clients who are on a retainer and who require regular coaching, guidance and motivation.

The core of our specialist's time is spent consulting with, advising and treating existing and prospective clients. Although some clients are happy for all services to be provided via video link and other virtual mechanisms, the bulk place a value on human contact and hence prefer face-to-face consultations. Our consultant makes a number of home visits but also likes to see patients in their consulting rooms where more specialist diagnostics and treatments can be performed. Groups of self-employed wellness specialists may share treatment rooms. They may also have shared administrative support to perform a range of tasks for clients ranging from ordering the weekly groceries through to liaising with medical services and performing personal banking. Wellness management networks may spring up where each consultant has a particular specialty such as medical care, exercise, coaching and financial advice.

The nature of the work means that hours could be long, with home visits being performed at the start and end of the day for clients who are still working. The consultant's personal background and qualifications will determine the range of services they can perform. Hence those who are not medically trained may need to work in partnership with medical specialists to provide the full range of services required by clients. Others may have qualified through new models of medical training that enable them to perform certain medical tasks and interventions such as drug prescribing. While some clients may pay for themselves, others may receive the service as part of their retirement package or as part of the support provided to enable them to carry on working past normal retirement age.

## **5. Memory Augmentation Surgeon<sup>16</sup>**

This is a new category of surgeons whose role is to add extra memory to people who want to increase their memory capacity. A key service would be helping those who have literally been overloaded with information in the course of their life and simply can no longer take on any more data - thus leading to sensory shutdown.

### **Possible Emergence as a Profession: 2030**

#### **A Day in the Life**

A memory surgeon would be able to work as much or as little as they wanted. Whilst most would work privately, some would be employed by public health services to help those in the greatest need who cannot afford treatment themselves. Leading companies will increasingly hire such surgeons to enhance the capabilities of their top performers, and raise the standards of the entire workforce.

A typical day would involve consultation with prospective patients – including review of an extensive battery of cognitive, psychological, neurological and emotional tests. These will help determine if a patient is suitable for treatment and the appropriate interventions to make. Each intervention would be designed using sophisticated computer modelling tools and would need to be peer reviewed by two other memory augmentation surgeons and submitted for approval by the Neurological Augmentation Authority before treatment can be performed. Typical patients could be in surgery for many hours given the complex nature of the procedures involved.

Considerable time will be spent communicating with data information filter specialists, security experts, and consultants on issues such as the design of virus protection and personal human firewalls. Surgeons would be expected to undertake continuous professional development, stay abreast of the latest thinking and practice in their field and have their performance reviewed and qualifications renewed regularly. Surgeons will have to be part of a professional association and pay a significant annual contribution to association research and marketing budgets. The association will play a key role in financing original research, promoting the profession, trying to address the ethical outcry and influencing the debate around memory enhancement. The leading surgeons will command six figures or more for a single surgery and will be popular figures in the media. Memory augmentation surgeons will have the highest insurance premiums of any medical practitioner – with an occupational hazard being the risk of being sued for memory loss.

## **6. 'New Science' Ethicist<sup>17</sup>**

As scientific advances accelerate in new and emerging fields such as cloning, proteomics and nanotechnology, a new breed of ethicist may be required. These science ethicists will need to understand a range of underlying scientific fields and help society make consistent choices about what developments to allow. Much of science will not be a question of can we, but should we.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

Science ethicists may come from a range of fields including the new sciences, ethics, philosophy, religious studies, sociology and journalism. The field will be quite widely spread – ranging from essayists to those who focus more on classroom teaching or helping governments, scientists and corporations make tough choices about the bounds of acceptable practice in each discipline.

Much of the ethicist's work will involve extensive study of the underlying disciplines and the arguments for and against development in each field. Regular physical and virtual meetings will take place with leading scientific practitioners, government legislators, corporate representatives and lawyers. Ethicists may also visit the R&D centres where the research is taking place to form first hand opinions on the advances under discussion.

Participation in live and virtual lectures, workshops and public debates will be common. Some ethicists may be funded by government and / or corporations. Their role will be to take the ethical debate into schools and universities to help students understand the issues. For students and society as whole, a responsibility for ethicists will be to equip citizens with the decision making tools to enable them to evaluate the ethical challenges posed by scientific advances in a rational and consistent manner. Some ethicists may have academic tenure. A more controversial possibility is the idea of contract ethicists who hire themselves out to science companies to help them anticipate ethical challenges and frame their offerings in the most ethically acceptable light.

## **7. Space Pilots, Architects and Tour Guides<sup>18</sup>**

With Virgin Galactic and others pioneering space tourism, space trained pilots and tour guides will be needed alongside architectural designers to enable the habitation of space and the planets. Current architectural projects at the Sasakawa International Center for Space Architecture (SICSA) at the University of Houston include a greenhouse on Mars, lunar outposts and space exploration vehicles<sup>19</sup>.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

Initial developments in space tourism will involve two to three hour sub-orbital flights. This will gradually develop into longer trips – possibly extending to flights lasting several days or weeks for a visit to an orbiting space station or a distant planet. On the day of each flight, pilots will undergo rigorous health and psychological checks to ensure they are fit to travel. The next stage will be an exhaustive visual and automated programme of technical and security checks with the engineering team. The passenger manifest will be discussed in detail with the entire in-flight crew to understand exactly who is on board. Space flight is likely to remain the domain of the very wealthy for some time to come – everyone will believe himself or herself to be a VIP!

The flight itself will be handled largely by autopilot for most of the journey but the pilot and co-pilot will need to be fully in command throughout the trip. Flight rosters will typically involve extensive rest periods during and after each trip. Even days off will include regular physical and mental strength exercises to ensure the pilot is able to deal with the stresses of frequent space travel.

SICSA currently offers the only Masters of Science in Space Architecture. SICSA explains that Space Architects, like their earthbound counterparts, must address “the total built environment, not just its component elements and systems.” Hence designing solutions for space involves “a broad understanding of the issues and requirements that impact overall planning and design success. Important considerations include: influences of unique conditions of the space environment upon construction processes and material options; physiological, psychological, and sociological impacts of isolation and stress; and human factors design issues associated with human adaptation and performance in weightless and partial-gravity habitats.”<sup>20</sup> A space architect’s customers could include governments, private developers, manufacturers and, in time, firms such as banks, hotel groups and retailers.

Space tour guides will draw on cosmology, astronomy, space science, geography, history and geology to help passengers get the most out of their journey. While the factual side of the tour is important, space guides also need to be excellent storytellers and imaginers to help inspire their charges and encourage them to experience the true awe of space travel. Regular tour guides will need to undergo a similar level of physical and mental preparation and testing as pilots before each trip.

## **8. Vertical Farmers<sup>21</sup>**

There is growing interest in the concept of city based vertical farms, with hydroponically fed food being grown under artificial growth-enhancing lighting in multi-storey buildings. These offer the potential to dramatically increase farm yield and reduce environmental degradation. The managers of such entities will require expertise in a range of scientific disciplines, engineering and commerce.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

Many models can be envisaged for how such farms could be run. One would involve a professional farm manager supported by a mix of human and robotic farm hands and specialist scientists. Another model envisages such farms being part of new community developments with the local residents donating time as farm labour in return for a regular supply of fresh produce and a share of the commercial returns from the farm.

A typical day would typically start with monitoring plant health, atmospheric conditions and crop growth. A number of routine daily tasks would be performed including tending the plants, planting, harvesting, irrigating the various plants, waste recycling and maintaining the ventilation equipment and other machinery. Each day, time would be dedicated to working on new developments in special areas of the farm given over to experimentation on new crops and growing techniques.

A key element of the farm manager's responsibility will be maximizing the commercial returns on the crops planted. Whilst some farms may be owned by or tied to particular retailers, produce wholesalers or food processors, others may operate on an independent basis. Much of the commercial effort will be invested in identifying customers to pre-book capacity or to selling crops on the open market once produced. Once proven, successful farms with a record of achieving high yields may be able to auction their capacity to the highest bidder.

## **9. Climate Change Reversal Specialist<sup>22</sup>**

As the threats and impacts of climate change increase, a new breed of engineer-scientists are required to help reduce or reverse the effects of climate change on particular locations. They need to apply multi-disciplinary solutions ranging from filling the oceans with iron filings to erecting giant umbrellas that deflect the sun's rays.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

The three most frequent models for engaging a reversal specialist will be firstly as part of a planned long-term strategy on the part of a location to intervene before an anticipated climatic disaster occurs. The second and possibly more common approach will be for specialists to be brought in when a climatic crisis is considered imminent or has started to occur. The third approach will be for our specialists to be brought in 'after the event' to try to help locations that have been devastated by climate change.

The strategies adopted will depend on the stage at which the reversal specialist is bought in. These will typically involve changes in carbon-based energy and transport infrastructure, and fine-tuning of existing alternative energy systems. In the physical environment, interventions could include protecting and rebuilding destroyed or damaged ecosystems such as tropical rainforests and ocean beds. A critical aim will be to ensure that the local people benefit from the changes being made.

A typical intervention might start with detailed data gathering and assessment on the current situation. In parallel, in-depth discussions would be held with the local citizenry and civic leadership to understand their vision and aspirations for their location. The next stage might involve solution conferences with a range of experts and local citizens to identify and evaluate reversal options. These would typically be modelled and costed and an assessment of the long-term impact and benefits drawn up. A strategy and set of recommendations would then be offered up and the preferred solutions would then be integrated into an implementation plan. Such plans will hinge on the funding and time available to see them through. Where there is time available, a number of experiments may be run to see which option best meets the needs for a sustainable solution – e.g. for ecosystem protection.

## **10. Quarantine Enforcer<sup>23</sup>**

If a deadly virus starts spreading rapidly, few countries, and few people, will be prepared. Doctors and nurses could be in short supply to prevent or treat the problem. Hence, quarantines could be imposed to keep people in or out of particular locations. Moreover, as mortality rates rise and neighbourhoods are shut down, someone will have to guard the gates.

### **Possible Emergence as a Profession: 2030**

#### **A Day in the Life**

The position may be seasonal or full time depending on the nature of the problem, possibly switching from the southern to northern hemisphere as the seasons change. Having to deal with possibly infected people trying to get through the gate and deciding whether to use lethal force to protect everyone that is healthy is stressful. This suggests enforcers will work in frequent short shifts, possibly with robotic help.

A key requirement for enforcers will be a strong immune system and the ability to stand up to intense psychological pressures - a common scenario will be family members pleading to be allowed through the gate to see their quarantined loved ones. Hence an enforcer's daily routine may include taking a range of vaccines and supplements, a rigorous physical exercise routine, psychological training and testing and personal coaching to help them 'let go' of any issues that could prevent them performing in a consistent and resilient manner.

A typical guard duty for an enforcer might include operating a checkpoint, reviewing the papers of those seeking to pass through, making instant decisions on right of access and rejecting people in a diplomatic manner. The ability to diffuse a tense situation will be critical as will clear judgement on when to use force and on what level of force is appropriate.

## **11. Weather Modification Police<sup>2425</sup>**

The act of stealing clouds to create rain is already happening in some parts of the world, and is altering weather patterns thousands of miles away. Weather modification police will need to monitor and control who is allowed to undertake weather modification activities e.g. shooting rockets containing silver iodine into the air as a way to stimulate rainfall from passing clouds.

### **Possible Emergence as a Profession: 2020**

#### **A Day in the Life**

The day never finishes – there is merely a night and day shift. Within a modification policing team, a range of specialist roles will exist ranging from climate scientists to surveillance and counter-terrorism specialists. A typical day might start with reviewing surveillance footage of suspect activity and analysing real time data collected from unmanned aerial vehicles and ground based sensors. The goal is to track possible unauthorised weather modification attempts. Where concerns exist, field teams would then investigate the case further and visit the suspected illegal modifiers

The Weather Modification Police may also perform the role of vetting applicants and granting licences to those with legitimate reasons for wanting to intervene in natural weather patterns. Where modification licences have been granted, routine inspections might be performed to ensure that the owners are operating within legally acceptable bounds. As with drug enforcement, a key role of weather police will be to break up supply chains. Hence duties would include covert surveillance and interventions to track down contraband shipments of silver iodine and other weather modifying agents. Where criminal activity is detected, routine policing tasks of preparing and prosecuting a case would kick in.

Scientists play a key role in this policing function. A common activity would be analysing rain and soil samples to identify the presence of possible modification agents. Where suspect shipments are intercepted, the contents will need to be analysed to determine its possible use in modification activity. A strong cross-border liaison will be required to share intelligence and pass on new case examples of illegal weather modification technologies and approaches being adopted. A key part of intelligence gathering will be horizon scanning for possible new technologies, processes and bio / nano / chemical agents that could be used in weather modification activity.



## **12. Virtual Lawyer<sup>26</sup>**

As more and more of our daily life goes online, specialists will be required to resolve legal disputes that could involve citizens resident in different legal jurisdictions.

### **Emergence as a Profession: 2010**

#### **A Day in the Life**

The internet is a major facilitator of innovation in both the legal and illegal realms. Hence a significant part of a virtual lawyer's time will be spent monitoring new legal developments and precedents that apply to the virtual world. Much of the legal territory remains the same e.g. disputes, contractual failures, ownership issues, intellectual property theft, sabotage, copyright infringements and trademarks. However, the complexity comes from the global nature of the web and the different legal jurisdictions that could be involved.

Some of the most interesting challenges will arise from dealing with international web-based criminal acts. For example, consider a British passenger on a flight from Paris to Singapore on an Australian airline. The passenger uses the onboard web-access to commit a hacking or phishing attack on victims in Luxembourg whilst flying over Bulgaria. Under whose legal jurisdiction should the crime be prosecuted?

Virtual lawyers will make extensive use of technology – for example setting up bots and spiders to develop a reverse audit trail of suspect transactions and scanning the web for possible clues or experts that could help in the prosecution of a case. A key role will be to advise customers on how to set up online activities – particularly e-commerce transactions – in a manner that is legally sound across a range of jurisdictions. The goal is to prevent possible future prosecutions in areas such as online gaming and content download.

### **13. Avatar Manager / Devotees - Virtual Teachers<sup>27</sup>**

Avatars could be used to support or even replace teachers in the elementary classroom, i.e., computer personas that serve as personal interactive guides. The Devotee is the human that makes sure that the Avatar and the student are properly matched and engaged<sup>28</sup>.

#### **Possible Emergence as a Profession: 2015**

##### **A Day in the Life<sup>29</sup>**

An Avatar Manager will typically have an educational background and extensive training in programming the online learning environments their students will be working with.

Daily tasks for a manager of these online learning experiences could include:

1. Welcoming and interviewing new learners to build rapport and gain insight into their learning needs and interests
2. Using a guided protocol to translate the interview data to determine the appropriate combination of virtual classes / modules
3. Prompting the learner to develop his or her own avatar as he or she becomes more familiar with the virtual teacher avatar
4. Monitoring students (virtually) who are in different learning stages and making behind-the-scenes adjustments to the software
5. Providing feedback to learners on their progress and obtaining feedback on their virtual learning experience
6. Using feedback to extract new rules and recommendations for the avatar teaching software and process - perhaps contributing to self-analyzing/self-learning modules that make the intelligent agent in the software learn and reprogram itself
7. Meeting (virtually) with other managers to coach each other and develop a collaborative community among people in this role
8. Spending time each day being a virtual learner and test subject for future software iterations and breakthroughs in the field
9. As manager of the human side of learning, monitor and foster mutually positive emotional experiences, offer mediation services between learners and teaching avatars, initiate termination of ineffective relationships and manage the transition/goodbyes and introductions as learners advance to new avatars or leave the program.

#### **14. Alternative Vehicle Developers<sup>30</sup>**

Designers and builders of the next generations of vehicle transport using alternative materials and fuels. Could the dream of truly eco-friendly transport and cars that travel underwater or fly become a reality within the next two decades?

#### **Emergence as a Profession: 2010**

##### **A Day in the Life**

While a lot of alternative vehicle development will take place within existing car manufacturers, even more is likely to happen in start-ups that come from outside the industry. Some will be offshoots of battery and other fuel cell technology developers – others will be pure start-ups operating on a very low budget. Key for this new breed of vehicle developers will be innovation and a wide range of partnerships from financiers through to component suppliers and distribution channels.

A typical day for an alternative vehicle developer could include design and prototyping of vehicles and vehicle subsystems and wide horizon scanning for techniques and processes being developed elsewhere. Communication with others in the industry – possibly embedded in a corporate entity - is critical and places an emphasis on the personal skills needed to make open source innovation and partnerships work.

A significant part of a developer's time will be spent running tests to prove the performance, safety, reliability and environmental characteristics of the vehicle and its subsystems and submitting these for approval by the appropriate authorities. To bring such fledgling projects to market requires significant development funding, manufacturing partners and distribution channels. Hence a lot of the developer's time will also be spent presenting their ideas to these potential partners and selling themselves as the best option.

## **15. Narrowcasters<sup>31</sup>**

As the broadcasting media become increasingly personalized, roles will emerge for specialists working with content providers and advertisers to create content tailored to individual needs. While mass-market customisation solutions may be automated, premium rate narrow casting could be performed by humans.

### **Emergence as a Profession: 2010**

#### **A Day in the Life**

Narrowcasting programmers will be judged on how well they understand the needs of their audience(s) and how effectively they then tailor programming content to address those preferences. In the media world, feedback is rapid – customer either consume your media, stop part way through or don't consume it all. If they do consume it once, the acid test is whether they return. Hence narrowcasters will spend significant amounts of their time evaluating this usage information, engaging in dialogue with customers and monitoring the social media on which customers discuss what content they are consuming.

The content offered will vary from channel to channel, but increasingly the narrowcaster's role will be to integrate original content with that sourced from a variety of third party media. The challenge is to present it in a manner that suits the end-consumer's personal preferences. Hence a lot of personalisation tools are offered to help customers further customise that which has already been tailored for them.

Making extensive use of artificial intelligence tools, web crawlers and customised alerts, narrowcasters will programme personalised content. This will then be grouped and presented according to different perspectives like emotional tone, originality and reliability. Customer personality tests will increase the relevance and specificity of search information given to data mining facilities. This will help ensure a stronger fit between the information collected and the user's interests. The narrowcaster will also provide a summary at the end of every day of the content delivered that day.

## **16. Waste Data Handler<sup>32</sup>**

Specialists providing a secure data disposal service for governments, corporations and those who do not want to be tracked, electronically or otherwise.

### **Emergence as a Profession: 2010**

#### **A Day in the Life**

Waste Data Handlers will operate at two levels. For the mass market they will develop a range of applications run on the basis of 'Software as a Service' (SaaS). Clients will either log in to request a sweep of their data or have automatically programmed sweeps performed on a regular basis. Customers may ask for routine sweeps to remove cookies, audit trails of e-banking and records of electronic transactions. Others may have more complex requirements that could border on the illegal – for example removing all traces of suspect email conversations in the face of a criminal trial. Hence both legal and illegal data handling services will emerge.

For those that can afford it, a more personalised service will be offered. For electronically stored data, the handler would log on to each of his client's devices and search for and purge pre-agreed categories of data to be removed and data labelled 'to be disposed of'. A more personalised service still would be for the handler to perform more regular sweeps, sampling the data held and providing advice on purging and the implications of retaining it.

The ultimate in personal service will offer personal visits to a client's home to review all of their records whether on paper or electronic media and to perform both physical and virtual purges. The nature of the job will require handlers to be trained in the latest electronic data management techniques, software encryption, legal issues and customer service. Those offering a personal service may need police security checks and a form of personal accreditation. Data handlers will require high levels of insurance cover to protect claims arising for erroneous destruction of client data. The interesting legal issue here is that if the handler or handling software are good at their job, the client will have no proof that the data existed in the first place!

## **17. Virtual Clutter Organiser<sup>33</sup>**

Specialists will help us organise our electronic lives. Clutter management would include effective handling of email, ensuring orderly storage of data, management of electronic ID's and rationalizing the applications we use.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

A Virtual Clutter Organiser will typically be an expert in data management, security and networking and operate in three different ways – offering a downloadable solution to reside on your electronic devices, providing an online Software as a Service (SaaS) solution and delivering a totally personalised service managing your data for you.

The personalised service would be offered to those who simply have no time or lack the technical proficiency to use such downloads or online services. The Organiser will either visit you or access your devices remotely. They scan everything, work through your emails, documents and online registrations and create a data management framework to hold your electronic information. They would install routines that guide the user to ensure data is stored properly as it is created and encourage deletion of redundant data.

In the local model, the Organiser's software tools are downloaded into your computer from the web. The programs would review and arrange your data based on key word identification. The software would advise the user on any risks and encourage the deletion of redundant and duplicate data as it is being saved. The programs would also have the capacity to learn and would gradually build up a profile of the computer owner, develop additional categorisations as appropriate and identify where software upgrades are required to deal with new situations. Suggested refinements to the program are fed back to the manufacturer in real time, who modifies the software and updates the remote installations.

The online version would be run on request or on a scheduled basis – performing similar tasks to the downloadable version. In both cases the software would also offer a data management framework to guide the user through every activity – e.g. automatically offering to set up folders to handle correspondence with any new contacts and providing a central repository to capture all electronic ID's as they are created.

## **18. Time Broker / Time Bank Trader<sup>34</sup>**

Alternative currencies will evolve their own markets – for example time banking already exists. Time Banks are community exchanges that enable individuals to earn time credits for performing services for the community and spend those credits on buying services from other community members.

### **Emergence as a Profession: 2010**

#### **A Day in the Life**

Most members of a time banking community will simply seek to earn time credit for performing services e.g. washing someone's car. They will then spend the credits earned on purchasing services from other time bank members – e.g. having someone paint your home. Others may seek to become Time Brokers and profit by running a time banking exchange and providing the matching service between providers and users of services. So for example, a buyer may pay ten time credits for someone to walk their dog, the dog walker in turn receives nine time credits, with the time bank broker taking one credit as profit. Their accumulated profits can then be used to purchase services within the community.

The time broker's day would be spent arranging transactions, suggesting a value to put on new services, vetting potential new members of the time exchange and resolving disputes between buyers and sellers. The community element of time banks will require a strong focus on encouraging dialogue between members and profiling case examples of the kinds of time exchanges taking place.

A time bank trader may operate within a time banking community, buying and selling time credits – possibly for hard currency. A notional exchange rate would be established so, for example, a time credit could be brought for one pound and sold for 95 pence. Buyers might be willing to purchase time credits for hard currency if they think that services can be purchased more cheaply that way. If the going rate to have your lawn mowed is ten pounds and the service is on offer for eight time credits, it would be worth your while buying credits from a time broker. The time broker will make their profits on the differences between the buying and selling price for time credits.

## **19. Social 'Networking' Worker<sup>35</sup>**

Social workers for those in some way traumatised or marginalised by social networking.

### **Possible Emergence as a Profession: 2015**

#### **A Day in the Life**

These social workers for the digital world will combine social work and counselling skills with a deep understanding of the dynamics of social networks and the best practice strategies for surviving in a connected world. A typical day might start with an hour attending to their own social networks. There then follows a visit to a corporate client for one to one sessions with staff who feel they are being bullied within the internal social networks or not performing effectively in the external communities of which they are a part. A session might follow with the client chief executive to help them determine why the company is portrayed so negatively across the social networks despite an active commitment by the firm to engage and share in the virtual world.

On returning to the office, a series of face to face and virtual consultations follow with clients experiencing a range of social networking problems. A common issue is stress created by trying to keep up with discussions and communications received across a range of networking platforms. Issues of virtual bullying are common as are clients who feel pressurised to participate in the virtual world even though they don't want to share their personal thoughts and actions.

Our social worker has adopted key strategies for dealing with the challenges of the 24/7 society. Although the phone doesn't ring for incoming messages whilst a consultation is underway, images are projected of incoming callers on the rear wall of the office behind the client with a footnote explaining whether the message is urgent or routine. Between consultations, the social worker handles urgent calls. A couple of hours are then devoted to their own social networking, participating in virtual forums and catching up on the latest research. A couple of times a week they attend physical evening networking events as these still prove to be a vital source of generating new business.



## **20. Personal Branders<sup>36</sup>**

An extension of the role played by stylists, publicists and executive coaches –advising on how to create a personal ‘brand’ using social and other media. What personality are you projecting via your Blog, Twitter, etc? What personal values do you want to build into your image - and is your virtual image consistent with your physical world persona and your goals?

### **Emergence as a Profession: 2010**

#### **A Day in the Life**

A day typically starts with a review of the press and social media to see how clients have been portrayed in the previous 24 hours. Extensive use is made of alerts, web crawlers and bots that are constantly scanning every form of media for any mention of our clients and their ‘competition’. A screen on the office wall flags up alerts as each new report comes in. A staff member – usually an intern - is dedicated to scanning these alerts in case any immediate action is required. Each client has a dedicated web space where every mention, image or video of them is logged for their review. All client communications with the outside world can be captured instantly, including instant recording of all verbal conversations.

There then follows a series of video and face to face consultations with potential clients. The aim is to understand their personal branding goals – often this involves a level of life coaching to help them determine what they want to achieve before working out how to brand them. For premium clients, a service is offered to actually be their online presence – managing contributions to other networks, posting updates and responses to their own multi-media blogs. Regular meetings are held with media to ‘sell’ the latest story on our clients and to try and create interesting angles through which to profile them.

Client meetings take place to present ideas, discuss the success of branding activity to date, plan future actions and determine how to respond to both positive and negative brand coverage. For many clients with ‘legacy’ the issue is how best to redress past misdemeanours and negative coverage. Common issues include how to remove embarrassing and damaging past postings to websites, blogs and other forums and how to prevent stories from the past rearing up again. Advice could include the right places to be seen, people to be with and how to get invited to the right events. Evenings are often taken up with visits to social events to see how our clients are performing and to help avoid any personal indiscretions.

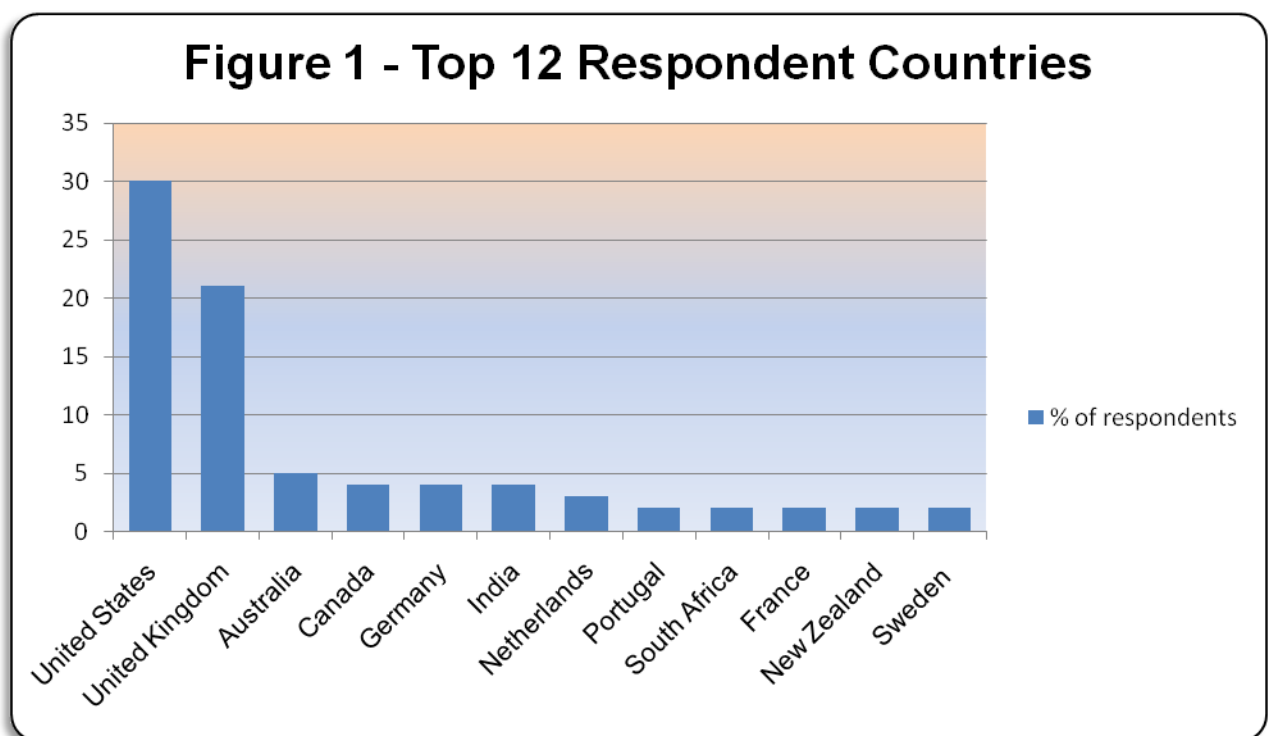
## 5. Global Survey Findings

An online survey was used to test opinions from around the globe to the twenty job profiles. The survey was run from August 12<sup>th</sup> – 21<sup>st</sup>. The invitation to participate was distributed to Fast Future’s global network. The survey was also promoted extensively by Penny Power founder of the Ecademy Network, Joyce Gioia’s Herman Trend Alert, the Foresight Network, and the networks of a number of futurists including Adam Gordon, Marcel Bullinga, Ann Feeney, Tom Hoffman, Michael McAllum, Steven Millett and Verne Wheelwright. In addition, it was promoted via the LinkedIn and Xing social networks. The survey attracted 486 responses from 58 countries on 6 continents - including 104 from the UK. Of the total respondents, 65% were male and 35% female.

The Survey focused on assessing the popularity, job impact, environmental impact, educational benefits, developing country benefits, financial rewards and attractiveness of the twenty jobs. The results are presented and discussed below.

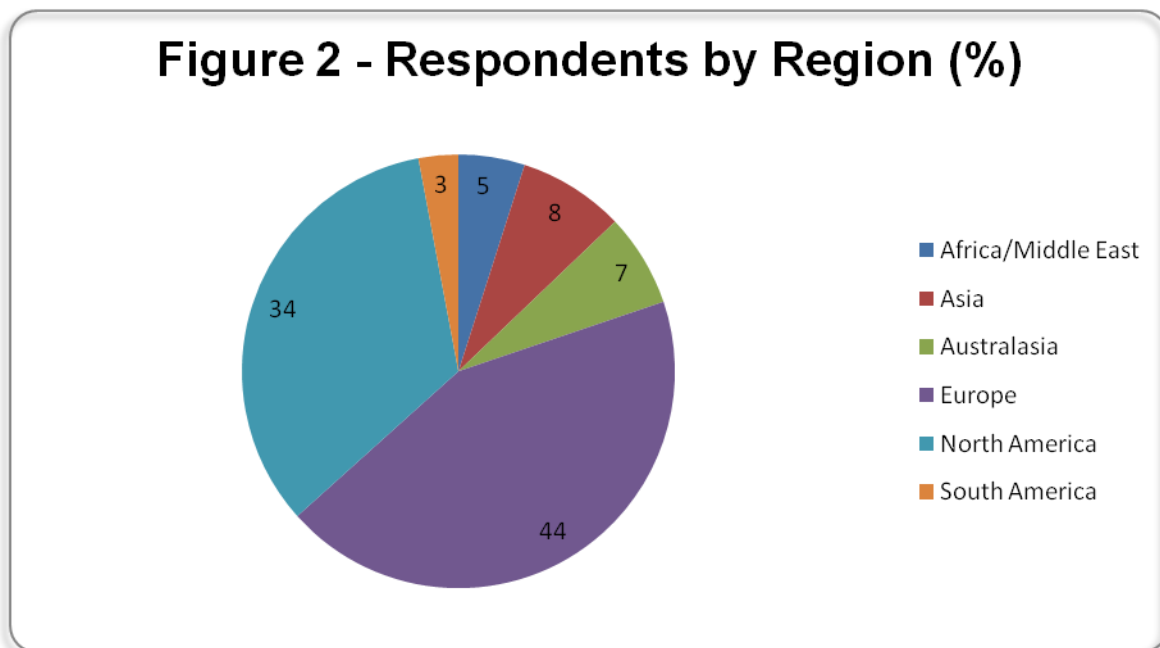
### 5.1 Participant Demographics

Figure 1 below shows that the two largest groups of respondent came from the USA (30%) and the UK (21%). A full listing of the respondent countries and level of response by country is presented in Appendix 5.



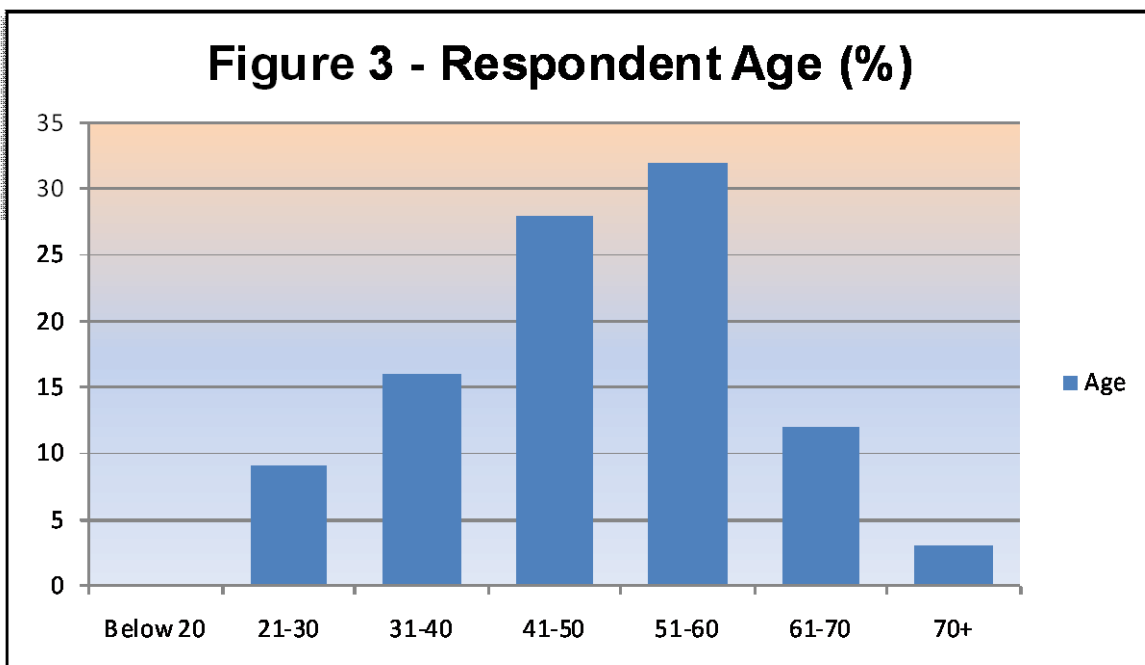
Total respondents: 486

Figure 2 below shows that the largest proportion of respondents came from Europe (44%) followed by North America (31%).



Total Respondents: 481

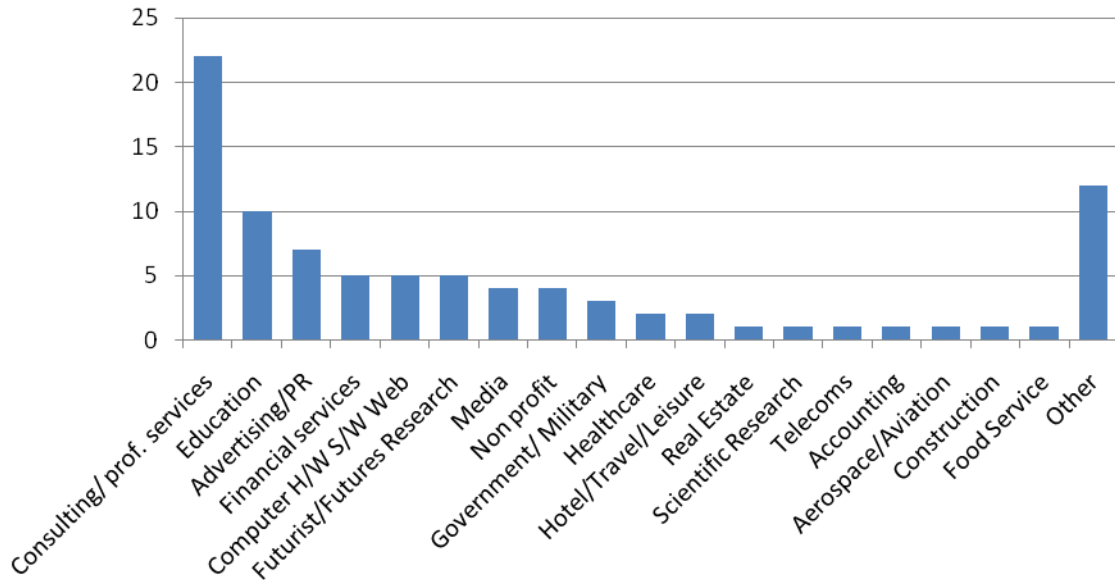
The largest group of respondents were in the 51-60 age group (32%) followed by those aged 41-50 (28%). (Figure 3)



Total Respondents: 475

Respondents came from a wide range of industry sectors (Figure 4), with the largest groups coming from the consulting / professional services (22%) and education sectors (10%).

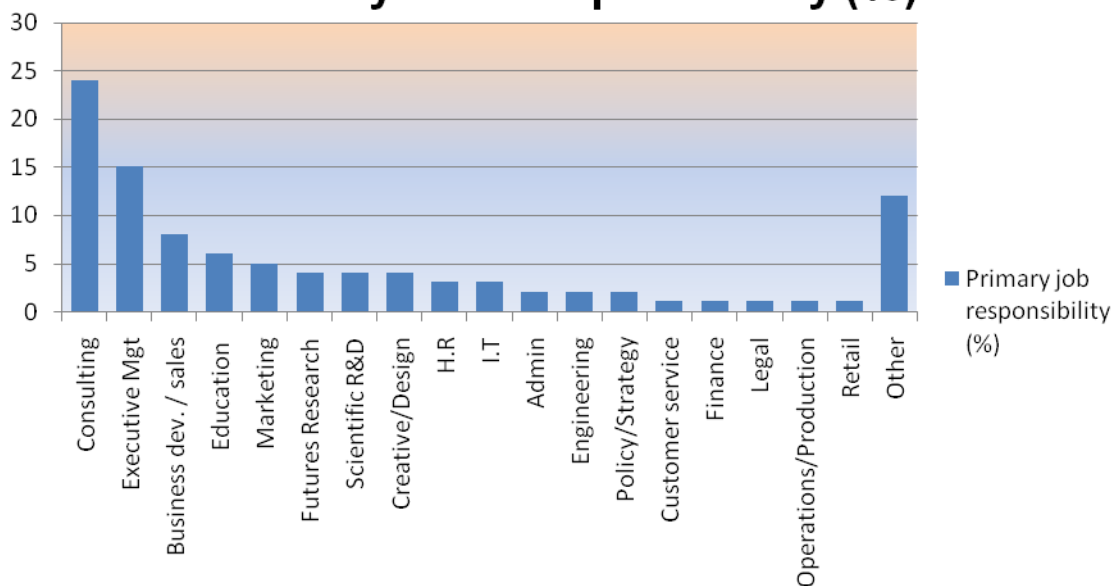
**Figure 4 -  
Respondents by Industry Sector (%)**



Total Respondents: 477

Consulting (24%) and Executive Management (10%) were the most common job responsibility among respondents (Figure 5).

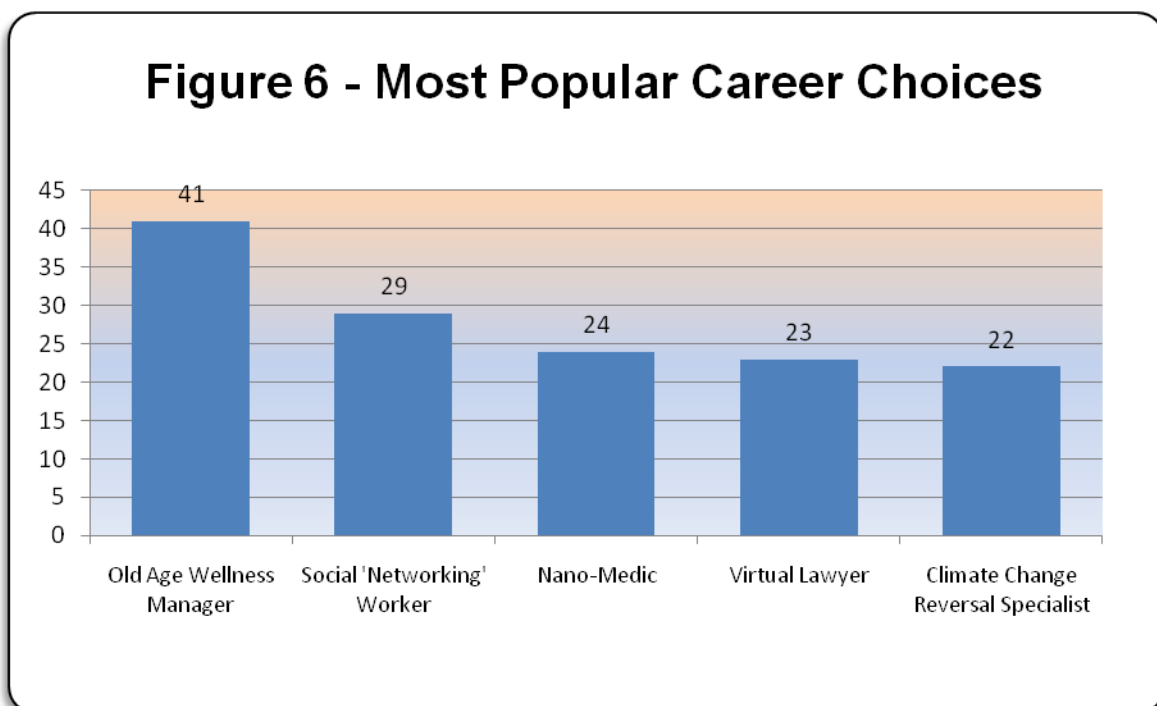
**Figure 5 -  
Primary Job Responsibility (%)**



Total Respondents: 476

## 5.2 Popularity as a Career Choice

Participants were asked to select the three jobs that would be the most popular career choices (Figure 6). Despite the preponderance of high technology roles, the most popular was the 'high touch' Old Age Wellness Manager / Consultant (41%). Females (46%) favoured this option over males (39%). Perhaps unsurprisingly, this option was favoured by those continents facing the most imminent challenges from an ageing population – led by North America (54%), Australasia (39%) and Europe (37%). In contrast, the proportion choosing this option were far lower for regions with a younger population profile – namely Africa / Middle East (26%), Asia (30%) and South America (31). Over time, we would expect the popularity of these roles to rise in these regions as the twin effects of increasing life expectancy and more elderly people impact their economies. Across the age groups, it got the lowest score from those aged 21-30 (24%), compared to at least 38% for older age groups, with the 51-60 age group scoring it highest (49%).



Total Respondents: 484

Amongst the highest responding professional groups, the Old Age Wellness Manager role was most popular with Futures Researchers (60%), Consultants/Professional Services (49%) and those involved in Education (42%). The high score amongst the futures community comes as no surprise given the importance they have placed on the demographic time bomb and rising life expectancy.

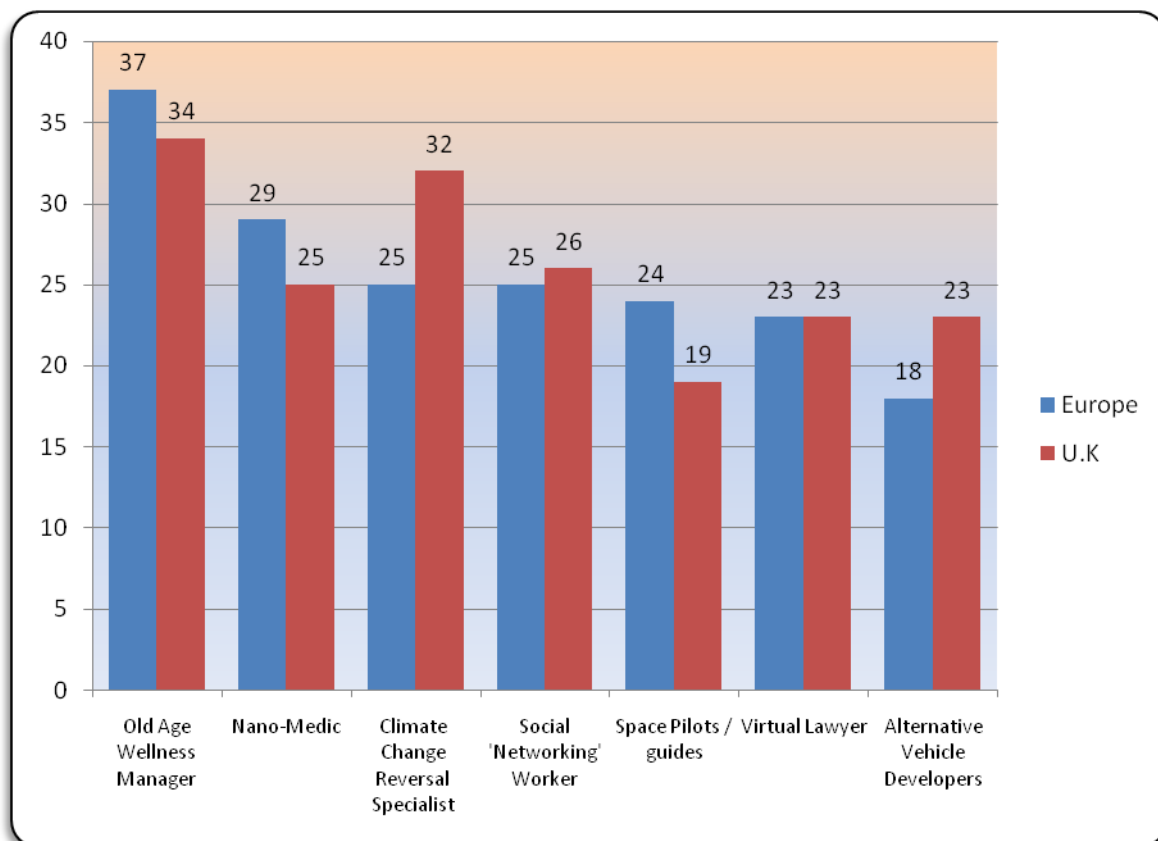
The next most popular choice 'Social Networking Worker' (29%) is also a potentially high touch' job, albeit created in response to high tech developments. Somewhat surprisingly, this proved more popular with males (30%) than females (25%). Geographically, the role was more supported by those in Australasia (40%), South America (39%) and Asia (32%) than by respondents from North America (30%) and Europe (26%). The role was also ranked more highly by those aged over 40. This possibly reflects lower levels of comfort for some over-40's in dealing with the rate of development in social media and the fundamental changes

they are bringing about in how we work, interact and share information. Interestingly, there was little meaningful deviation from the global popularity ranking in the ratings allocated by different professions.

Figure 7 below shows that despite facing some of the most pressing demographic challenges anywhere in the world, Europe (37%) and the UK (34%) both registered lower popularity figures for 'Old Age Wellness Manager' than the global figure (41%). However, it still remained the most popular choice. For both Europe and the UK, the next most popular choices differed from the global ranking. For the UK, 'Climate Change Reversal Specialist' (32%) came second while 'Nano-Medic' (29%) proved to be Europe's second choice.

For Europeans, the next most popular choices were 'Climate Change Reversal Specialist' (25%), 'Social Networking Worker' (25%) and Spaceline Pilot / Space Architect / Space Tour Guide (24%). For the UK, the rankings were broadly similar although 'Alternative Vehicle Developers' (23%) was the fifth most popular job choice – possibly reflecting the UK's growing concerns over climate change and the resulting rise of interest in green vehicles.

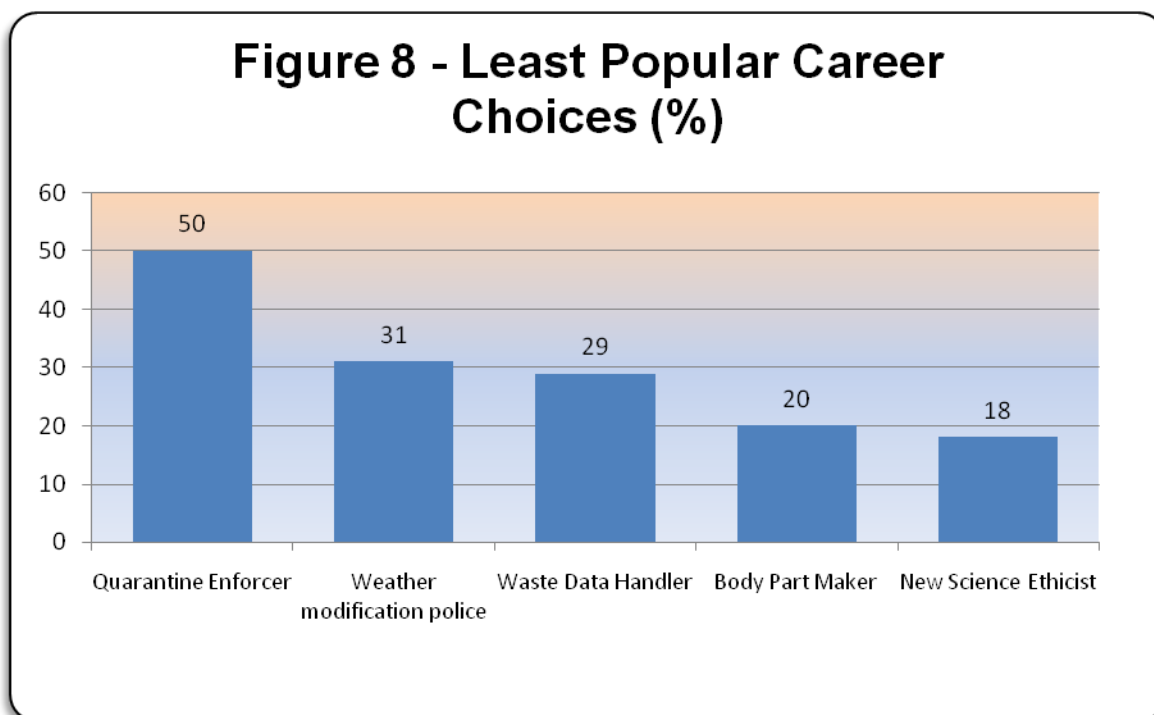
**Figure 7 – Most Popular Career Choices – Europe and UK**



Total Respondents: Europe 210 , UK 104

Respondents were then asked to select what they considered would be the three least popular career choices (Figure 8). The least popular roles were those that involved some form of policing function. The most disliked role was that of 'Quarantine Enforcer' (50%) – proving particularly unpopular with females (58%) compared to their male counterparts

(46%). The potentially dangerous and possibly morally dubious nature of the job was a commonly cited reason for the low ranking. Asia (38%) registered the lowest unpopularity vote for this job whilst two thirds of respondents from Australasia (66%) gave it their lowest rating. From an industry perspective, the role was least popular with Non-Profits (74%) and those in Government/Military (67%), whilst the lowest scores among the larger sector response groups came from Computing (33%).

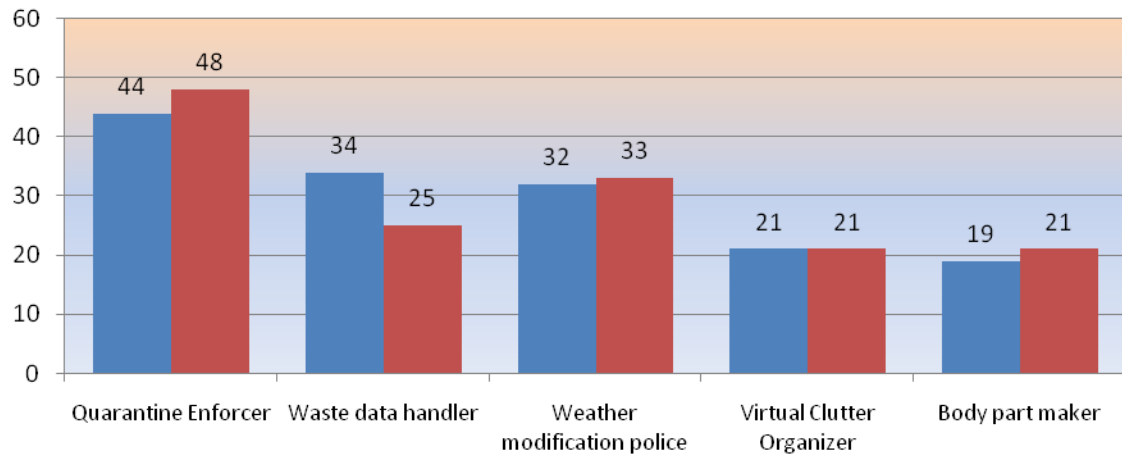


Total Respondents: 482

The role of 'Weather Modification Police' was most unpopular with North American respondents (39%) compared to just 16% of Asians. Whilst there was little difference when viewed from a gender perspective, there is a distinct pyramidal reaction when viewed from an age perspective. The role is significantly more unpopular with the 51-60 (36%) and 61-70 (37%) age groups. The figures for those aged 31-40 (30%) and 41-50 (29%) are broadly in line with the overall score while relatively low scores were registered by those aged 21-30 (15%) and 70+ (20%). Again the role is most unpopular with Non-Profits (74%). The role of 'Waste Data Handler' is almost equally unappealing to both genders and significantly more unpopular with those under 30 (34%) than those aged 61-70 (19%).

The main differences for Europe and the UK against the global picture (Figure 9) are firstly that Europe ranks 'Waste Data Handler' as a slightly more unpopular role than 'Weather Modification Police'. Secondly, both the UK and Europe have replaced 'New Science Ethicist' with 'Virtual Clutter Organiser' in the top five most unpopular roles.

**Figure 9 - Least Popular Career Choices  
Europe and UK (%)**



Total Respondents: Europe 209 , UK 104

### 5.3 Impact on Job Creation

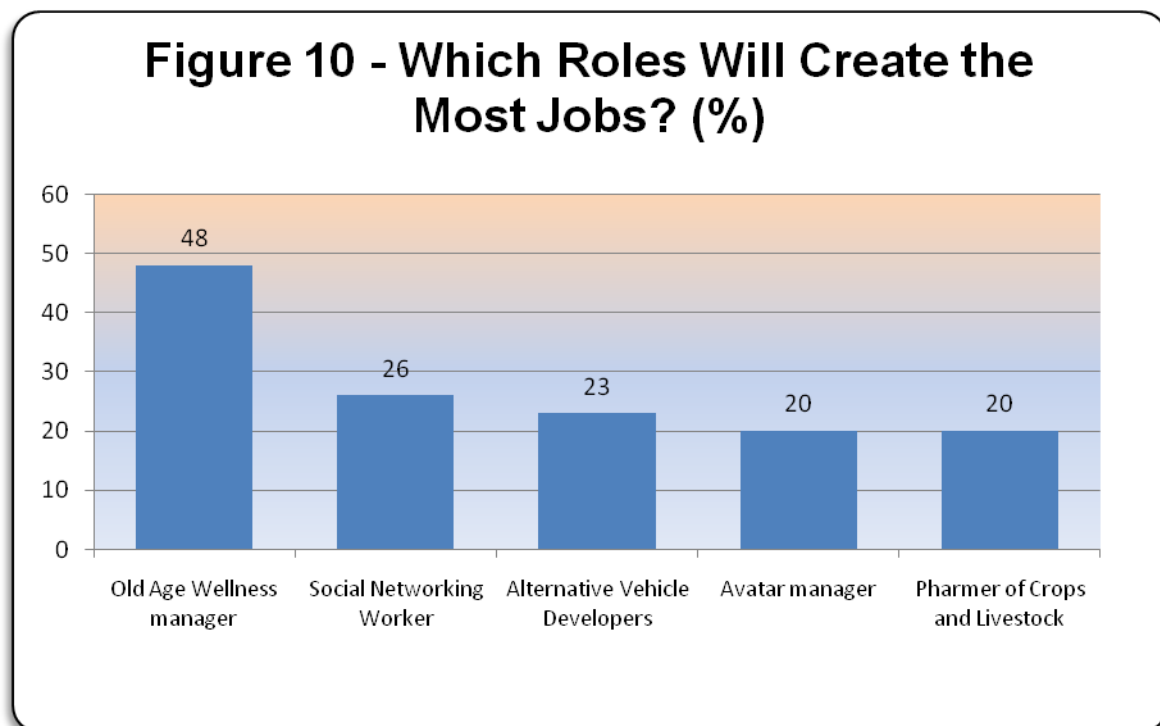
Respondents were asked to select the three jobs that they thought would create the most new jobs (Figure 10). Given the growing awareness of rising life expectancy, an ageing population and the relative wealth of the 'baby boom' generation (born 1946-64) it was perhaps natural that the 'Old Age Wellness Manager' is seen as having the most job creating potential (48%). There was no real difference between the male and female rating of this role. Interestingly, 40% of most age cohorts scored this role as the highest job creating role, except the 70+ age group (33%) – who possibly didn't see themselves as buyers of such services. The three continents facing the most immediate ageing challenges also ranked this role as the leading job creator, namely Australasia (55%), North America (51%) and Europe (48%). In the other three regions 35% or more ranked it as the most significant job creator on the list.

82% of those in Healthcare and 71% of Futurists compared to 48% overall, see 'Old Age Wellness Manager' as a major job creator –the highest responses amongst the larger respondent groups. An interesting outlier was Government/Military respondents where only 8% saw this as a major job creator.

The next most popular choice - 'Social Networking Worker' (26%) was ranked significantly higher by males (29%) than females (21%). The role was seen as a more important job creator by those aged 21-50 than those aged 51 or over. This is possibly an indication of how extensively networking is impacting the lives of the younger respondents, and the challenges faced by the 41-50 age group in particular to learn the new behaviours required to be effective in the social networking environment. In contrast, there was a sense from the



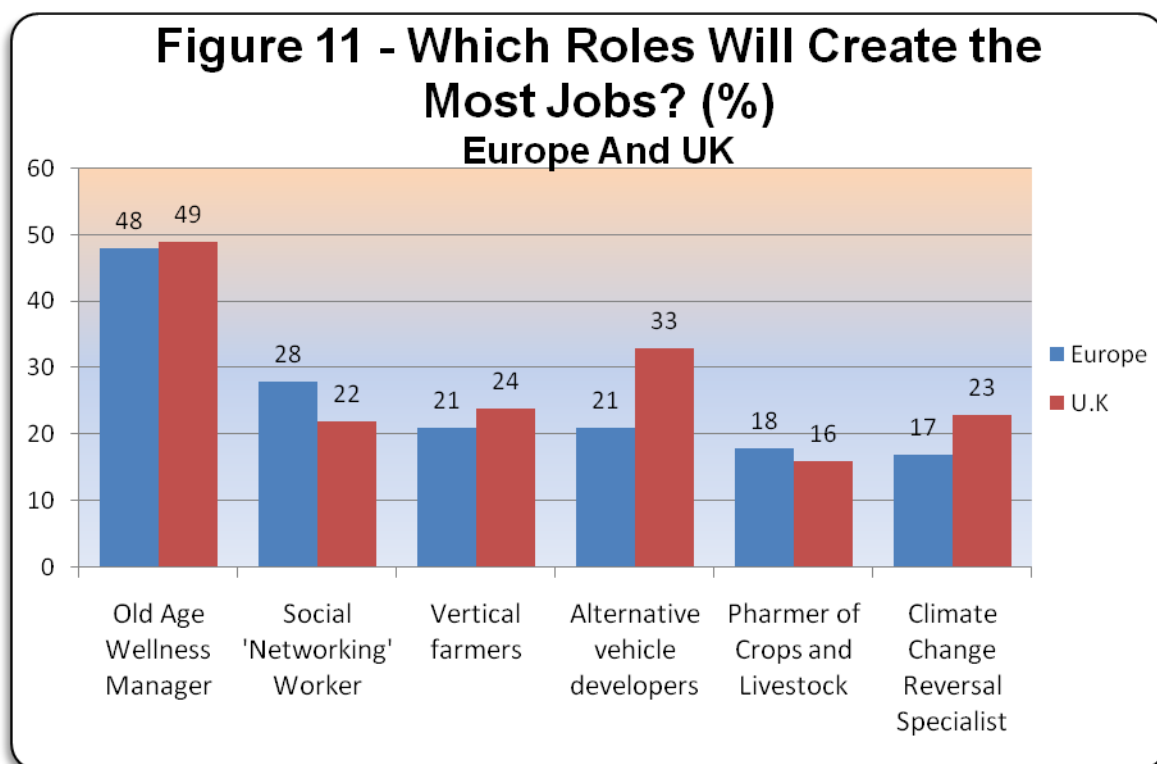
comments that those over 50 felt slightly less pressure from social networking or had yet to embrace it fully and understand the degree of impact it could have. The role received a much higher proportion of the vote from respondents in South America (54%) and Asia (35%), and while three of the other regions were close to the global average, Australasia (16%) was significantly lower. There were few outliers to the overall score amongst industry and functional groups. The one exception was Advertising and PR where only 42% cited it as a leading job creator.



Total Respondents: 477

The third most popular role – ‘Alternative Vehicle Developer’ (23%) received a significantly higher proportion of female votes (28%) than from males (20%). Given the current state of the US auto industry it came as no surprise that the North American vote (29%) was above the global average. The youth of Africa’s car industry and the relatively small size of the market to date, coupled with low fuel prices in the Middle East perhaps explain why the Africa / Middle East region registered a considerably lower than average vote of just 14%.

Given that both Europe and the UK respondents believed that ‘Old Age Wellness Manager’ would prove the most popular career choice, it is no surprise to see both groups citing it as number one for job creation. While ‘Social Networking Worker’ was also the second most popular job creator for European respondents, it ranked only fifth for the UK. For the UK ‘Vertical Farmers’ and ‘Alternative Vehicle Developers’ were voted as slightly more popular job creators. Interestingly both European and UK respondents placed ‘Vertical Farmers’ third – although it only ranked sixth globally. ‘Climate Change Reversal Specialist’, despite its relatively exclusive sounding title, was thought of as a major job creator by the UK who, at 23, were above the global score of 19% and the European score of 17%.



Total Respondents: Europe 209 , UK 104

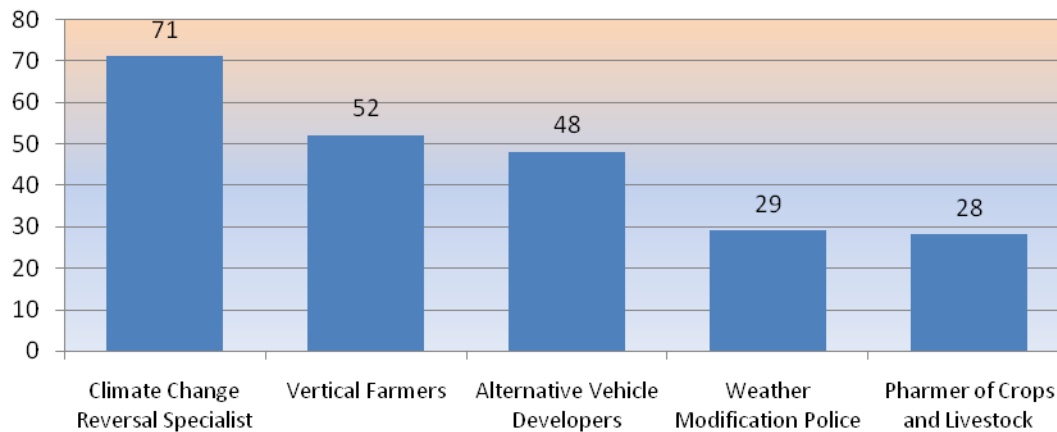
#### 5.4 Environmental Impact

Participants were asked to select the three jobs which would have the greatest environmental benefit (Figure 12). 'Climate Change Reversal Specialist' (71%) was the most popular choice globally – proving more popular with females (74%) than males (70%). All age groups voted above 70% except the 31-40 cohort (59%). It was ranked even higher by those aged 51-60 (75%) and 61-70 (74%). South America (77%), North America (75%) Asia (75%) and Australasia (74%) all scored above the global vote, while Europe (68%) and Africa / Middle East (65%) came in below it.

The next most popular choice was 'Vertical Farmers' (52%) – which proved particularly popular with females (65%) compared to males (45%). There is a major difference in regional perspectives for this role. Africa / Middle East (70%) and North America (64%) saw it as bringing major environmental benefits compared to Asia (22%) and South America (39%). Among the age groups, the role was considered most environmentally beneficial by the 51-60 cohort (59%) compared to the 61-70 and 70+ groups (36%).

The role ranked as the third most environmentally beneficial globally was 'Alternative Vehicle Developers' (48%). Again a considerably higher proportion of females (54%) ranked it of importance than males (44%). Regionally, Asia (36%) gave it the lowest positive ranking while North America (55%) and Australasia (52%) came in highest. The 61-70 cohort (55%) were the age group ranking it highest with those aged 41-50 (38%) coming in lowest. While most professions ranked the top five in very similar proportions in the global scoring, 83% of those in 'Non-Profits,' ranked 'Vertical Farmers' as providing the highest environmental benefits compared to just 29% in the 'Media'.

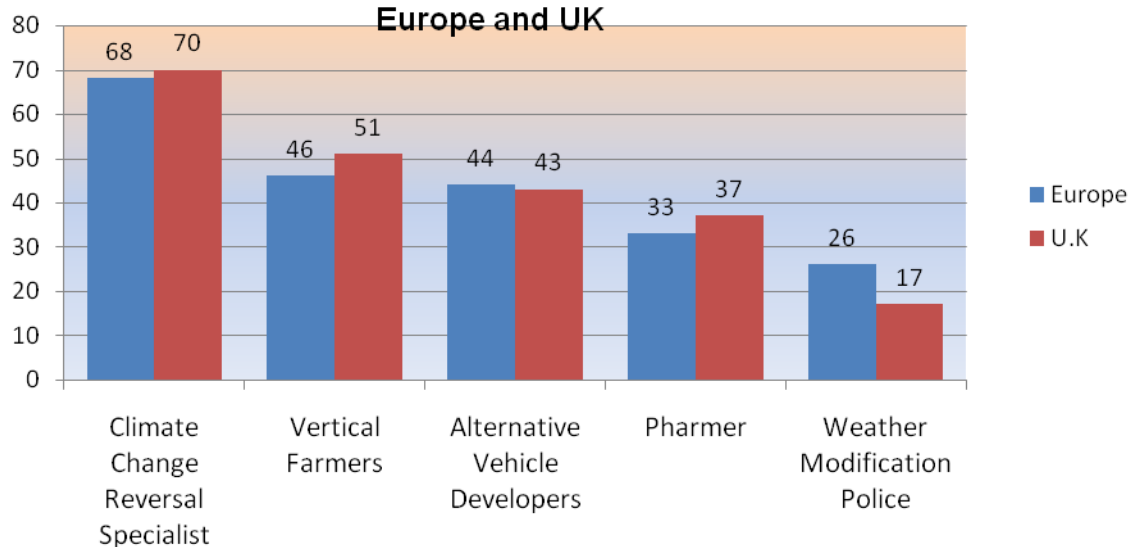
**Figure12 -  
Greatest Environmental Benefit (%)**



Total Respondents: 478

Europe and the UK (Figure 13) have similar rankings and scorings to the global picture. The one noticeable difference is that both place 'Pharmer' higher, with 37% of UK respondents ranking it in their top three for environmental benefits compared to 28% globally. While 'Weather Modification Police' still ranks in the top five, Europe scored below the global rating at 26% , while the UK seems even more sceptical, with just 17% thinking it would confer environmental benefits.

**Figure 13 - Greatest Environmental Benefit (%)  
Europe and UK**



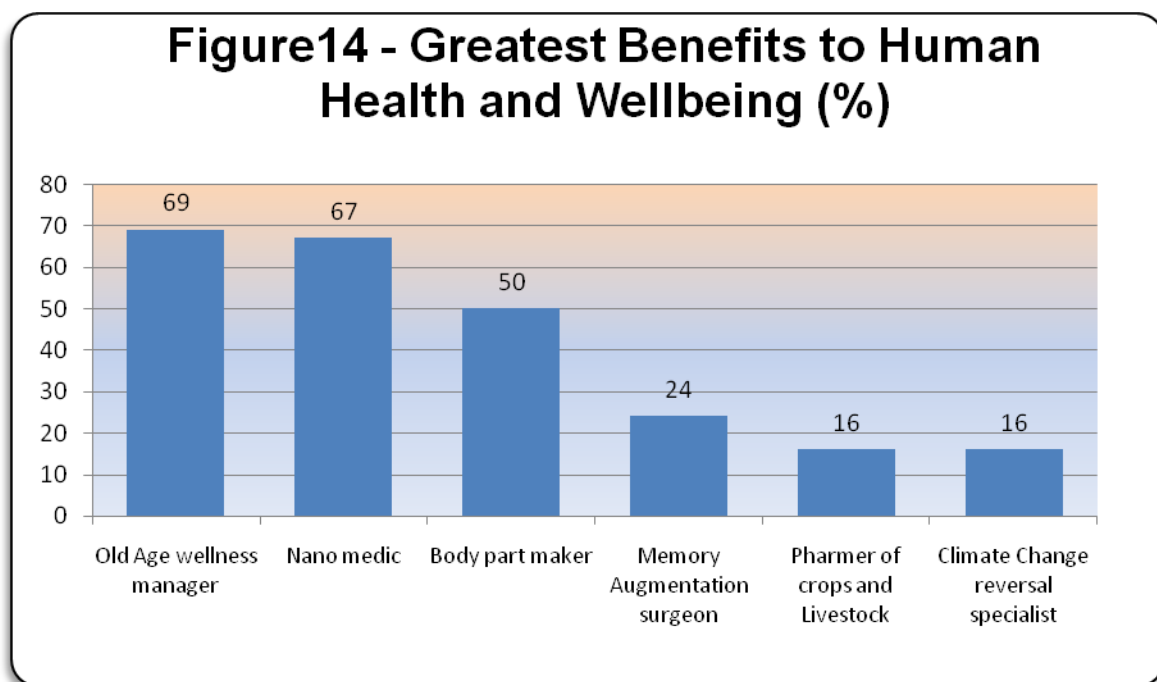
Total Respondents: Europe 209 , UK 103

## 5.5 Impact on Human Health and Wellbeing

Next, participants were asked to select the three jobs that would have the greatest impact on human health and wellbeing. Those deemed to bring major benefits in terms of human health and wellbeing (Figure 14) were 'Old Age Wellness Manager' ranking first at 69%, 'Nano-medic' follows with 67% and 'Body Part Maker' ranks third with 50%.

71% of females and 68% of males chose 'Old Age Wellness Manager' amongst their top three. The role scored highest with those aged 61-70 (84%) and the over 70's (86%). Geographically, the major outliers were Australasia (78%) and Asia (49%). 'Nano-Medic' was chosen by 70% of men and 62% of women. There were no major variations from the global ranking by age group.

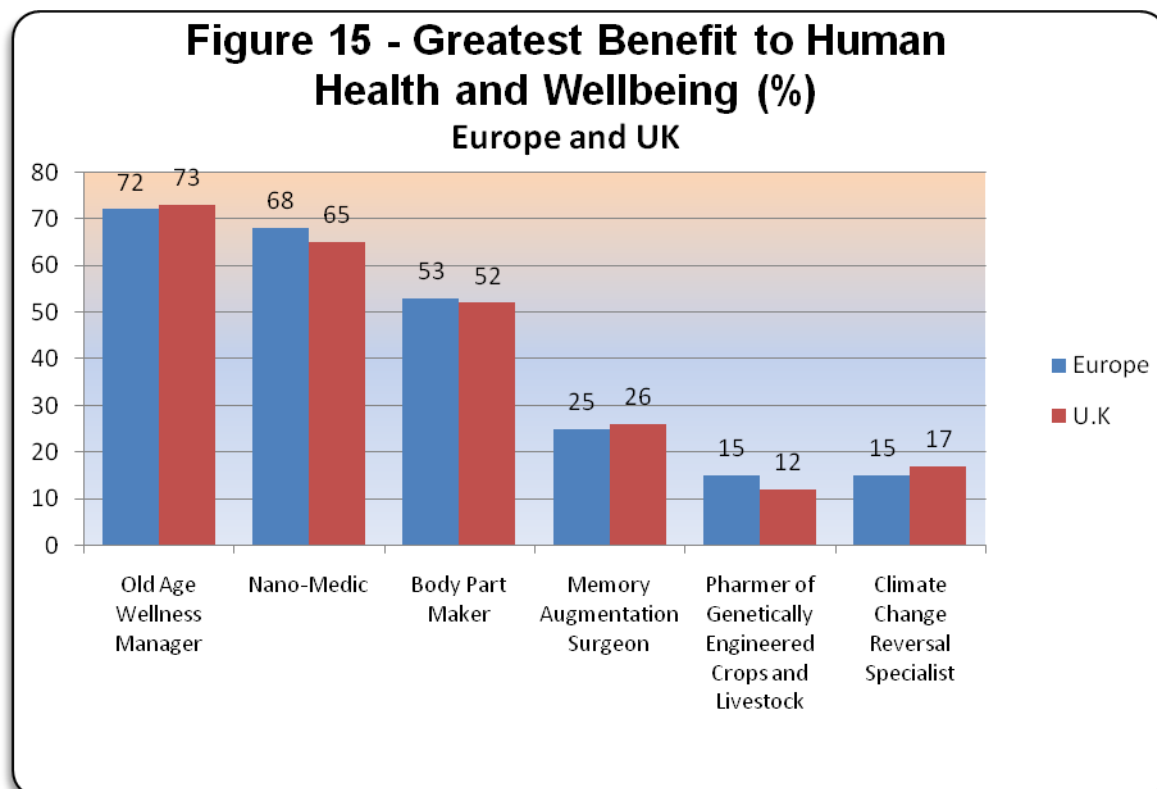
The value of the 'Body-Part Maker' role in delivering health benefits was supported by 54% of males, compared to only 42% of women. From an age group perspective, only the 51-60 cohort (57%) and the 41-50 age group (43%) differed markedly from the global ranking. When these results are viewed by continent, the main variations from the global score were that 66% of Australasians voted for the role compared to just 41% of Asians.



Total Respondents: 477

Given the relatively close ranking of 'Old Age Wellness Manager' (69%), and 'Nano-Medic' (67%), there are some interesting differences when comparing the two from a sectoral perspective. For example, those in Advertising / Market Research / Marketing / PR showed a strong preference for 'Old Age Wellness Manager' (76%) over 'Nano-Medic' (61%). Others showing similar rankings were 'Education,' with a 78/69% split, 'Futurists' (78/65) and 'Non-Profits' (63/42). Those ranking the 'Nano-Medic' position higher included 'Computer Hardware / Software' (79/ 58), 'Government / Military' (73/46) and 'Media' (63 /38). Amongst the largest respondent group – 'Consultants' - there is very little difference, with 71% choosing 'Old Age Wellness Manager' and 70% opting for 'Nano-Medic.'

While the European and UK respondent rankings (Figure 15) largely mirror the global scores, the one main difference is that the UK ranked 'Climate Change Reversal Specialist' higher than 'Pharmer'.



Total Respondents: Europe 209, UK 103

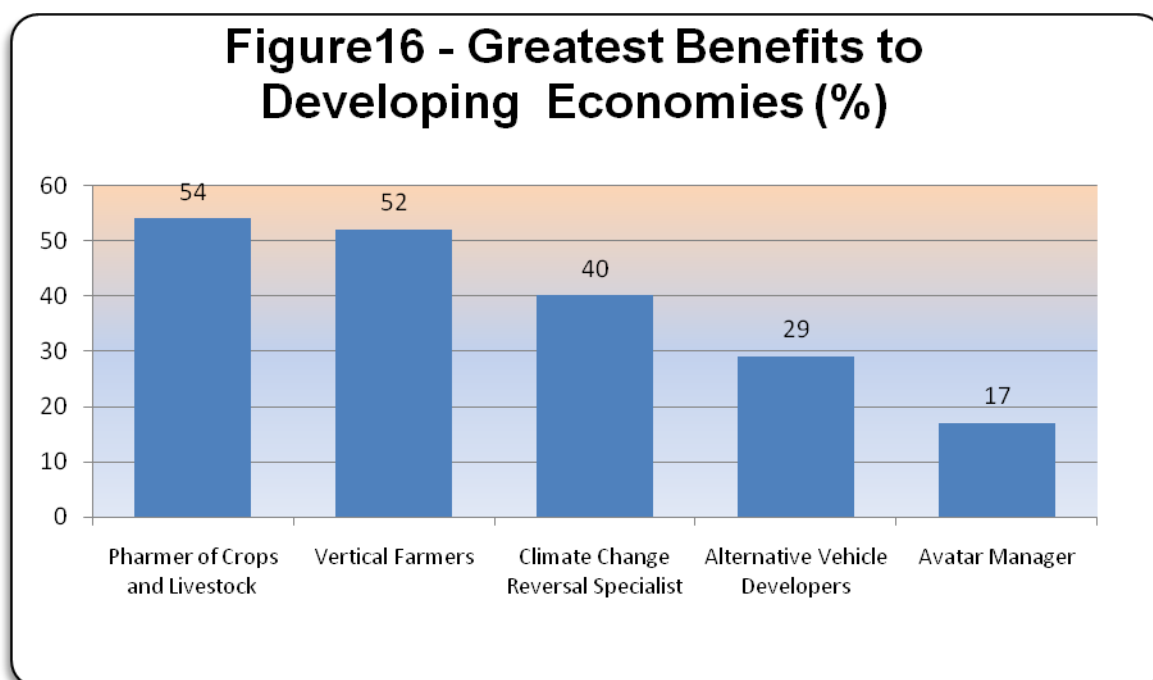
### 5.6 Impact on Developing Economies

Given the relative importance of farming to developing economies (Figure 16), it is perhaps unsurprising to see 'Pharmer of Genetically Engineered Crops and Livestock' and 'Vertical Farmers' top of the list with 54% and 52% respectively. Given a growing scientific consensus that the impacts of climate change are also set to disproportionately impact the poor, it is also understandable to see 'Climate Change Reversal Specialist' (40%) as the third choice.

By gender, 'Pharmers' was more popular with males (58%) than females (49%). The biggest support among the age groups came from the 70+ cohort (64%), while only 48% of 31-40 year olds cited it as amongst their top three jobs for delivering benefits to developing economies. From a regional perspective, 'Pharmers' was most popular with respondents from Africa / Middle East (63%), Australasia (61%), Europe (56%) and North America (53%). Although the most popular choice alongside 'Vertical Farmers' for Asians, it gained support from only 42% of respondents from the region.

'Vertical Farmer' was more favoured as benefiting developing economies by females (55%) than males (50%) and by the three older cohorts, scoring highest with those aged 70+ (64%) and lowest with the 21-30 age group (40%). Regionally, among respondents from what might be considered 'developing regions', the role of 'Vertical Farmer' was chosen by 62% of South Americans, 59% from Africa / Middle East and 42% from Asia. The high attraction for the Middle East may be accounted for by their having little arable land and a harsh climate.

The role was also ranked as providing the greatest benefits for developing economies by 56% of respondents from North America, 55% of Australasians and 48% of Europeans.



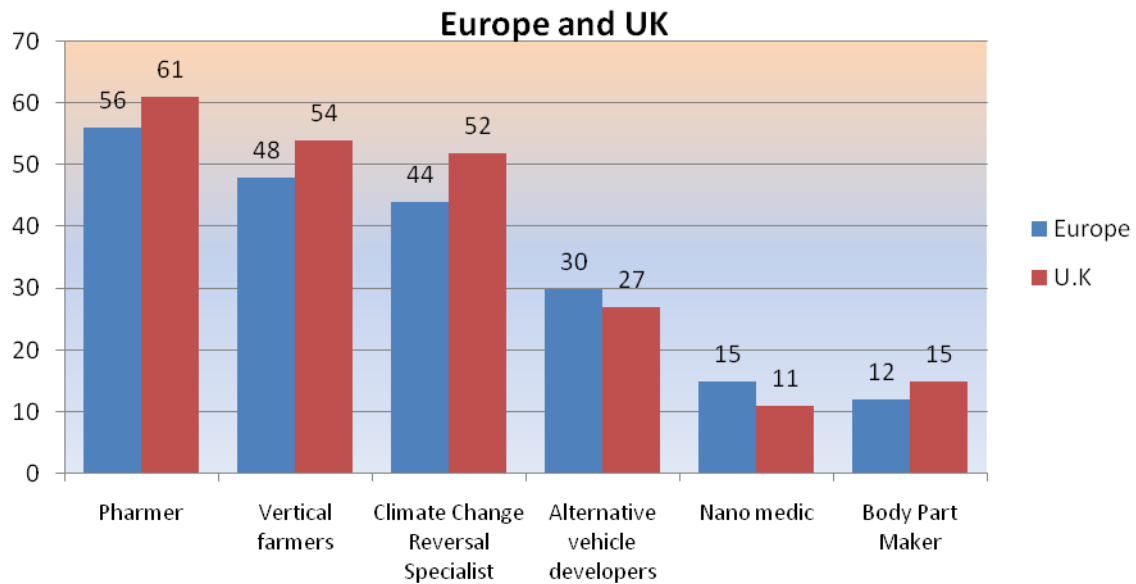
Total Respondents: 471

‘Climate Change Reversal Specialist’ was ranked similarly across genders. Within the age bands, the role got the highest support from the 51-60 cohort (48%) and the lowest from the over 70’s (29%). The role was largely seen as more important by respondents from developed economy regions, led by Australasia (55%), Europe (44%) and North America (33%). In contrast only 28% in Asia and 23% in South America ranked it highly. Africa / Middle East is the outlier at 46%.

When analysing the responses by profession, most opt for the same ranking of the top two roles globally. The only groups to favour ‘Vertical Farmer’ over ‘Pharmers’ were the ‘Futurists’ (74/61) and the ‘Non-Profits’ (63/37). This may reflect these two groups’ professional interest in studying these areas and their understanding of the long term benefits and risks associated with each role.

There are differences between the European and UK positions on which roles will confer the greatest benefits to developing countries. Both agree with the primary choice of ‘Pharmer,’ and both are above the global vote, with Europe at 56% and the UK at 61%. On ‘Climate Change Reversal Specialist’, the UK (52%) registered a significantly higher share of the vote than Europe or the global score. Interestingly, globally ‘Avatar Manager’ was thought to confer benefits to developing countries – receiving the support of 17% of global respondents. Neither Europe nor the UK ranked it amongst their top five – with Europeans opting for ‘Nano-Medic’ and UK respondents selecting ‘Body Part Maker’ in its place.

**Figure17 - Greatest Benefit to Developing Economies (%)**

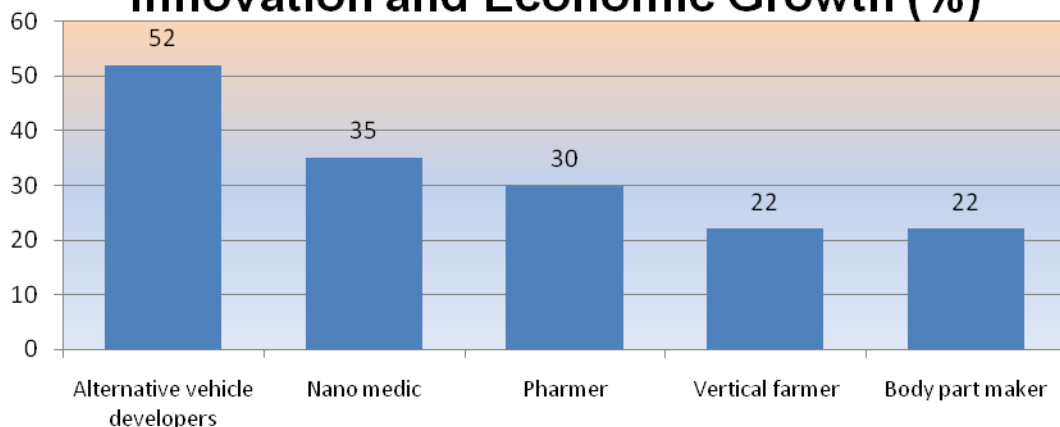


Total Respondents: Europe 207 , UK 102

### 5.7 Impact on Commercial Innovation and Economic Growth

Transport, health and food supply were considered important domains when selecting jobs with greatest potential commercial and economic impact. The three highest ranked roles were 'Alternative Vehicle Developers' (52%), 'Nano-Medics' (35%) and 'Pharmers' (30%).

**Figure 18 - Greatest Impact on Driving Commercial Innovation and Economic Growth (%)**



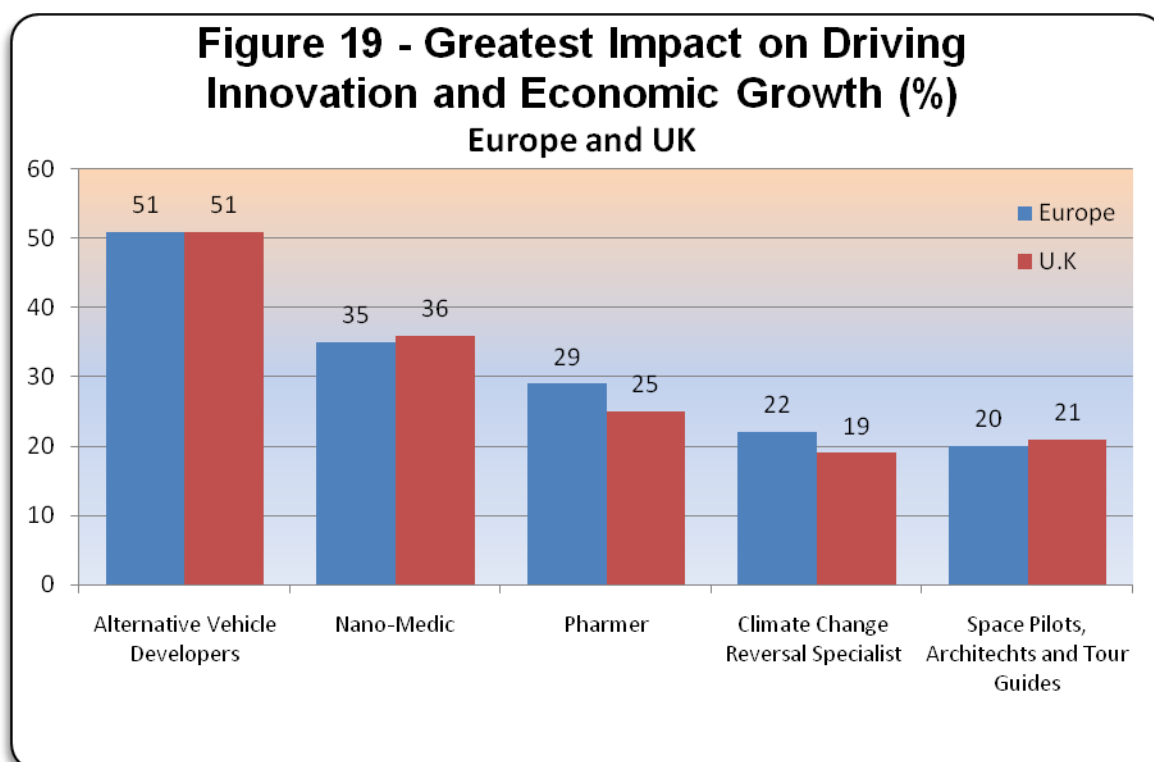
Total Respondents: 474

Favoured by 57% of females against 50% of males, 'Alternative Vehicle Developer' was most popular with the three older age groups – ranking highest with the 51-60 cohort (59%), and got least support from those aged 31-40 (41%). From a regional perspective, the role gained the highest support from South America (77%), Australasia (65%) and Africa / Middle East (57%). Europe (51%) and North America (50%) mirrored the global vote, whilst it got the least support from Asia (43%).

Most regions' voted for the commercial and economic impact of 'Nano-Medic' at similar levels to the global score except Africa / Middle East (22%). The role received higher support from males (37%) than females 30%. It also ranked highest with the over 70's (43%) and gained least support from 21-30 cohort (18%) – possibly the group in the best health and seeing the least economic value for such a role at this point in their lives.

'Pharmers' got the most votes as an economic and innovation catalyst from Africa / Middle East (48%) and Australasia (36%), perhaps reflecting the challenging agricultural conditions currently prevalent in parts of these regions. The role of 'Pharmer' was more popular with males (33%) than females (26%). While most age groups rated the role close to the global scoring, the major outlier was the 70+ age cohort (14%).

Amongst the professions, two groups voted against the general trend. Among those in 'Healthcare' 55% selected 'Nano-Medic' compared to 36% opting for 'Alternative Vehicle Developers' - possibly not a surprise. Similarly those in 'Computer Hardware / Software / Internet' voted 46% to 33% in favour of Nano-Medic'.



Total Respondents: Europe 206, UK 102



Both the UK and Europe selected the same top three jobs as those ranked highest at the global level. Interestingly both Europe and the UK opted for 'Climate Change Reversal Specialist' and 'Space Pilots, Architects and Tour Guides' among their top five – replacing 'Vertical Farmer' and 'Body Part Maker' which came fourth and fifth in the global rankings.

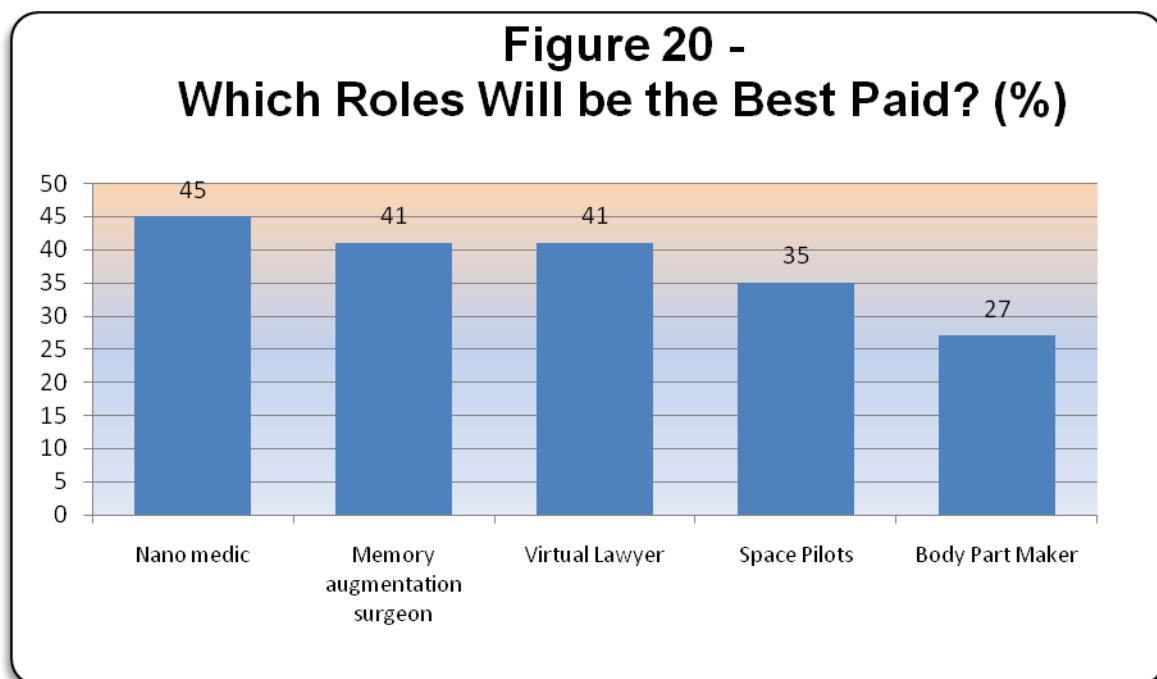
### 5.8 Financial Rewards

Globally the three roles considered likely to be the best paid (Figure 20) were 'Nano Medics' (45%), 'Memory Augmentation Surgeon' (41%) and 'Virtual Lawyers' (41%). While most age groups mirrored these rankings, 'Virtual Lawyer' was the most popular choice for the 41-50 age group (43%) and the over 70's (64%). While the genders voted roughly evenly for 'Virtual Lawyer', the male: female split was 49% to 41% for 'Nano-Medic' and 39% to 45% for 'Memory Augmentation Surgeon'.

From a regional perspective, the roles considered the best paid were:

- Nano Medic – South America (58%)
- Memory Augmentation Surgeon - Africa / Middle East (50%), North America (50%) and Australasia (44%)
- Virtual Lawyer – Europe (48%)
- Space Pilots, Architects and Tour Guides – Asia (43%).

Among the professions, those favouring 'Nano-Medic' included 'Futurists' (70%), 'Financial Services' (58%), 'Media' (56%) and 'Education' (53%).



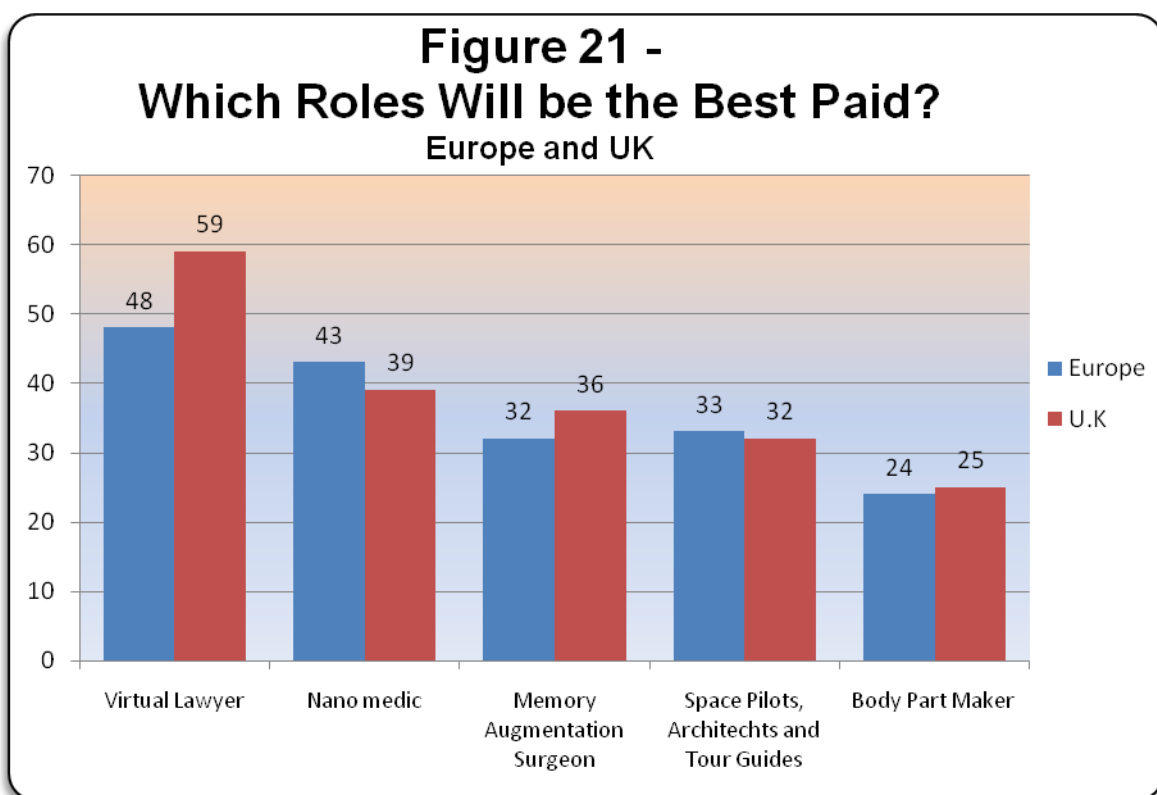
Total Respondents: 472

Those most frequently citing 'Memory Augmentation Surgeon' as the highest paid role included 'Non-Profit' (58%) and 'Consulting' (45%). 'Virtual Lawyer' was favoured by those in

‘Advertising / Market Research / Marketing / PR’ (50%) and was joint most popular for those in ‘Education’ (53%).

The relatively narrow overall gap between the top four jobs on expected income is further indicated by the popularity of ‘Space Pilots, Architects and Tour Guides’. Despite it polling fourth overall, those in ‘Computer Hardware / Software / Internet’ rank this job first at 50% and it also ranks highly for those within ‘Financial Services’ (54%).

While the same jobs are considered to be the best paid by respondents in Europe and the UK as in the global rankings, there are marked differences in the ordering. For Europe and the UK, Virtual Lawyer is considered the most likely to be the best paid. ‘Memory Augmentation Surgeon’ falls to fourth in the European ranking and third for the UK.



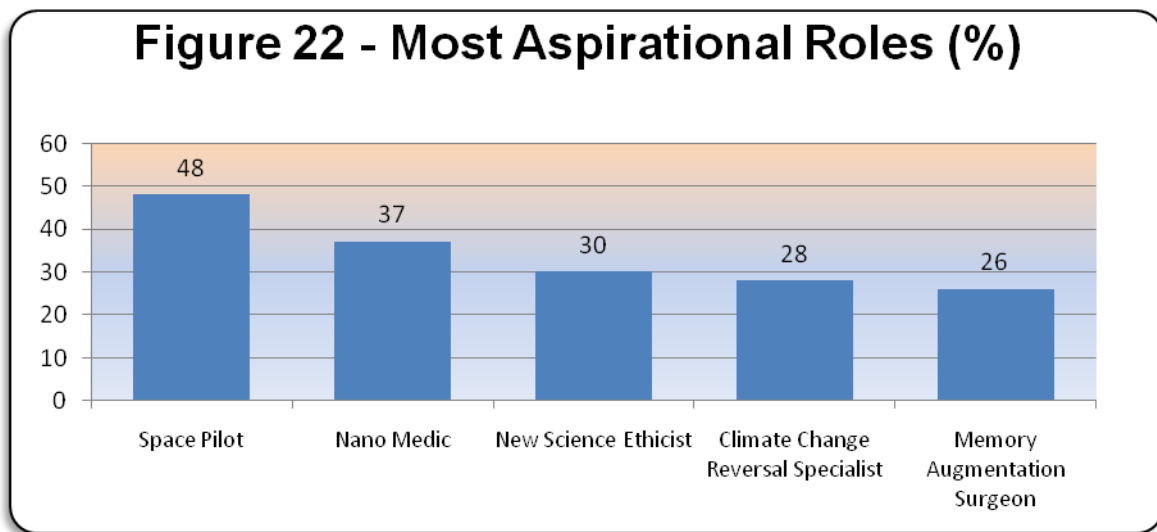
Total Respondents: Europe 206, UK 102

### 5.9 Aspirational Status

When asked to pick which would be the three most aspirational jobs (Figure 22), globally participants selected ‘Space Pilot’ (48%), ‘Nano-Medic’ (37%) and ‘New Science Ethicist’ (30%). The only significant gender difference in scoring was for ‘Nano-Medic’ which was selected by 40% of males compared to 31% of females. For the four groups between 21 and 60, ‘Space Pilots, Architects and Tour Guides’ was considered the most aspirational, while for those in the 61-70 cohort it was ranked joint top with ‘New Science’ Ethicist’. For the 70+ age group the thrills of space were ranked second behind ‘Nano-Medic’.

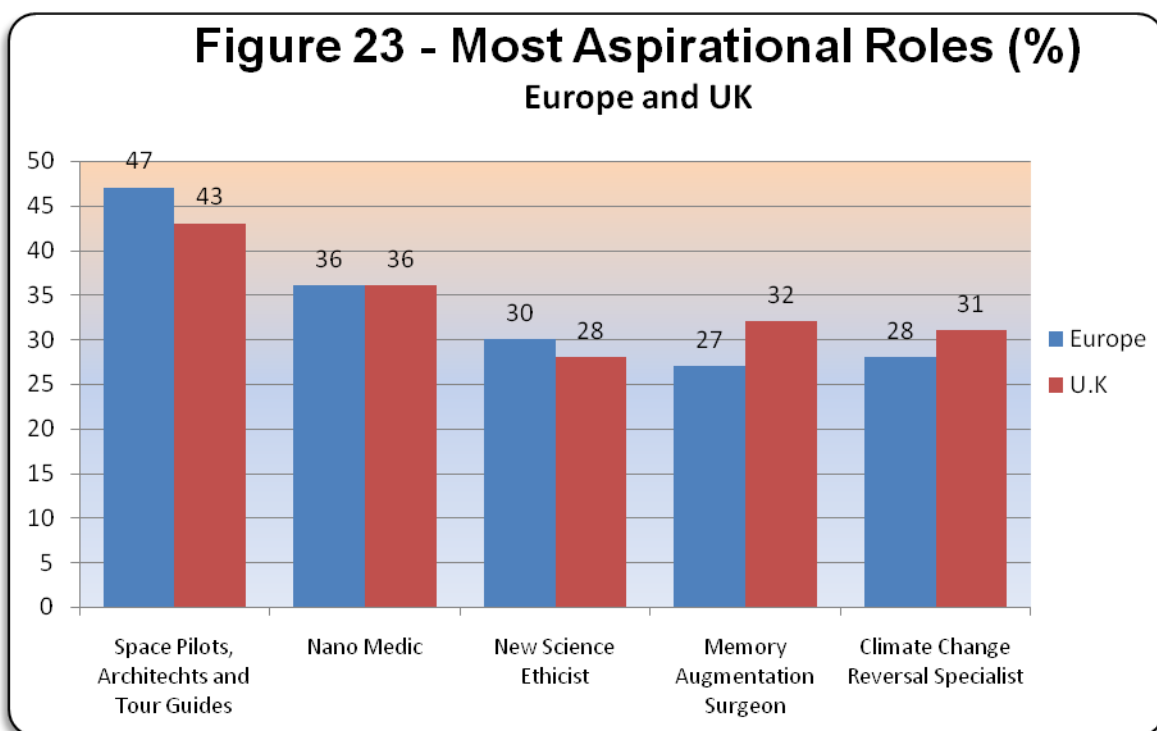
Regionally, the only significant variation was Australasia which put ‘Nano-Medic’ in first place and ranked ‘New Science’ Ethicist’ fifth. The latter role also received similarly low rankings from Africa (6<sup>th</sup>) and Asia (7<sup>th</sup>). The only two professional groups not ranking ‘Space Pilots,

Architects and Tour Guides' as the most aspirational were 'Consultants' and 'Financial Services' who both opted for 'Nano-Medic'.



Total Respondents: 460

Again while the top aspirational jobs for Europe and the UK are the same as those chosen globally, there are variations. Both European and the UK gave slightly lower scores than those achieved globally for 'Space Pilots, Architects and Tour Guides' and 'Nano-Medic'. A higher proportion of respondents in the UK also selected 'Memory Augmentation Surgeon' and 'Climate Change Reversal Specialist' than in the European and global rankings.

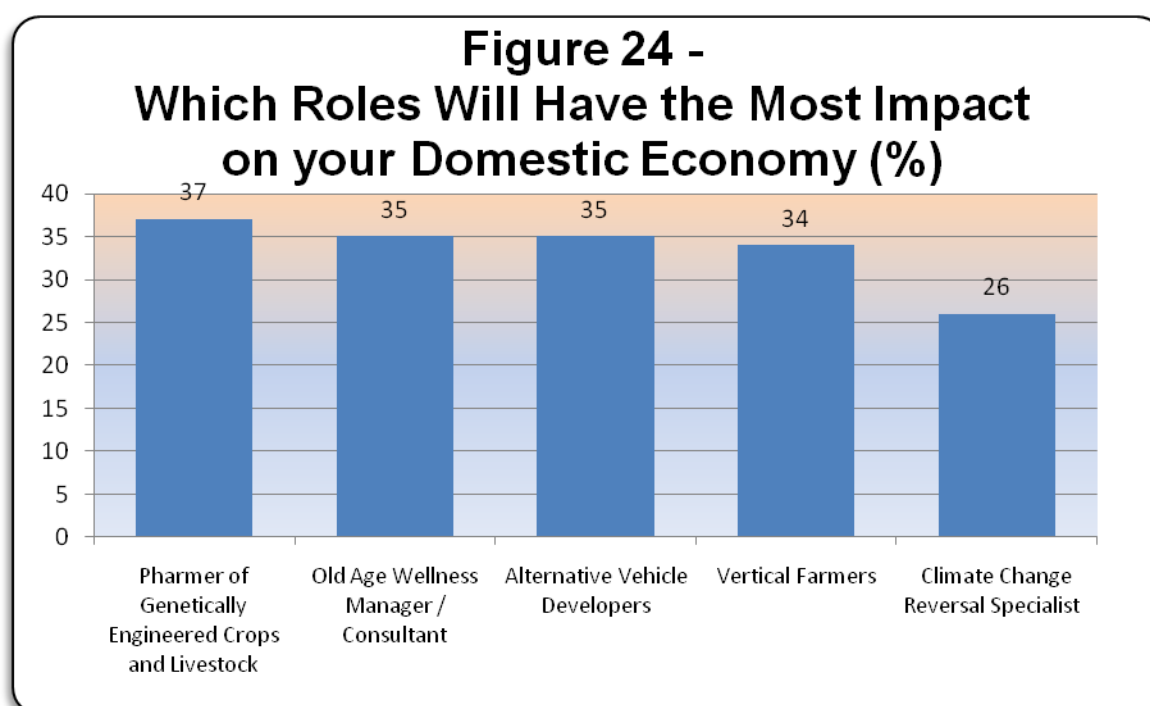


Total Respondents: Europe 203, UK 102

### 5.10 Impact on Domestic Economies

Participants were asked to select the three roles that would have the most impact on their domestic economy (Figure 24). The roles which gained the most support globally were 'Pharmer of Genetically Engineered Crops and Livestock' (37%), 'Old Age Wellness Manager / Consultant Specialists' (35%) and Alternative Vehicle Developers (35%). Of most interest here are the regional perspectives. What can be seen is the importance of the 'Pharmer' role for every region. The 'Vertical Farming' role also ranked highly for all markets except North America. The more developed markets of Europe and North America also place a high importance on Old Age Wellness Manager / Consultant' role:

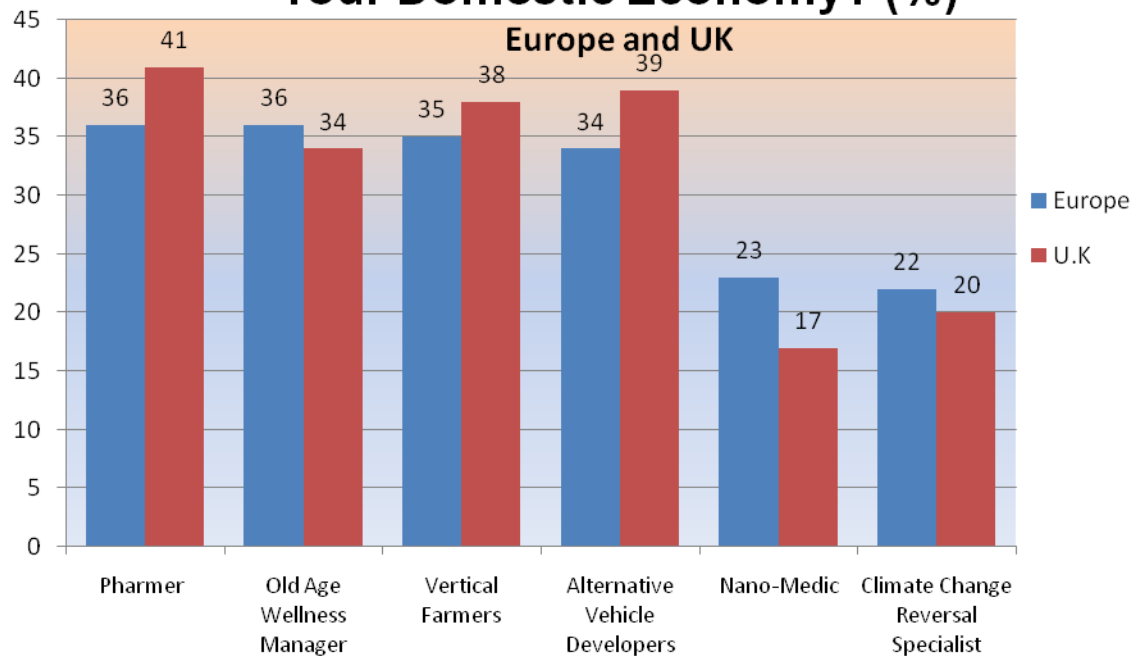
- Respondents from Africa / Middle East selected 'Pharmer of Genetically Engineered Crops and Livestock', 'Vertical Farmers' and 'Alternative Vehicle Developers'.
- For Asia, 'Pharmer of Genetically Engineered Crops and Livestock', 'Vertical Farmers' and 'Climate Change Reversal Specialist' were ranked in joint first place.
- For Australasia, 'Climate Change Reversal Specialist' ranked first followed by 'Pharmer of Genetically Engineered Crops and Livestock' and 'Vertical Farmers' in equal second place.
- Europe selected 'Pharmer of Genetically Engineered Crops and Livestock' and 'Old Age Wellness Manager / Consultant' in first place followed by 'Vertical Farmers' in third place
- For North America, three roles were considered equally important - 'Pharmer of Genetically Engineered Crops and Livestock', 'Old Age Wellness Manager / Consultant' and 'Alternative Vehicle Developers'
- South American respondents selected 'Vertical Farmers' followed by 'Pharmer of Genetically Engineered Crops and Livestock' and 'Alternative Vehicle Developers'.



Total Respondents: 460

For the UK (Figure 25), the roles considered most important were 'Pharmer of Genetically Engineered Crops and Livestock', 'Alternative Vehicle Developers' and 'Vertical Farmers'.

**Figure 25 -  
Which Roles Will Have Most Impact on  
Your Domestic Economy? (%)**



otal Respondents: Europe 204, UK 102

### 5.11 Most and Least Hoped For Roles

Finally, participants were asked free text questions to identify the jobs they would most and least like to see materialise and why. Those pertaining to personal and environmental health were considered the most desirable. Figure 24 sets out an analysis of the comments. The five most desirable roles are listed below along with some example comments:

#### Old Age Wellness Manager (12%)

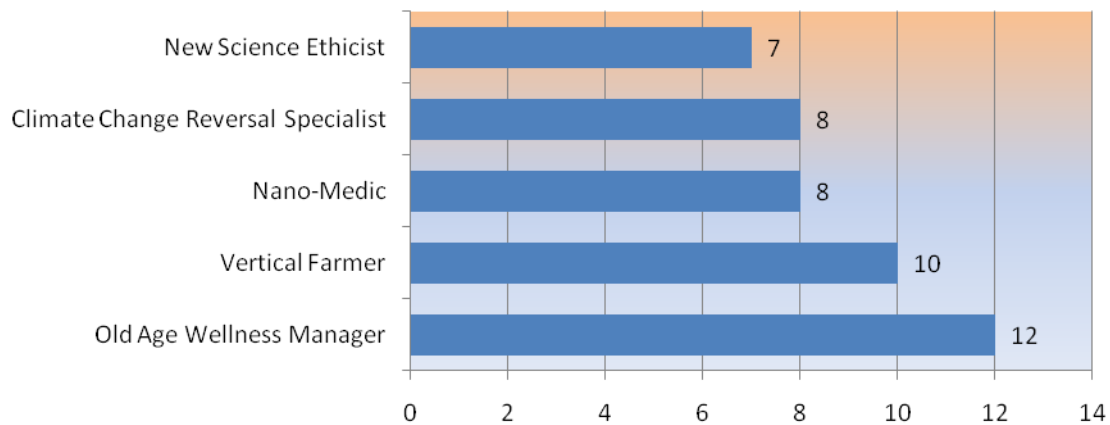
*“Providing support for aging people will reduce demands on the programs that put the highest costs on society - economically and psychologically. Promoting better mental health and responsibility for oneself will provide purpose for aging people when they usually are at a stage where they feel they have no purpose. This is a win-win.”*

*“Taking the time to maintain themselves will keep them busy, be self-rewarding, and minimise the burden on social programs, families, and government budgets.”*

#### Vertical Farmer (10%)

*“We expand our ability to grow more food in areas that will bring it closer to the people who consume it (by reducing transportation). Expanded capacity reduces delivery costs. It should also make food less expensive and more readily available (as well as having positive environmental results, such as reduced agro-pollution i.e. run-off).”*

**Figure 26 - Please State the Job you Would Most Like to Appear (%)**



Total Responses: 227

Nano Medic (8%):

*“Advances in science will revolutionize health care and increase personal life spans and quality of life, particularly among the aging.”*

Climate Change Reversal Specialist (8%)

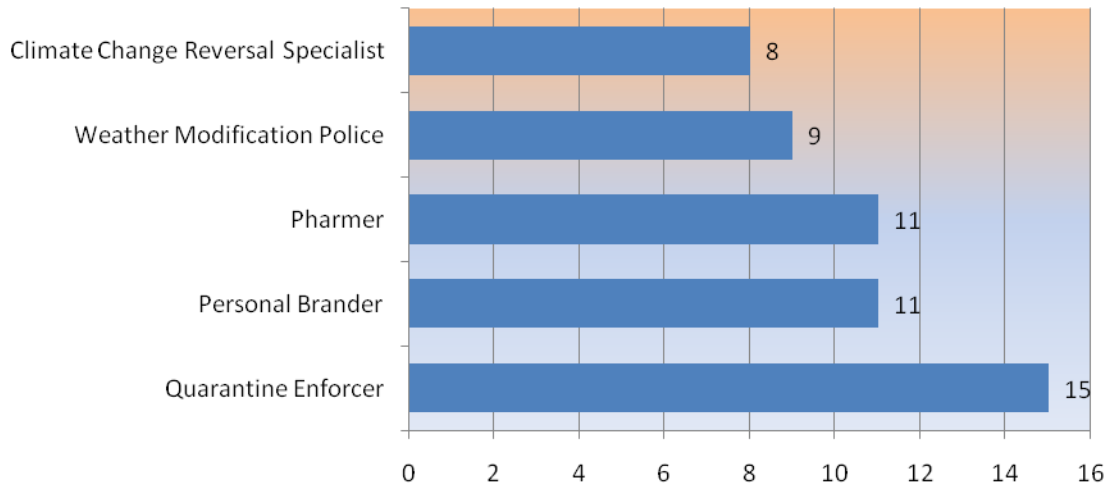
*“As I perceive things, if we do not mitigate our environmental impact soon, the consequences could be so disastrous in 50 - 75 years from now that we will all be in survival mode facing a holocaust of unimaginable proportions.”*

New Scientists Ethicist (7%)

*“Innovation may lead to incredibly powerful technologies. Many of the technologies we see in science fiction movies will eventually be developed- it's only a question of time. However, the power of these new technologies could have devastating side effects. Without wisdom and ethical standards, any tool invented could be destructive. Assessing any new technology based on its ethical relevance may be more important than developing the technology in the first place.”*

The roles which respondents least wanted to see appear focused on various forms of policing task, personal branding, genetic intervention in farming and failing to address the challenges of climate change. Figure 27 sets out an analysis of the comments received. The most commonly cited roles are listed below along with some example comments:

**Figure 27 - Please State the Job you Would Least Like to Appear (%)**



Total Responses: 225

Quarantine Enforcer (15%)

*"It's not a pleasant future if we need this type of position."*

Personal Brander (11%)

*"I don't think the future's going to be about 'me'."*

Pharmer of Genetically Engineered Crops and Livestock (11%)

*"GMO products have the potential to destroy whole classes of crops, reduce our food choices, cause waves of new health problems and put farming out of economic reach of most current farmers and their families."*

Weather Modification Police (9%)

*"It would indicate that we've got a problem. It would also add complexity to geo-political issues and enhance the potential for conflict."*

Climate Change Reversal Specialist (8%)

*"We do not understand the system perfectly – let's try to adapt better rather than preserve the status quo on a planet that has seen wild swings throughout its history."*

Interestingly, as many people were against this job as people who were for it in the previous question, indicating the polarising nature of the climate change issue.

## 6. *The shape of jobs to come* – Key Implications

### 6.1 Expert Opinions

The survey responses highlight the scale of impact and opportunity presented by the twenty jobs profiled in this report. So what are the implications of the underlying advances in science and technology and the jobs they could create? It is not too dramatic to suggest they will affect every aspect of our lives from the state of the economy to governance systems, from human health to the nature of work and from tackling human development challenges to protecting the environment. To help provide a broad perspective on the implications, we invited a number of respected futurists from around the world to provide their perspective on the following dimensions of *The shape of jobs to come*:

- **New Era - New Careers - New Challenges** – Personal futures specialist Verne Wheelwright overviews the broad scope of impacts and the implications for education
- **Commercial Reality Check** – International foresight consultant and educator Adam Gordon highlights the critical role of commercial viability in determining which areas of science and which careers will progress
- **Critical Domains** – Technology futures expert Ian Pearson suggests critical domains which could provide the greatest commercial and employment opportunities
- **Automation and Personalisation** – Future strategy and innovation specialist Stephen Millett explores the implications arising from continued automation and the increasing desire for individually customised services
- **Solutions for a Low Carbon Economy** – Global futures authority Michael McAllum argues the critical importance of the specialist roles that will help us transition to a post-carbon economy
- **New Roles in Social Media** – Social network founder and strategist Penny Power highlights opportunities that could emerge once corporations fully embrace social media
- **Jobs in Space** – Educational futures specialist Tom Hoffman explores the wealth of opportunities that could arise from space exploration and colonisation of other planets
- **Adapting to Change** – Influential Dutch futurist and trendwatcher Marcel Bullinga highlights the need for a mindset shift to help us prepare for a new era of opportunities
- **Implications for Education** – Respected futures researcher Ann Feeney examines the implications for how educational systems will need to adapt to prepare us for these roles.

### 6.2 New Era - New Careers - New Challenges

In 1981, when the IBM personal computer was introduced, the general public started encountering and using computers for the first time. From that introduction, it was only a few years before hard drives, Internet, email, spam, notebooks, and other technologies of the personal computer era arrived. Along with those technologies came new job titles like webmaster, content manager, hacker, spammer and specialized designers of personal software including firewalls, spyware, antivirus, spam filters and many others.

Today we see new industries nearly ready to explode into the public's view in much the same manner. The needs of industry and medicine to work at the sub-atomic level are bringing nano-materials, nano-machines and nano-medicines. The fields of genetics and protein synthesis are already here and will introduce additional careers and job titles. Space



tourism appears on the verge of launching another group of careers. Finally, the aging of the population and the Boomer generation in particular will create a demand for care and services that have yet to be recognized.

This is just the beginning of a new decade of changing technology, changing careers and new job descriptions and titles. The basic research and proofs of concept have already been done in most of the fields on this list, and commercialization is already underway in several fields. Which of these jobs will actually materialize and when? That is part of the commercial process, and is dependent on markets for each of the end products.

As each of these new fields becomes commercially viable, there will be demand for training from people who want to work in the new industries as well as from the industries themselves. Courses and technical training will be developed at technical schools and community colleges. Universities will introduce classes and departments to train specialists and professionals to meet the needs of the new industries and will eventually grant higher degrees in the new fields. Our children or grandchildren may be the students who graduate from one of those schools to enter these exciting new industries. Welcome to the world of fast moving change!

**Verne Wheelwright**

**Futurist - Personal Futures Network USA**

### **6.3 Commercial Reality Check**

One of the benefits of thinking about science and technology foresight in terms of jobs is that doing so encourages a reality check, forcing the question: will someone get paid to do this, if so, by whom and why (how will it be profitable to the job giver?) In other words, the question goes beyond whether one can imagine a job that will need doing or a job that someone might like to do it – that's just mental bubble gum. It forces us to focus instead on the more interesting and taxing issue of whether the need will justify enough paying customers such that the job will exist at all. Of course, science and technology progress will make new products and services possible partly by reducing the price point of providing them. For example, here are three jobs I think would be needed and economically justifiable:

1. Organ Agent: a person who sources and negotiates real or artificial organs on behalf of those in who want them.
2. Automated Systems Trouble-shooter: a person who oversees automated systems (e.g. smart highways) and intervenes and corrects as necessary.
3. End-of-Life Planner: a person who helps people plan and manage their own death - combating the fact that medicine/technology will be able to keep most people technically alive pretty much forever.

**Adam Gordon**

**Foresight Consultant and Educator - The Future Studio UK**

### **6.4 Critical Domains**

So which are the domains of science and technology that could have the most commercial impact and lead to significant numbers of new jobs and careers? The trends and resulting future jobs which I think will be most important are those associated with augmented reality, developments from NBIC, energy technology, human longevity and health, robotics and new

interfaces. An area we should not underestimate is the huge potential impact of Artificial Intelligence (AI) - especially the ability of computers to design their own offspring. New roles will also emerge around the application of AI in the arts.

Specialist roles will also emerge developing advanced solutions for the consumer space such as digital jewellery, active skin, active make-up and displays in clothing. As take up increases, so a second wave of opportunities will emerge to address the consequences of people using all this virtual world technology in the real world, i.e. what developments will augmented reality facilitate when people start to harness it regularly?

**Ian Pearson**

**Futurist – Futurizon UK**

### **6.5 Automation and Personalisation - Anticipating Employment Patterns to 2030**

Arguably the single most important long-term trend in employment patterns has been the automation of labor. As manufacturing shifted the burden of labour from handcraft to industrial production, so automation is progressively replacing the functions of industrial workers. This shift is occurring primarily among unskilled workers, but it is also impacting highly skilled workers as well as managers.

Automation will likely continue as the most important driver of employment patterns in the developed world over the next two decades. As technologies become more sophisticated, more routine and labour-intensive jobs will be automated. This trend is already spreading from manufacturing to the service sector. An important implication is that all employees, in both the manufacturing and services sectors, will be expected to increase their productivity and increasingly add more value to their work. The key to adding value will be personalisation for individual customers and clients when automation cannot be fully achieved at acceptable prices or to customer satisfaction. Therefore, the emerging pattern in employment favors customizing services. For example:

- Personal wellness coaches who guide individuals or small groups of people toward better health and disease prevention through exercise, nutrition, and health monitoring. This service area will extend to personal health care providers, such as paramedics, nurses, and nurse-practitioners. There will likely be a new category of professionally trained wellness and health care providers with several years of medical training beyond college but short of the full rigor of becoming physicians.
- Financial and legal service providers will attend to the personalised needs of financial health. There will be a growing number of professionally trained financial planners, insurance and investment agents, accounting and tax preparers, and bankers. Because legal concerns can be so personal, the legal profession will continue to expand to meet growing demands for individualized legal services. There will likely be a growth in paralegal and quasi-professional legal services similar to the pattern in wellness and health care providers.
- Educators will provide more individualised learning services for all segments of the population, from the very young to the elderly. Digital technologies have introduced a new wave of virtual education opportunities around the world. This trend could lead to mass production of information, but education will remain bigger than just the accumulation of information. Even through Web-based courses, students seek the

personal attention of instructors. A new pattern that is just emerging now is the hybrid of traditional classroom and complementary online learning experiences.

**Stephen M. Millett**

**Futurist - Futuring Associates USA**

### **6.6 Solutions for a Low Carbon Economy**

As the far reaching effects of the nano-bio-info-cognitive convergence play out, they make almost anything we can imagine possible. They will create “work opportunities” - for I doubt there will be jobs as we understand them – that have yet to be thought of. However, fascinating as that might be, what I hope are the most interesting new jobs will be created by cities and organizations determined to move, within the next two decades, to a post carbon, low footprint economy. Some of these jobs will be characterised by their ability to radically shift the “*resources –to –value*” equation, through technology or business model shift. Still others will emerge, as we finally reform the quaint and mostly ineffective institutions that deliver health, education and other instruments of public good, and that for so many reasons seem stuck halfway through the 20<sup>th</sup> century. These are the jobs of excitement and opportunity. If for any reason we fail to create them, in a timely manner, then a new set of rather gruesome jobs will be required, as we struggle to survive on a planet where the systems for life support have gone past crisis point.

**Michael McAllum.**

**Futures Architect - Global Foresight Network Australia.**

### **6.7 New Roles in Social Media and the Implications for Employment**

Social Media is available to the public for free, yet requires enormous investment from risk takers, the investors, the pioneers and the entrepreneurs. How can innovative jobs and careers be created within an industry when the consumer of the services wants it all for free? We have seen Social Media evolve from E-Business in the 90's to Social Networks in the 2000's. As we look to 2010 and the decade ahead, we will see a new world evolve. A social world is emerging that will transform the idea of the internet being a channel for selling and marketing into a place where business happens through conversation and contribution.

Creation of new roles and growth in employment in this sector will occur when the large organisations realise that they must invest in the management of data and the aggregation of conversations in real-time. Conversation based knowledge sharing, and connecting people to the source of the solution they seek in real-time will become a resource that large organisations will need to own internally. We will see the emergence of the ‘Conversation Manager’ who aggregates and records all the conversations being had in real-time around the service they provide. Their prime task will be matching the external need to the person within their company who can solve it.

The greatest problem for organisations will be the management of data. ‘Blog Managers’ will manage the online brand by sharing thoughts and ideas. ‘Video Managers’ will produce and distribute content. ‘Photo Image Managers’ will record and distribute images that will ‘share’ the company’s day to day experiences. ‘Online Event Managers’ will become the norm, creating webinars and real-time community based discussions. The ability to control, select and manipulate the information that companies want to share will be lost in this open,

random and transparent world. The critical factor will be 'knowing' what is being said and managing the conversation in real-time to maximise the gain and minimise the risk of this new connected global world

In this new world, I believe that the employment market will increasingly become a supplier based one. A globally connected world will require low cost business models and the ability to source skills globally. People will have to create their own brands as 'suppliers' rather than employees. Home Working will explode. This requires a shift in attitudes and a change in the way we teach our children as they move through further education. Being self-employed is a very different skill set to being employed.

**Penny Power**

**Co-Founder of The Ecademy Network UK**

### **6.8 Jobs in Space**

The “20 Jobs that don’t yet Exist,” as compiled by Fast Future, all seem plausible and important, given the study’s 10-20 year horizon. When reviewed through the specific and longer-term lens of space and planetary exploration, as currently driven by a growing number of international private and governmental initiatives, many of these innovative jobs suddenly seem essential and even mundane. In a future outer space or foreign planet environment, could one imagine not having access to Body Part Makers, Nano-Medics, Vertical Farmers, Space Pilots, Quarantine Enforcers, and a host of virtual advocates and facilitators, and the like? Some dystopian environmental scenarios suggest that humans will need to locate off-planet en masse sooner rather than later, simply for survival. Those that remain on Mother Earth would be engaged as Climate Change Reversal Specialists, Weather Modification Police and associated professions. In all of these locations, organisations and governments will rely heavily on New Science Ethicists for guidance.

Plausible space / planetary scenarios suggest that in practice we will see modifications to and multiple variations of some of the proffered jobs which will introduce a host of new professions. If humans engage in long-distance space travel, for example, “time” and “aging” (as we know them) go haywire, completely redesigning “Time Banking” and “Old Age Wellness” as described here. And, as humans begin to reside off-planet permanently, we’ll see the emergence of the “Neo-Renaissance Wo/Man.” These early explorers and settlers in very isolated and unpredictable locations will be competent in a number of disparate but essential disciplines such as farming, medicine, mechanics, astrophysics, and psychology, and able to practice these on a low-tech scale when required. This means that some of the best templates—and warnings—for these new professions will be found, not in emerging trends, but rather in the exploration accounts of past centuries.

**Tom Hoffmann**

**Principal and Chief Consultant - FastForeward USA**

### **6.9 Adapting to Change**

On a shining Sunday 20 years from now, your child, now grown up, takes you to a museum. They ask “how it was back then?” Ah, sweet old times... And then you suddenly realize that was *your* time, and *you* lived in a museum back then -- without realizing it. With a glimpse of

sadness, you recall all those old jobs with names so alien to your child and so familiar to you. Carpenter, painter, bookkeeper.

Hey, what do we see there in the showcase? A “future jobs listing”, on a piece of printed paper, gone a bit yellow, and you think, “Hey, they got it quite right.” All those new jobs reflected a major change in some area: the greening of the economy, the increased need for senior healthcare, the abolition of oil cars. Technology changed every profession. Bookkeeper, painter and carpenter - they all got intelligent production and communication tools. It destroyed most work patterns, eliminated some jobs completely, and made the economy hypercompetitive.

The museum tour has ended. Your child taps your arm and says: “Well done Mum! You had the mental flexibility to move along and embrace the challenges.”

**Marcel Bullinga**

**Futurist – Futurecheck Holland**

### **6.10 Implications for Education**

In some ways, identifying titles for jobs of the future is a straightforward process for a futurist. Identify various needs and desires that will extend into the future, such as water shortages, and add either the promising leading-edge technology that could solve the problem (e.g. certified grey-water redistribution plumber) or the leadership, management, or advisory roles required if the problem encompasses more than a physical solution (e.g. water rights negotiations advisor). However, a number of factors necessitate that our formal educational systems must emphasize adaptable learning skills, including unlearning and relearning e.g.

- The proliferation of technology and ensuing specialization
- The rate of new scientific and technological discoveries
- Complexity of a globalized and interdependent world, and
- Information systems that create an overload of information and contradictory findings.

A medical student, for example, may find herself needing to learn, then relearn, and unlearn her previous understandings of biology throughout her studies and throughout her career. Even in the most quantifiable sciences, this can be difficult from a psychological point of view, and even more so in the more qualitative fields, where personal judgment or ethics are even more deeply involved. So clearly, as we look forward to the new job titles and skills, we must be even more ready to develop the skills and attitudes that have been vital since the concept of learning itself began to apply, approximately 200,000 years ago.

**Ann Feeney**

**Futures Research - USA**

## 7. Conclusions

### 7.1 A New Era for Science and Technology

This short study has identified that we are entering an exciting new era for science and technology. This era is being driven by ten factors that have combined to raise the prominence, attention, respect and funding being given to science and technology:

1. A greater understanding of - and reliance on - the role and impact of science and technology in our daily lives
2. Rising public trust in science and scientists
3. Exciting advances in fields as diverse as nanotechnology, genetics, synthetic chemistry, cognitive sciences, energy technologies, electronics, information technology and artificial intelligence that have opened up possibilities previously only considered the realm of science fiction
4. Rapid developments in multiple disciplines have delivered major benefits across fields as diverse as education, healthcare, the internet, manufacturing, construction, environmental protection and travel
5. The prominence of innovation led businesses among the world's largest and most respected companies (e.g. Apple, GE, Google, GSK, Microsoft)
6. Greater understanding of the role science and technology can play in driving industry innovation, creating new business models and spawning entire new industries
7. A recognition of the macro-economic importance of science based industries
8. Rising awareness and expectation of the contribution science and technology can play in tackling persistent challenges in areas such as poverty reduction, food supply, water and sanitation, education, housing, urbanization, health, infrastructure development and maintenance, transportation, biodiversity loss, climate change and environmental degradation
9. Continual improvements in the quality, breadth and depth of science and technology education and research on offer at a growing number of institutions around the world
10. A major commitment from developing economies to pursue sustainable economic development through investment in scientific and technological innovation.

### 7.2 New Career Opportunities in Science and Technology

With growing impact, visibility, trust and funding also comes a major growth in career opportunities. These will arise both in existing disciplines and in new ones that will emerge as a result of the many advances taking place and the new fields being created. This study has outlined 110 such roles and profiled twenty of these future jobs in more detail. The aim was to facilitate thinking about what such roles might entail and the impact they can have.

The response to our global survey suggests these roles can individually and in various combinations make a significant contribution to tackling the care challenges of an ageing society, feeding a growing population and maintaining and enhancing our health. They are also seen as essential to giving us greener mobility solutions and reducing the impact of dangerous climate change. Finally they are expected to help us survive and thrive in the cyberworld, whether through legal protection, counselling or management of our virtual data

and image. As a result the survey suggests that many of these roles will be popular, well-rewarded and aspirational.

### **7.3 Raising Interest – Stimulating Debate**

We hope that this report acts as a useful stimulus for raising public interest in and discussion of the key role science and technology will play in shaping the world around us and in creating new jobs and career opportunities over the next twenty years. Target audiences for this material include students of all ages, parents, teachers and those who might want to retrain for a new career. The aim is to encourage children and young people in particular to research forthcoming science and technology developments, imagine the kinds of jobs they will create and explore how these developments could help tackle a number of the ‘grand challenges’ facing our planet.”

## **Appendices**



## **Appendix 1 - The World in 2030 Background Data**

### **1. Demographic Shifts**

The two critical demographic stories for the first half of 21st century will be population growth and ageing, and both will present challenges. The UN predicts the global population will reach 9.1 billion by 2050<sup>37</sup>. Based on these projections, population growth in Asia to 2050 could outstrip the populations of Europe and North America combined. Indeed, large chunks of Europe as well as Japan and a number of other countries will actually see their population decline amidst the global boom<sup>38</sup>. The UN also projects that up to two million people will migrate from poor to rich countries every year until 2050 with around 1.6 million coming to Europe<sup>39</sup>.

The ageing of the global population will bring with it tremendous financial liabilities for governments, business and families as well as providing a stern test for pension and healthcare systems. The IMF estimates the impact could be ten times that of the current financial crisis<sup>40</sup>. Between 2005 and 2050, the working-age population of emerging economies is expected to increase by 1.7 billion<sup>41</sup>, compared with a decline of 9 million in the developed economies. Allied to the regional variation is a general pattern of aging; the U projects that there will be almost 2 billion (22% of the overall global population) people over 60 by 2050, whereas this cohort currently accounts for only 10% of the global population<sup>42</sup>. In addition, life expectancy continues to rise across the world – in the developed economies estimates are being revised upwards by up to five months every year. Indeed some actuaries now suggest there is a 90% chance that those currently aged under fifty could live to one hundred years of age.

### **2. Economic Turbulence**

Even without the current economic downturn, economic power was already shifting around the planet. As a result, organizations must rethink assumptions about the balance of global opportunities and risks. The rise of the G20 in relative importance to the G7/8 indicates the growing economic influence of developing economies. Indeed, rising government and personal indebtedness within developed western economies threaten to limit their economic potential with much talk of a lost decade and rich country debt rising above 100% of GDP<sup>43</sup>. At the same time, internal power struggles are evident as governments increase their share of the economic pie in many developed free market economies.

China and India contributed 58% of all global growth in 2007 and it is estimated that BRIC economies could be delivering 40% of all global growth by 2018<sup>44</sup>. Current forecasts from the OECD (Chinese Economic Performance in the Long Run, 2008) suggest that China's GDP could overtake that of the U.S. as early as 2015<sup>45</sup>.

### **3. Politics Gets Complex**

The political agenda has become increasingly crowded and complex as increasingly diverse issues, interest groups and challenges compete for governments' attention. The global financial crisis has led to even further complexity inside nations, between nations, and between developing and developed countries.

The G20 economic consensus offers more hope for collaborative approaches to handling future crises. At the same time, the internet and social media are changing the nature of political dialogue and citizen activism. Complexity increasingly manifests itself as risk - 35 countries were on the highest risk 'alert' status in the 2008 Fund for Peace failed states index – a four year high, with 127 countries in 2008 at Alert or Warning status compared to 76 in 2005<sup>46</sup>. An increasing number of individual countries are now considered at higher risk of political instability including Greece and Malaysia – placing greater emphasis on importance of rigorous country due diligence for market expansion plans. While finance remains a key global topic, other concerns over health, education, security and environment will arise. Against this backdrop, there is a rising public apathy - according to a 2009 GfK poll, only 14% of Europeans trust politicians<sup>47</sup>.

### **4. Business 3.0 - An Expanding Agenda**

Long held assumptions about how to compete and recipes for success are being overturned. The rapid rise of emerging countries has created a wealth of opportunities for business but also a more complex set of challenges. Enhanced global competition, ever widening technological options, a quickening pace of innovation, and the pressure to create new business models have generated a great deal of market turbulence. The rise of the internet has opened up new possibilities for communications, collaboration and customer engagement and given rise to a wave of new business models. Across industry sectors there is rising adoption of open innovation and open sourcing for new product and process development.

Expectations concerning Corporate Social Responsibility (CSR) and work-life balance amongst employees are also increasing with a growing focus on ethical sourcing. According to Richard Edelman, chief executive of Edelman PR, "Business leaders need to think differently about what it means to be a public company. No longer can their sole objective be to maximise profits." He argues that a new strategy of "public engagement" is needed to restore the public's trust in business. Indeed Edelman's 2009 Trust Barometer found that 77% of Americans and 62% globally trust corporations less than they did a year ago<sup>48</sup>. In contrast, trust in business was rising in China and Brazil.

Against this backdrop, the business landscape is evolving rapidly. Increased levels of women owned business, social ventures and entrepreneurship generally are accompanied by CSR concepts being embedded within organisations and becoming critical to recruitment and retention. In a survey of 7200 privately held businesses in 36 countries (Grant Thornton, 2008) 65 percent of the respondents cited that recruitment and retention of staff was the most important factor for doing CSR. Saving the planet came fifth<sup>49</sup>.

## 5. Science and Technology Go Mainstream

Nations and businesses alike are now recognizing and seeking to compete on the 'innovation advantage' that comes from leadership and investment in science and technology. Several national recovery packages feature heavy R&D spending - in Germany EUR 965m, France EUR 731M and large portions of China's 10Tn Yuan are dedicated to R&D<sup>50 51</sup>. Technology is increasingly embedded at the heart of business and is becoming a critical part of everyday life for the young middle classes around the globe. Technology is also offering an ever-increasing array of options for connectivity and personalisation of both products and services.

The Public awareness of the importance of science is also rising, as recognition grows of its contribution in fields as diverse as health, new materials, and environmental protection. The increase in public awareness accompanies a rapidly evolving personal 'technological ecosystem' that will see the consolidation of multiple electronic gadgets such as the phone, camera and PDA into one mobile device. There is also an increasing blurring of the boundaries between virtual and real worlds – for example using internet connected cameras to provide digital overlays of information on physical real world objects. Indeed, 55% of internet experts in the US believe that by 2020 many lives will be touched by the use of augmented reality or be spent interacting in artificial spaces<sup>52</sup>.

## 6. Generational Crossroads

There is an increasing prospect of intergenerational conflict as values and expectations differ. Each major group - Aging Baby Boomers (born 1946-1964), Generation X (born 1964-1980), the 'Millennial' Generation (born 1980-1994) and emerging Generation Z (1994 - Present) - brings widely differing attitudes to working practices, communications preferences, the use of technology and work-life balance. The challenge for employers will be to create an environment where each group can feel valued and be effective. Indeed, a Randstad USA survey found that 51% of baby boomers and 66% of the generation that preceded them reported having little to no interaction with colleagues from Generation Y<sup>53</sup>.

The European Commission's April 2009 Ageing Report warns the economic downturn 'could make the challenges created by ageing more acute, and lead to intergenerational conflict'<sup>54</sup>. With house prices lower and thus individuals' net worth reduced, retirement is becoming less of an option for some baby boomers, further increasing generational tension associated with the workplace.

For the UK, the April 15th 2009 release by the Office for National Statistics<sup>55</sup> (ONS) of its annual report on the latest social trends, highlighted the following:

1. There is a growing reluctance of Britain's twenty- and thirty-somethings to fly the parental nest - almost a third of men and a fifth of women aged between 20 and 34 live at home with their parents.
2. Since 2001, the number of young adults continuing to live in the family home increased by 300,000. The ONS said one reason for young people delaying setting up a home of their own was rising participation in higher education. Another was lack of affordable housing. Graduates carrying a burden of student debt found it harder to pay the rising costs of renting or buying property.

3. The latest available figures were for the second quarter of 2008. They showed 29% of men aged 20-34 and 18% of women of the same age lived with their parents. This compared with 27% of men and 15% of women in 2001.

"A narrowing of the generation gap has led to changing relationships between parents and children, which can make it easier for adult children to remain in the parental home."

## **7. Rethinking Talent, Education and Training**

The constantly evolving nature of the business environment, the work undertaken and the technologies we use are driving the demand to update our existing skills and learn new ones. Rising life expectancy also implies that our working lives will increase and add further impetus to the need for lifelong learning.

The so-called 'demographic time-bomb', describing the pending retirement wave of aging workers, is creating an impending skills crisis for employers - a 31% worldwide talent shortage was identified in a 2009 Manpower study<sup>56</sup>. The talent shortage appeared to be least problematic in India (12%), the United Kingdom (12%), Ireland (14 %), China (15%) and the Netherlands (15%). At the same time, the constantly evolving nature of the business environment, the work undertaken and the technologies used are driving the demand to update our existing skills and learn new ones. To this end, both schools and higher education institutes are embracing virtual learning. Rising life expectancy also implies that our working lives will increase and add further impetus to the need for lifelong learning.

Other education issues revolve around employer concerns over graduate literacy, numeracy, employability and cost of remedial education. A 2008 UK CBI found 23% of employers felt graduates struggled with literacy, and 20% complained about poor numeracy. A quarter said they were unhappy with graduates' employability skills. Employers also perceive a growing demand for graduate-level skills - more than three quarters (78%) said there would be increased demand for high-level leadership and management, and two-thirds (66%) said they needed graduates with technical skills<sup>57</sup>.

18 different uses of virtual worlds in UK higher and further education have been identified. Medical sciences, mathematics and art and design feature prominently. Simulations, the visualisation of complex structures and safety role are also stated as the most popular specific uses of this technology<sup>58</sup>.

By 2019, nearly half of all public high school courses (in the U.S) will be taught online, according to Clayton Christensen, a Harvard Business School professor, and Michael Horn<sup>59</sup>. Nationwide in the U.S, 700,000 kids attended virtual schools as of January 2008<sup>60</sup>.

## **8. Global Expansion of Electronic Media**

The internet is increasingly becoming a core tool for business and the individual in developed economies, with the developing world catching up fast. Global internet usage grew 265.6% from 2000 to 2007<sup>61</sup>. China has overtaken the US in terms of number of internet users and estimates put the total global web population at 1.6 billion and rising<sup>62</sup>. Social web tools such as blogs, wikis, social networks, virtual worlds and portable computing

devices are becoming mainstream – evolving into essential tools for marketing, communications and customer engagement. At the same time a major rise in both media spending and user-generated content is anticipated. On the downside, increases in cyber crime and cyber war are also forecast.

Sectors such as mobile internet have significant growth potential - Nokia forecasts the total number of mobile subscribers will rise from 4 billion in 2009 to 5 billion by 2015 and expects extraordinary growth in mobile data traffic - rising 300-fold from 2009 to 2015<sup>63</sup>. Active users of social media (MySpace, Facebook, YouTube, LinkedIn, Flickr) are expected to rise from around 700 million at the start of 2009 to over 1 billion by 2012, representing 75% of all broadband users<sup>64</sup>. By the end of 2008, ecommerce sales to British buyers totalled £40 billion (\$82 billion), according to the price comparison site uSwitch.com<sup>65</sup>. Online shoppers in the UK are expected to spend £162 billion (\$336 billion) per year on products via the internet by 2020.<sup>66</sup>

Figures from Personalize Media<sup>67</sup> below give a sense of the true scale of the growth of social media:

- 20 hours of video are uploaded every minute onto YouTube (source YouTube blog August 09)
- Facebook claims it is adding 600,000 new members per day, and 700 million photos and 4 million videos per month (source Inside Facebook February 09)
- Twitter has added 18 million new users in the last year, with 4 million 'tweets' sent daily (source TechCrunch April 09)
- 900,000 blogs posts are put up every day (source Technorati State of the Blogosphere 2008)
- YouTube claims 1 billion videos are watched every day (Source SMH 2009)
- In Second Life, US\$250,000 worth of 'virtual goods' are traded daily (source Linden Lab release Sep 09)
- 1250 text messages are sent per second
- An estimated US\$5.5 billion is spent annually on virtual goods (source Viximo Aug 09)
- Facebook gift purchases have reached US\$70 million annually (source Viximo Aug 09)
- Flickr has 73 million visitors a month who upload 700 million photos (source Yahoo Mar 09)
- There were 92.5 million mobile social network subscribers at the end of 2008. This is forecast to rise to between 641.6-873.1 million by the end of 2013 (source Informa PDF)
- Over 2.3 trillion SMS messages were sent across major markets worldwide in 2008 (source Everysingleoneofus sms statistics).

## **9. A Society in Transition**

Many countries are experiencing an increasingly diverse, multi-generational and multi-ethnic society with changing family structures and evolving views concerning values and standards of behaviour. Higher ethical standards and a sense of the greater good are two of these evolving trends. Increasing expectations are concurrent with a decline in trust of key institutions. Edelman's 2009 study found trust down from 2008 for most types of news outlet and organisational spokesperson. Corporate or product advertising is least trusted – down

from 20% to 13% in 2009. In the US, trust in information from a company's top leader is at a six-year low at 17%. Outside experts at 59% remain the most trusted purveyors of information about a company. Only 29% and 27% view information as credible when coming from a CEO or government official respectively, declining from 36% and 32% in 2008<sup>68</sup>.

Greater corporate social responsibility (CSR), more transparency, and higher standards in public life are being demanded. These are being driven by growing public awareness of the scale of social challenges, environmental pressures, changing consumer values and a rise in 'ethical consumption'. These will rise in prominence through the communications accelerator effect provided by social media and more widespread adoption of reporting and accountability standards. At the same time, volunteer rates are beginning to decline at a time when budget cuts for many public services mean the need has never been higher.

The UK has 26 million volunteers<sup>69</sup>. People aged 18-24 are the most likely to be volunteers. 36% of people cite learning career skills as being their main motivation for volunteering followed by 27% who volunteer to make a difference. 1.2 million full-time workers would be needed to replace the UK's total formal volunteers<sup>70</sup>.

## **10. Natural Resource Challenges**

For the last two decades, there have been many voices warning about unsustainable natural resource demands and the resulting pressures on the natural environment. Forecasts suggest these voices will increase. Over the next decade radical action is expected on a number of fronts. Achieving emissions targets could cost over \$11Tn by 2030 whilst energy demand is forecast by the IEA to increase over 50% by 2030<sup>71</sup>. University College London says climate change poses the biggest 21st century threat to human health<sup>72</sup>, while MIT's comprehensive May 2009 study suggests the threats posed by climate change could be twice as severe as previously projected<sup>73</sup>.

The IEA says \$45Tn investment is required for an energy revolution over the next 50 years to prevent energy shortages and greenhouse gas emissions from stunting growth<sup>74</sup>.

From a business perspective, being more transparent and issuing CSR reports no longer helps you to stand out – it is expected. Rising eco-literacy amongst consumers, increasingly ethical consumption and the highlighting of 'green' practices are some of the trends pushing CSR up the business agenda.

## Appendix 2 - The Science and Technology Horizon- Key Trends

The trends presented in this appendix are drawn from a wide range of authoritative sources citing well referenced examples of science and technology developments on the horizon. As such, extensive use was made of the UK Government Horizon Scanning Centre (HSC) outputs – most notably the Delta and Sigma horizon scans of emerging trends and developments. Other key sources used extensively included MIT's Technology Review, the BT Technology Timeline and TechCast – an acknowledged resource pooling expert knowledge on science and technology forecasts.

Where possible we have tried to remain true to the source definition of the trend or development – except where we feel further clarification or expansion is required.

### Science Policy, Strategy and Funding

- **R&D Takes Centre Stage:** Germany is investing EUR900M by 2010 to fund R&D projects commissioned by medium-sized business and EUR65M to expand and develop research infrastructure. Norway is set to increase its Research and Innovation Fund capital by EUR685M and create over 200 new research positions each with EUR90,000 funding. France is committing EUR731M in 2009-10 to refurbish universities and research institutions. China's 10Tn Yuan 2009-11 stimulus package includes major investments in science and technology, including "key research projects related to enlarging the domestic market." (University World News)<sup>75</sup>.
- **Global Diffusion of Science**<sup>76</sup>: Over the next 50 years, the long US dominance of a wide range of fields in science and technology is likely to end as the global scientific playing field becomes flatter and more diverse (Sigma Scan)
- **Global Standards for Global Science**<sup>77</sup>: Standards provide the language in which innovation is written. Until recently, the assumption has been that USA and Europe would dominate standards discussions. However, with the growth of Asian economies, the scale of their markets and the huge investments being made in science technology, their power and influence in standards discussions will change, as will the technologies they allow into their markets. (Sigma Scan)
- **Growth of Chinese Science and Technology**<sup>78</sup> PhD production in China increased fiftyfold between 1986 and 1999, from less than 200 to more than 7,000 degrees granted annually. By some estimates, China now graduates more engineers than the rest of the world combined. Peking already appears as a top institution in the THE/QS World University Rankings, at 50 in 2008, and there are six Chinese and four Hong Kong universities in the top 200 (Sigma Scan).
- **Brazil: A Potential Scientific Leader**<sup>79</sup> Brazil could emerge as one of the world's leading scientific powers by 2025, if it pursues a policy of intelligent investment and maximises the benefits of international collaboration (Sigma Scan).
- **Convergence on a Theory of Everything**<sup>80</sup>: Experimental physicists are seeking a single underlying theory that describes all the fundamental workings of the universe, from subatomic particles ruled by quantum mechanics to the gravitational forces

explained by Einstein's general theory of relativity. Our universe is made up of building blocks much smaller than atoms. These particles, such as electrons, leptons, and quarks, are governed by three forces: electromagnetism and strong and weak nuclear forces. A fourth force – gravity - remains harder to explain and integrate.

The goal is a Grand Unified Theory, a 'theory of everything' that ties together all of these phenomena in a single equation or expression that explains the nature and behaviour of all matter. Building such a theory, Einstein suggested, would be like 'reading the mind of God'. This theory of everything could illuminate some of the biggest mysteries at the heart of physics, from the origins of space and time to the secrets of black holes and the cause of the universe's accelerating expansion (Sigma Scan).

### Medicine, Biology and Biogenetics

- **NBIC-convergence:** NBIC-convergence is the ongoing unification of nanotechnology, biotechnology, information technologies and cognitive science evident in applications such as the nanovaccine. The developments in these fields no longer merely complement each other, indeed the fields are gradually merging into one (Fontela and de Castro<sup>81</sup>)
- **Risk of Major Global Health Pandemic:** With aviation linking an ever shrinking and crowded world, the risk of pandemics is rising. On July 14<sup>th</sup> 2009 the British government warned that the number of swine flu cases could eventually affect one in two people in the UK<sup>82</sup> More potent infections are more probably a matter of when and not if. (Department of Health)
- **Synthetic Biology:** Synthetic biology involves designing and building biological components to perform functions such as producing drugs or fuels. Synthetic biologists are envisioning creating bacteria with artificial chromosomes to enable them to harvest sunlight into fuel, clean up industrial water and work as bio-surveillance agents to track a range of activities. It is predicted that synthetic biology will aid in creating new life forms in biology, but will also be applied in electronics and nano-biotechnology<sup>83</sup> (Foundation for Biotechnology Awareness and Education).
- **Growth of Biomedical and Genetic Enhancement**<sup>84</sup>. University of California Los Angeles Professor Gregory Stock argues that "The Race for Biomedical and Genetic Enhancement will-in the Twenty-First Century-be what the Space Race was in the Previous Century. Humanity is ready to pursue biomedical and genetic enhancement, and the money is already being invested," but, he says, "We'll also fret about these things-because we're human, and it's what we do."
- **New Converging Markets (food, pharmaceuticals, drugs, cosmetics)**<sup>85</sup>: The boundaries between market segments are increasingly blurring and will continue to dissolve. Food infused with medicine is one such area of application. The total Europe and US market for heart health food and drinks is predicted to be \$7.4bn (€5.6bn) in 2010. The comparable figures for heart health pharmaceuticals are \$105bn (€80.8bn) respectively (Nutra-Ingredients).
- **Biological Machines:** A giant flower beetle flies about, veering up and down, left and right. However, the insect isn't a pest, and it isn't steering its own path. An implanted



receiver, microcontroller, microbattery, and six carefully placed electrodes allow an engineer to control the bug wirelessly. By remotely delivering jolts of electricity to its brain and wing muscles, the engineer can make the cyborg beetle take off, turn, or stop midflight.<sup>86</sup> (DNA India)

- **Lab on a Chip / Rapid Bioassays:** Global markets for better means of testing personal and public health and monitoring the environment are emerging rapidly. Novel biochips to detect and analyze genes and proteins are enabling very fast tests for diseases and pathogens. The specificity and sophistication of these advanced bioassays has increased to the extent that some lab-on-a-chip systems can even perform as small-scale laboratories using miniaturized devices. These types of bioassays could identify or eliminate threats to public health, significantly improve patient outcomes, and accurately detect pathogens in the environment and the food supply (Rand Corp.)<sup>87</sup>.
- **Systems Biology:** Observers of the life science enterprise agree that, while genomics has present priority, proteomics represents the wave of the future. "Some groups are beginning to look at shotgun sequencing approaches to microbial ecosystems. Then their attention moves naturally and quickly from genes to proteins," says Donald Kennedy, editor-in-chief of Science-Mag and president, emeritus of Stanford University. "We'll see a convergence between what we learned from genomic analysis and what we know about the networks that link gene products — the proteins that genes produce — through signalling functions within the cell."<sup>88</sup> (Science-Mag)
- **Haptics Technology:** Haptic technology interfaces via touch by applying forces, vibrations, and/or motions to the user (effectively mechanical stimulation). Computerized image analysis is used to extract information from images. It can be used in medical applications to determine the size of organs or to build 3-D models of organs before surgery. For example, a PhD candidate at Uppsala University, Sweden, has developed new technology to make it easier to diagnose and plan the treatment of cancer. He used haptics technology to develop new interactive methods 'where the mouse and keyboard are replaced by a pen-like three-dimensional mouse that enables the user to feel the virtual organs'<sup>89</sup>. (Uppsala University, Sweden)
- **Neuroprosthetics:** Researchers at the University of California, Berkeley, have demonstrated how rhesus monkeys with electrodes implanted in their brains used their thoughts to control a computer cursor. Once the animals had mastered the task, they could repeat it proficiently day after day. The new study, which should apply to humans, provides hope that physically disabled people may one day be able to operate advanced prosthetics in a natural, effortless way. (The IEEE)<sup>90</sup>
- **Biomechatronics**<sup>91</sup> is the merging of man with machine -- like the cyborg of science fiction. It is an interdisciplinary field encompassing biology, neurosciences, mechanics, electronics and robotics. Biomechatronic scientists attempt to make devices that interact with human muscle, skeleton, and nervous systems with the goals of assisting or enhancing human motor control that can be lost or impaired by trauma, disease or birth defects. (HowStuffWorks)
- **Bionics Renaissance:** Similar to biomechatronics, bionics seeks to provide virtually any human body part with a replacement (artificial alternative) that works just as well, if not better than the original. Bionics could lead to a market in self-improvement with the desire to be stronger, faster or have better eyesight.<sup>92</sup> (Economist Intelligence Unit)

- **Gene Therapy:** Human genetic enhancement, achieved by inserting genes into one's cells, is still not approved by the U.S Food and Drug Administration. Only one controversial product exists in the market (Gendicine, approved only in China) since 2004. Hence gene therapy is very much in its experimental stages. The global market for gene therapy is already projected to reach \$484 million by 2015 (BlissTree)<sup>93</sup>.
- **Growth and Further Development of Bioinformatics<sup>94</sup>:** It is predicted that the field of bioinformatics, that is the application of IT to molecular biology, will continue to grow in importance over the next two decades, as biological data becomes increasingly abundant and more complex biological processes are being investigated. Developing a suitably trained cohort of research scientists and staff versed in the use of bioinformatics tools is crucial for future development in all branches of the life-sciences and biomedical applications. In particular the need for data integration will continue across all sectors employing bioinformatics areas, including industry and healthcare. (Sigma Scan)
- **Synthetic Chemical Cells – A New Way for the Invention, Discovery, Synthesis and Production of Molecules and Materials<sup>95</sup>:** As opposed to synthetic biology strategies, where scientists use the naturally available molecular building blocks (DNA, RNA, proteins, lipids) to try to find new applications, synthetic chemical strategies involve synthesising and assembling chemical cells. The scope of synthetic chemical cells is much greater than what we can do with natural materials. All of the knowledge and concepts of chemistry are relevant to this area and not just reactions and processes in life-supporting biologically-based laboratory conditions that need to be very tightly controlled and therefore severely limiting on potential outcomes we can expect.<sup>96</sup> (Foundation for Biotechnology Awareness and Education)
- **Growth of Evolutionary Psychology<sup>97</sup>** Evolutionary psychology (the contention that many aspects of our behaviour and emotions are evolutionary adaptations) may merge with cognitive neuroscience to produce a new understanding of how the mind and brain evolved and thus offer a platform for deeper understanding of human behaviour (Sigma Scan).
- **Stem Cell Organs On-Demand:** Now that any cells can be used to develop stem cells, we will see organs created to prolong life and health. This will lead to an avalanche of new solutions for medicine that will drive life extension.<sup>98</sup> (Global Futurist)
- **Biomarkers as Predictive Tools:** A Biomarker is a biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process, or of a condition or disease. A biomarker may be used to see how well the body responds to a treatment for a disease or condition. Also called molecular marker and signature molecule<sup>99</sup>. Hence they can indicate potential future biological changes. Changes in the chemistry of cerebrospinal fluid have been identified as early signs of Alzheimer's disease. If and when treatments are available for Alzheimer's, diagnosing the disease early may help prevent it from developing.<sup>100</sup> (Bio-Medicine.org).
- **iHealth:** New wearable devices and information applications will empower consumers with real-time information customised to monitor and track the health status of individuals, measuring risks and downloading customised personal health info.<sup>101</sup> (Global Futurist).

- **Personalized Medicine:** BioNanomatrix, a start-up, is pursuing what many believe to be the key to personalised medicine: sequencing technology so fast and cheap that an entire human genome can be read in eight hours for \$100 or less. With the aid of such a powerful tool, medical treatment could be tailored to a patient's distinct genetic profile. (DNA India)<sup>102</sup>.
- **Virtual-Reality Medical Simulations:** Many believe virtual reality will become the dominant mode of medical training (Global Futurist).<sup>103</sup>.
- **Cyber-health Care** The role of the internet in healthcare is increasing rapidly and developing into its own field. It is customised for us as individuals and designed to monitor, diagnose, educate, and intervene regardless of location or time.<sup>104</sup> (Global Futurist).
- **Curing Diseases Before they have even Evolved:** Michael Goldblatt, who once led the biodefence programme for the Pentagon's research arm, DARPA, and now heads Functional Genetics is working on an entirely new class of antiviral drugs that he claims should do something seemingly impossible: work against a wide range of existing viruses and also be effective against viruses that have not even evolved yet. What's more, it is claimed that should be extremely difficult for any virus to become resistant to these drugs.<sup>105</sup> (New Scientist)
- **Bioviolence** will become a greater threat as the technology becomes more accessible. Emerging scientific disciplines (notably genomics, nanotechnology, and other microsciences) could pave the way for a bio attack. Bacteria and viruses could be altered to increase their lethality or to evade antibiotic treatment. Another long-term risk comes from nanopollution fallout from warfare. Nanoparticles could potentially cause new diseases with unusual and difficult-to-treat symptoms, and they will inflict damage far beyond the traditional battlefield, even affecting future generations (World Future Society).<sup>106</sup>

## Energy

- **Growing Energy Demand and Search for Alternatives:** The US Energy Information Administration (2008) predicts global energy demand could rise 50-55% by 2030. The International Energy Agency says \$45Tn investment is required for an energy revolution over the next 50 years to prevent energy shortages and greenhouse gas emissions from stunting growth. The EU and China have set targets of 20% and 15% of energy from renewables by 2020. The US is to increase federal spending on renewables tenfold to \$150Bn over 10 years<sup>107</sup>. (EIA, IEA, Credit Suisse)
- **Rising Investment Requirements:** The International Energy Agency in its annual report, of November 2008, states that to limit the increase in temperatures to 3 degrees Celsius by 2030 would require a huge increase of low-carbon energy - nuclear, hydropower, biomass, renewables, and underground carbon storage. That scenario would require a \$4.1 trillion investment, or 0.2 percent of the world's annual GDP<sup>108</sup>. (IEA)

- **Mainstreaming of Alternative Energy:** Different studies converge on 2023 +/- 5 years as the serious beginning of this transition period, when 30% of all global energy is most likely to be derived from alternative sources<sup>109</sup>. (TechCast)
- **Access to Electricity will Reach 83% of the World by 2030:** Electrification has expanded around the world, from 40% connected in 1970 to 73% in 2000, and may reach 83% of the world's people by 2030. Electricity is fundamental to raising living standards and access to the world's products and services. Impoverished areas such as sub-Saharan Africa still have low rates of electrification; for instance, Uganda is just 3.7% electrified<sup>110</sup> (World Future Society).
- **Peak Oil:** Fatih Birol, chief economist of the International Energy Agency says (August 3<sup>rd</sup> 2009) that "peak oil" is a lot closer than most governments realize. Crunch time, when the maximum rate of global petroleum extraction is reached and then passed, is now set for 2020<sup>111</sup> (IEA, cited in The Independent)
- **Risk of Energy Shortages across the Developed World<sup>112</sup>:** In the UK, many power stations are due to close over the coming decade. UK government estimates that, of a total of around 75GW in generating capacity, 20GW will disappear by 2015 (the Economist).
- **Decentralised Energy Systems:** A decentralised energy (DE) system has two key characteristics. Firstly, buildings (from terraced houses to industrial units) double up as power stations because they have within them one or more energy generating technologies such as solar panels, wind turbines or cogeneration units. Local impact is important, whilst cumulative impact could be enormous. Secondly, local energy networks proliferate, distributing heat and power. These networks will be supplemented by community scale plants generating close to the point of demand. For example heat from cogeneration plants would be captured and distributed for nearby use. This radically improves efficiency and so reduces overall demand, increasing security of supply and cutting emissions.<sup>113</sup> (Greenpeace)
- **Development of the Smart Grid:** The Federal Energy Regulatory Commission (FERC) has taken a major step to accelerate the development of a smart electric transmission system that could improve the efficiency and operation of the grid. The Smart Grid Policy Statement (July 16<sup>th</sup> 2009) sets priorities for work on development of standards crucial to a reliable and smart grid. Smart grid advancements will apply digital technologies to the grid, enabling two-way communications and real-time co-ordination of information from both generating plants and demand-side resources. This will improve the efficiency of the bulk-power system and ultimately achieve long-term savings for consumers. It will also help promote wider use of demand response and other activities that will enable consumers to control their electricity costs.<sup>114</sup> (Telematics Update)
- **Increasing Role for Liquefied Natural Gas<sup>115</sup>** If construction of LNG transportation infrastructure accelerates along with demand, natural gas could, within the next 50 years, join oil as the second essential energy commodity. Natural gas (methane) is by far the cleanest-burning fossil fuel. Given its global abundance and cleaner emissions, it has become the power generation source of choice for industrialised nations. (Sigma Scan)
- **Energy Producing Kites:** Saul Griffith, an MIT graduate has founded Makany power. They specialize in clean energy and have invented a wing shaped kite that harnesses

high altitude air at 3168 feet. It can produce enough electricity for 100,000 homes<sup>116</sup> (National Geographic Adventure).

- **Liquid Battery:** Donald Sadoway has conceived of a novel battery that could allow cities to run on solar power at night. Without a good way to store electricity on a large scale, solar power is ineffective at night. One promising storage option is a new kind of battery made with all-liquid active materials. Prototypes suggest that these liquid batteries will cost less than a third as much as today's best batteries and could last significantly longer.<sup>117</sup> (MIT Technology Review)
- **Printable Batteries:** Researchers have announced a paper-thin battery that can be produced cost-effectively on large scale. Scientists from the Fraunhofer Research Institution for Electronic Nano Systems (ENAS) in Chemnitz, Germany, together with colleagues from TU Chemnitz and Menippos GmbH say the batteries are printed using a silk-screen printing method similar to that used for t-shirts and signs. It weighs less than one gram on the scales. It is less than one millimetre thick and can therefore be integrated into bank cards, for example. It contains no mercury and is in this respect environmentally friendly. Its voltage is 1.5 V. By placing several batteries in a row, voltages of 3 V, 4.5 V and 6 V can also be achieved (ZDNet<sup>118</sup>).

## Environment

- **Rising Risk of Climate Change:** A University College London report (05/09) says climate change poses the biggest 21st century threat to human health with huge death tolls from disease, food and water shortages and poor sanitation likely. MIT predicts a median probability of surface warming of 5.2 degrees Celsius by 2100 – suggesting a problem twice as severe as previously projected. Moreover, to achieve IPCC emission targets, will cost \$542Bn US per year, every year until 2030, estimates the World Energy Outlook. The EU estimates it at \$224 Bn per year<sup>119</sup>. (Guardian, Times, American Meteorological Society's Journal of Climate)
- **Rising Food Demand:** Global food production, already under strain from the credit crunch, must double by 2050 to head off mass hunger, Jacques Diouf, the head of the UN's Food and Agriculture Organisation, said in January 2009. The food crisis pushed another 40 million people into hunger in 2008. That brought the global number of undernourished people to 973 million in 2008 out of a total population of around 6.5 billion.<sup>120</sup> (UN Food and Agriculture Organisation)
- **Water Scarcity:** By 2025, the number of people living with extreme water scarcity will rise to a quarter of the world's population.<sup>121</sup> (CSR News)
- **Soil Degradation:** Land degradation adversely affects the ecological integrity and productivity of about 2 billion ha, or 23 percent of landscapes under human use. Up to 40 percent of the world's agricultural land is seriously degraded.<sup>122</sup> (Global Environment Facility)
- **Consumption Under Scrutiny:** \$1M of consumer food spend has an approximate 1,500 hectare eco-footprint. It is estimated that the richest half-billion people -7% of global population - are responsible for 50% of global CO2 emissions whereas the poorest 50% are responsible for just 7%.<sup>123</sup> (World Business Council for Sustainable Development)

- **Changing Consumption Patterns:** 60% of the Earth's ecosystems have been degraded in the past 50 years and natural resource consumption is expected to rise to 170% of the Earth's bio-capacity by 2040.<sup>124</sup>(World Business Council for Sustainable Development)
- **Urbanization will hit 60% by 2030:** As more of the world's population moves to the cities, rapid development to accommodate them could make existing environmental and socioeconomic problems worse. Epidemics could be more common due to crowded dwelling units and poor sanitation. Global warming may accelerate due to higher carbon dioxide output and loss of carbon-absorbing plants.<sup>125</sup> (World Future Society magazine)
- **GM Food:** The debate around GM food is likely to continue. The world will have another three billion mouths to feed within the next five decades. Development of crops like Golden Rice, which would add Vitamin A to rice to counter the deficiency which causes blindness in around half a million children every year<sup>126</sup> ( the Independent).
- **The Rise of Green Chemistry Practices**<sup>127</sup> We can expect progress in the development of new ways of preparing useful chemical feed stocks from biomass (SigmaScan).
- **Climate Modification:** 'Cloud ships,' are favoured among a series of schemes aimed at altering the climate that have evaluated by The Royal Society. The project, which is being worked on by rival US and UK scientists, would see 1,900 wind-powered ships ply the oceans sucking up seawater and spraying minuscule droplets of it out through tall funnels to create large white clouds.<sup>128</sup> (Daily Telegraph)
- **Understanding Micro climates:** Today, 50% of the world's population is living on about one percent of Earth's surface. Can this extreme concentration lead to other effects on our climate and weather? In 'Satellites and the city,' NASA says that it can help to provide an answer. "Our research suggests that, using satellite data and enhanced models, we will be able to answer several critical questions about how urbanization may impact climate change 10, 25 or even 100 years from now." (Goddard Space Flight Center<sup>129</sup>).

## Nanotechnology

- **Increasing Spending and Investment:** A technical market research report (May 2008), reveals that the global market for nanotechnology was worth \$11.6 billion in 2007. This is expected to increase to \$27.0 billion by the end of 2013, a compound annual growth rate (CAGR) of 16.3%<sup>130</sup> (Nanotechnology: A Realistic Market Assessment).
- **Rising Impact on Manufacturing:** By 2014, \$2.6 trillion in manufactured goods are forecast to incorporate nanotechnology--or about 15 percent of total global output<sup>131</sup> (Lux Research).
- **Emerging Applications:** Many of the novel applications such as new sensors, better photovoltaic cells, lighter and strong materials for defence, aerospace and automotives are already in use, and applications such as anti-corrosion coating, tougher and harder cutting tools, and medical implants and chips with 1 nm features may be developed in another 5-15 years. Nanostructured materials for nanoelectronic components, ultra fast processors, nanorobots for body parts are still in a state of infancy<sup>132</sup>. (A to Z Nanotechnology).

- **Growth of Nano-medicine:** Scientists at the University of California are using nanotechnology and microbiology to build "cargo ships" 50 nanometres wide that flow through the bloodstream. Plans are underway to "zip-code" the ships so they will seek out specific types of cancer. Analysts estimate cancer patients will approach normal life spans by 2023<sup>133</sup> (TechCast).
- **Rise of Nanobiotechnology:** Nanobiotechnology often studies existing elements of living organisms and nature to fabricate new nano-devices. Generally, nanobiotechnology refers to the use of nanotechnology to further the goals of biotechnology<sup>134</sup> (Foundation for Biotechnology Awareness and Education).
- **Emergence of Nanovaccines:** Scientists have already created nanovaccines which are in reality specialised nanoemulsions made up of tiny soybean oil droplets suspended in water and studded with bits of pathogenic organisms. These special nanovaccines can be ingested by swabbing into the nose to ease the penetration of the drug through the skin pores and down the shaft. Nanoemulsion vaccines have proved to be effective against a wide variety of microorganisms. The technology is borrowed from the cosmetic industry where nanoemulsions have been incorporated into skin creams. Since these vaccines are administered through the nose they produce immunity not only in the blood stream but also in the mucosal lining making them relevant for a wide variety of diseases.<sup>135</sup> (International Journal of Nanotechnology).
- **Nanotech Solar Cells:** Nanoporous oxide films such as  $\text{TiO}_2$  are being used to enhance photo voltaic cell technology. Nanoparticles are perfect to absorb solar energy and they can be used in very thin layers on conventional metals to absorb incident solar energy. New solar cells are based on nanoparticles of semi conductors, nanofilms and nanotubes by embedding them in a charge transfer medium. Films formed by sintering of nanometric particles of  $\text{TiO}_2$  (diameter 10-20 nm) combine high surface area, transparency, excellent stability and good electrical conductivity and are ideal for photovoltaic applications. Non-porous oxide films are highly promising material for photovoltaic applications. Nanotechnology opens the opportunity to produce cheaper solar cells (A to Z Nanotechnology)<sup>136</sup>.
- **Nano-Sensors:** Nanotechnology offers unlimited opportunities to produce new generation pressure, chemical, magneto resistive and anti-collision automobile sensors.<sup>137</sup> (A to Z Nanotechnology)
- **Nanopiezoelectronic Mini Sensors**<sup>138</sup>: Nanoscale sensors are highly sensitive, very frugal with power, and, of course, tiny. They could be useful in detecting molecular signs of disease in the blood, minute amounts of poisonous gases in the air, and trace contaminants in food. However, the batteries and integrated circuits necessary to drive these devices make them difficult to fully miniaturise. The goal of Zhong Lin Wang, a materials scientist at Georgia Tech, is to bring power to the nano world with minuscule generators that take advantage of piezoelectricity. If he succeeds, biological and chemical nano sensors will be able to power themselves (MIT Technology Review)
- **Microelectromechanical Systems (MEMS)** is the technology of the very small, and merges at the nano-scale into nanoelectromechanical systems (NEMS) and nanotechnology. MEMS technology can be implemented using a number of different materials and manufacturing techniques notes (Nanocomputers and Swarm Intelligence)<sup>139</sup>.

- **Membranes, Filters, and Catalysts for Water Purification:** Ensuring affordable access to clean water is a major global challenge. Technologies for purifying water are an important emerging area of S&T. Four applications are being developed:

- *desalination*: removing salt from sea water
- *disinfection*: removing microorganisms
- *decontamination*: removing toxic compounds
- *quality assurance*: detecting potentially harmful matter.

Novel nanomaterials can enhance current purification systems and may make them much more cost-effective. Examples include nanocomposite and biomimetic membranes, filters made of fibrous media, filters with nanoscale porosity, nanoscale catalysts, and DNA-nanoparticle composites. The principal challenge will be to scale up materials from labs to commercial applications. (Rand Corp)<sup>140</sup>.

- **Ultra Light Materials:** Nanotechnology is viewed as a key technology for the development of ultra light materials that would result in energy, fuel and materials savings and development of specialised high performance materials with complete control over structure and properties at a subatomic level not hitherto known to scientists and engineers. With the future development of nanocatalyst, diesel oxidant using nanoscale layers of Pt, Pd, the major environmental killers, smog, pollution and toxic pesticide, would be eliminated and humans will be able to breathe in healthy air. Improvement in nanofilters would enable bacteria less than 30 nm to be filtered and achieve water purity of 99.999997. (A to Z Nanotechnology)<sup>141</sup>.
- **Corrosion and Corrosion Prevention**<sup>142</sup>: Nano Zirconia powder has been used to coat engine components by plasma spray with success. Nanocoatings create a lotus effect and properties, which keeps corrosion away. (A to Z Nanotechnology)
- **Nanofibres:** In China and the UK, nanocarbon fibres have been produced. The production of nanofibres offers the potential of using the woven reinforcement as body armour. The future soldier's uniform would incorporate soft woven ultra strong fabric with capabilities to become rigid when a soldier breaks his legs and would protect him against pollution, poisoning and enemy hazards.<sup>143</sup> (A to Z Nanotechnology).
- **Self Cleaning Clothes:** Australian researchers have used nanotechnology to develop 'self-cleaning' wool and silk fabrics. The researchers 'prepared wool fabrics with and without a nanoparticle coating composed of anatase titanium dioxide, a substance that is known to destroy stains, dirt, and harmful microorganisms upon exposure to sunlight.' In one of their experiments, they poured red wine upon pristine and nanotechnology-coated wool. After 20 hours, their coated fabric 'showed almost no signs of the red stain, whereas the untreated fabric remained deeply stained.' The researchers think these fabrics could become available in a near future.<sup>144</sup> (American Chemical Society)

## Manufacturing

- **Green Manufacturing:** Both multinational corporations and consumers worldwide are increasingly embracing green manufacturing. In many developed economies, for example, governments have established national green chemistry awards for industry. Four approaches are commonly employed in green manufacturing:



- *Green chemistry: adoption of* environmentally benign chemical processes and products
- *Green engineering: selecting* feasible processes and products that minimize pollution and risks to health and the environment
- *Inherently safe process design: applying* smaller quantities of hazardous material, less hazardous material, and alternative reaction routes or process conditions
- *Good manufacturing practices (GMPs): adopting* methods, facilities, and controls to make high quality reproducible products that meet appropriate regulations and standards<sup>145</sup>. (Rand)
- **Rapid Manufacturing:** Chris Anderson in 'The Long Tail,' argues that all mass markets will become a very large collection of very small niche markets in the future. The internet has already enabled customers to personalise their purchase when it comes to books videos or music. The result is that there is not only demand for hit products but that a large number of items that sell only a few copies each can produce high turnover. Search engines and e-files have rendered this 'long tail' of low demand products easy to find and cheap to produce and store in the book and music industry. Now, rapid manufacturing is providing the tools to customise physical goods as well, in addition to several efficiency gains it promises to bring.<sup>146</sup> (Martijn Laar).
- **Niche Manufacturing:** Although nearly 5 million manufacturing jobs have been lost in the US over the past three decades, at the same time the higher-paying, high-skill manufacturing sector has grown 37 percent. (CBS News).<sup>147</sup>
- **3D Printing:** In the past few years, the cost of 3D printers has been falling steadily. In essence 3D printers are machines able to print three dimensional objects by bonding particles of material (typically resin) together layer by layer until a full object is formed. For small objects the printers can be desktop devices. In 2007 it was estimated that 3D Printers were as comparatively cheap as laser printers had been in 1985. In recent years these machines have been a useful rapid prototyping technology, but with Moore's law, scientists are now envisaging a much wider use – with factories, ships and even armies in the battlefield producing components on demand. In the consumer space it could lead to a massive expansion of individuals designing and producing their own goods.<sup>148</sup> (Predictive Domain).
- **Personal Fabricators:** The prospect of a machine with the ability to manufacture anything has long been considered an unrealisable concept from Star Trek. However advances in 3D printing, rapid manufacturing and nanotechnology are making the concept more viable. MIT physicist Neil Gershenfeld believes it's not too early to think about this possibility of such a machine, known as a personal fabricator.<sup>149</sup> (API.Ning.com)
- **Mechatronics:** Mechatronic products and processes are increasingly pervasive across a broad range of industries. Mechatronics is the synergistic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and manufacturing processes (Journal of International Federation of Automatic Control<sup>150</sup>).
- **Organic Electronics:** Organic electronics deals with conductive polymers, plastics, or small carbon molecules. Use of organic solar cells could cut the cost of solar power by making use of inexpensive organic polymers rather than the expensive crystalline silicon used in most solar cells. The polymers can be processed using low-cost equipment such

as ink-jet printers or coating equipment employed to make photographic film, which reduces both capital and manufacturing costs compared with conventional solar-cell manufacturing<sup>151</sup> (MIT Technology Review)

- **Manufacturing with Programmable Materials<sup>152</sup>:** Nanoscale physical materials that can be automatically assembled into useful configurations by computer instructions could usher in a new era in manufacturing, including the production of replacement body parts and implants. (Sigma Scan)
- **High Performance Computing (HPC)** One way in which manufacturers can innovate is by using high performance computing (HPC) technology to simulate real-world scenarios and products, saving materials and labour costs. An HPC cluster contains a group of connected computers that simultaneously work on a job, delivering results more quickly and cost effectively than a standalone system (Microsoft)<sup>153</sup>.
- **New Quantum Materials and Devices<sup>154</sup>:** Quantum devices will revolutionise sensor technology long before quantum computers become available. As well as improved law enforcement, this could mean more efficient energy generation and use, better-regulated manufacturing processes, and better pollution detection (Sigma Scan)

## Information and Communications Technology

- **Digital Convergence:** Convergence of computing and communications is opening up whole new possibilities and markets. Converged devices such as the iPhone, converged applications and converged networks are already with us and have led to new opportunities. Converged content may be the next area for development.<sup>155</sup> (IBM).
- **Exponential Growth in Data Storage<sup>156</sup>.** The challenge for information management is controlling the rising flood of data that surrounds us. Between 1999 and 2002 the volume of stored information in the world doubled. In 2008, a new attempt to measure the quantity of information began, but this will be complicated by the spread of different sorts of information - words, pictures and video are less easy to measure than numbers. (Sigma Scan).
- **Evolving Technological Ecosystem:** Handheld devices expected to become the control centre of a rapidly expanding personal ecosystem - where projection / pullout screens and keyboards could accelerate laptop replacement. Key enablers include augmented reality, intuitive interfaces, semantic computing and the increasing embedding of intelligence in a range of devices – often known as ambient intelligence or IP Everywhere. At the heart of the ecosystem will be a user capable of pulling data and software components from multiple sources to create their own 'mashups'. By 2010, Gartner estimate that mashups will create 80% of all new enterprise applications.<sup>157</sup> (Gartner)
- **Increasing Mobile Phone Take Up:** The International Telecommunication Union (ITU) reports an estimated 4.1 billion mobile subscriptions globally by the end of 2008, compared with about 1 billion in 2002. While there are far more than 4 billion handsets around the world, the figure refers to the number of in-use numbers, or connections. Nokia forecasts 5 billion will be connected by 2015 Nokia also forecasts extraordinary growth in mobile data traffic – rising 300-fold by 2015. "By 2020 I don't think it will be so easy to distinguish between a mobile phone and a laptop," Steve

Jones, Association of Internet Researchers said. "These will blend into a general 'mobile computing' category of device"<sup>158</sup> (Metemanda, Mediapost).

- **Emerging Markets Embrace the Mobile:** With the world's population currently estimated at 6.8 billion roughly three out of five people are using mobile phones. "The strongest growth in mobile phone usage now comes from emerging and developing countries," said Bitkom's Friedrich Jousssen, who also heads mobile phone provider Vodafone's German operations. In India alone, mobile phone usage is expected to grow by 32% in 2009, to 457 million people. In Brazil, a 14-per-cent increase is anticipated, while China's usage is predicted to rise 12%, to 684 million people (Earth Times)<sup>159</sup>.
- **Growth of Open Source:** Open source software offers access to source code (in application design, development and distribution). Recent survey data (April 2009) compiled by Forrester Consulting on behalf of information systems specialist Bull suggests that we are at the front end of a long cycle of open-source infrastructure and application adoption. Despite Gartner finding that 85 percent of enterprises have already adopted open source and Forrester Research's consulting arm finding that 45 percent of all companies that are using open-source software use it for mission-critical applications, the adoption appears to be somewhat thin, leaving a great deal of room for even more adoption, especially in open-source applications<sup>160</sup>. IDC believes (July 2009) that the worldwide revenue from open source software will grow at a 22.4% compound annual growth rate (CAGR) to reach \$8.1 billion by 2013<sup>161</sup> (Intel)
- **Software as a Service:** SaaS is a method of deployment where a provider licenses an application on demand to an end user – typically via the Internet. IDC (Jan 2009) expects SaaS growth to exceed 40% in 2009<sup>162</sup>. In a 2007 report, Gartner predicted a \$19.3 Billion *SaaS Market* by 2011 – this figure is set to be raised further (IDC, cited by peoplescube)
- **Greening IT:** Simon Mingay, an analyst at Gartner suggests that in the longer term, IT companies need to start thinking about renewable energy sources. Some are taking steps towards this - Google has installed solar panels on the roof of its headquarters in Mountain View, California, with the aim of generating 30% of its energy needs. In the UK, BT plans to spend £250m on building wind farms around the country<sup>163</sup>. The US Environmental Protection Agency says data centres account for 1.5% of national electricity consumption, but this will double to 3% by 2011 (Financial Times).
- **Increasing Server Energy Efficiency**<sup>164</sup>: Researchers at the University of Michigan have announced a plan to save up to 75 percent of the energy that power-hungry computer data centres consume by putting idle servers to sleep when they're not in use. Thomas Wenisch, assistant professor in the department of Electrical Engineering and Computer Science, and his team analysed data centre workloads and power consumption and used mathematical modelling to develop their approach. It will include PowerNap, an energy conservation method that eliminates almost all the power used by idle servers, and a more efficient power supplying technique. (ZDNet)
- **Increasingly Personalized and Mobile Advertising.** Personalised advertising, delivered largely on totally customized mobile computing & communication devices, could turn the \$ 1 Trillion USD advertising and marketing services economy upside down. Behavioural targeting and user-controlled advertising will become much-discussed issues. The trade off that 'I give you attention & personal data and you give me value e.g. content' will be even more pronounced on the Net. Gerd Leonhard forecasts mobile

advertising could possibly boost the global value of advertising-content more than 100% by 2015. (MediaFuturist<sup>165</sup>).

- **Collective Intelligence:** Jeff Jonas, an IBM Distinguished Engineer, is chief scientist of its Entity Analytic Solutions Software Group. He described collective intelligence as lots of piles of data, much gleaned from a ubiquity of sensors that have to be stitched together and put in context. "In 2050, collective intelligence is your personal digital agent, locating and telling you what you need," he said. Jonas gave the following example of this advanced collective intelligence. "There is a pile of data about the current status of an individual. There are also piles about the current migratory status of birds and the weather. The three piles are correlated, resulting in the individual being told to 'jump to the right' to avoid being hit by a descending pile of bird excrement". (CNet<sup>166</sup>).
- **Ambient Intelligence**<sup>167</sup>: Effectively, ambient intelligence is about creating electronic environments that are sensitive and responsive to the presence of people. This implies embedding intelligence and an IP address in everything from the paint on our walls to the windows and curtains and the furniture we sit on. There are already diverse applications using ambient technology on the market, but one crucial sticking point is that few of them are fully integrated into wireless communication systems. European researchers have been addressing this outstanding issue.

"The idea is to integrate sensor networks into wireless communication systems and to 'capture' the user's environment, perhaps using a mobile phone as a gateway, and then transmit this context to a service platform to deliver a personalised service and act on situations," says Laurent Herault, project coordinator of a research scheme developing new ways of capturing ambient intelligence in post-3G mobile communication systems through wireless sensor networks. The context captured can be an environmental one, such as location, but also the subject's emotional context – what is known as the "physiological state". (Science Daily)

- **Reality Mining**<sup>168</sup>: Personal reality mining infers human relationships and behaviour by applying data-mining algorithms to information collected by cell- phone sensors that can measure location, physical activity, and more. Models generated by analysing data from both individuals and groups could enable automated security settings, smart personal assistants, and monitoring of personal and community health. Mobile phones are now sophisticated enough to collect and analyse data on personal behaviour, and researchers are developing techniques that allow them to effectively sort through such information. (MIT Technology Review)
- **Collective Blanket Licenses**<sup>169</sup> One of the biggest issues for content owners is how to control and monetise the distribution of their content over the web. One view is that blanket licences which legalise and unlock legitimate access to basic content services via any digital network will emerge. Media futurist Gerd Leonhard suggests they are likely to take over as the primary means of content consumption around the world. (Media Futurist).
- **Practical Quantum Computing:** "A quantum computer is a device for computation that makes direct use of quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. The basic principle behind quantum computation is that quantum properties can be used to represent data and perform operations on these data."<sup>170</sup> Breakthroughs in quantum computing should provide useful

applications in encryption and data mining that could move into the mainstream marketplace within a few years. Financial traders might be able to better predict the future outcome of financial markets by using quantum tools.<sup>171</sup> (Global Futurist)

- **Quantum Cryptography:** In 'traditional cryptography' the data itself is encrypted using complicated mathematical functions. In 'quantum encrypted communications', a key is sent by beaming a string of photons, representing a code, from the source to the target. If it gets to the other end and matches what the target expects, then the data gets unencrypted. The Guardian notes that if anyone tries to intercept or break it, thanks to the laws of quantum physics, the mere act of observing the stream of photons changes it - and so it fails.<sup>172</sup> (Guardian).
- **DNA Computing**<sup>173</sup>: Scientists at IBM are experimenting with using DNA molecules as a way to create tiny circuits that could form the basis of smaller, more powerful computer chips. The company is researching ways in which DNA can arrange itself into patterns on the surface of a chip, and then act as a kind of scaffolding on to which millions of tiny carbon nanotubes and nanoparticles are deposited. That network of nanotubes and nanoparticles could act as the wires and transistors on future computer chips. If it works as planned, it could lead to a new way of fabricating features on the surface of chips that allows semiconductors to be made even smaller, faster and more power-efficient than they are today. (PC World)
- **Room Temperature Ferromagnets: New Materials for Data Storage in Next Generation Computing**<sup>174</sup>: Spintronics, or spin based electronics, are a new generation of devices that rely upon the spin of an electron to facilitate transfer of information, rather than the traditional electron charge that is used in conventional electronics. (Sigma Scan)
- **Cyberwar**<sup>175</sup>: Jeff Green, senior vice president of McAfee Avert Labs, says "Cybercrime is now a global issue. It has evolved significantly and is no longer just a threat to industry and individuals but increasingly to national security." He predicted that future attacks will be even more sophisticated. "Attacks have progressed from initial curiosity probes to well-funded and well-organized operations for political, military, economic and technical espionage." (McAfee)
- **E-Bombs**<sup>176</sup>: The International Institute for Counter-Terrorism says electromagnetic pulse weapons capable of frying the electronics in civil airliners can be built using information and components available on the net. All it would take to bring a plane down would be a single but highly energetic microwave radio pulse blasted from a device inside a plane, or on the ground and trained at an aircraft coming in to land. Yael Shahar, director of the International Institute for Counter-Terrorism in Herzliya, Israel, and her colleagues have analysed electromagnetic weapons in development or used by military forces worldwide, and have discovered that there is low-cost equipment available online that can act in similar ways. "These will become more of a threat as the electromagnetic weapons technology matures," she says. (NationalTerror Alert)

## Internet and Virtual World

- **Falling Cost of Web Access**<sup>177</sup>: Media Futurist Gerd Leonhard predicts that very cheap or free wireless broadband operating at fairly high speeds of at least 2MB / sec will be

available in most places, particularly in the booming new economies of Asia, India, Russia and South-America, and a bit later, in Africa. He predicts that implementation will be funded by the likes of Google and by the future 'telemedia conglomerates', governments, cities and states, and suggest that wireless broadband will probably reach 3-4 out of 5 people on the globe by 2015-2018. He expects user-generated & derived content (UGDC) virtual co-production, mobile editing and instant network sharing to explode by a factor of 1000, making control of distribution a very distant concept of the past. He suggests UGC or UGDC could make up to 50% of global content consumption by 2015. In this model, consumers will be (co)-creators, marketers, sellers and buyers, and range from totally passive to totally active. (Media Futurist)

- **I.P Growth**<sup>178</sup>: Forecasts suggest that by 2012, the internet could be 75 times its size in 2000 with over 400 times the traffic due to the rise of online video. It is estimated that \$130bn of investment is needed improve the network worldwide to avoid reaching the physical limits of capacity of the internet by 2010. (Silicon Republic)
- **The Semantic Web**: The Semantic Web is the concept of extension of the World Wide Web to enable people to share content beyond the boundaries of applications and websites.<sup>179</sup> In essence it uses language that computers understand, to give information a clearly defined meaning. The goal is to improve the usability and capability of the web such that humans and machines can access the content they need with ease. A variety of working groups are establishing common standards for the semantic web. These are agreeing, for example, 'rule interchange formats' that will allow systems using a variety of rule languages and rule-based technologies to interoperate with each other and with other Semantic Web technologies.<sup>180</sup> (Business Portal)
- **Social Media Explosion** There were 691M unique social network visitors in November 2008. In August 2009 Facebook was ranked as the fourth most popular global website with 340M unique monthly users.<sup>181</sup> Forrester predicts social media spending will rise from \$716M in 2008 to at least \$3.1Bn 2009<sup>182</sup> (Mashable, Tech Crunch)
- **Web 2.0**: The concept of Web 2.0 "is commonly associated with web development and web design that facilitates interactive information sharing, interoperability, user-centered design<sup>[1]</sup> and collaboration on the World Wide Web. Examples of Web 2.0 include web-based communities, hosted services, web applications, social-networking sites, video-sharing sites, wikis, blogs, mashups and folksonomies. A Web 2.0 site allows its users to interact with other users or to change website content, in contrast to non-interactive websites where users are limited to the passive viewing of information that is provided to them."<sup>183</sup> Forrester estimate that companies will spend \$4.6 billion on Web2.0 related technologies by 2013.<sup>184</sup> (Forrester)
- **Rise in Virtual Learning**: Michael B. Horn author of Disrupting Class predicts that by 2019, nearly half of all public high school courses will be taught online. Nationwide in the US 700,000 kids attended virtual schools as of January 2008. There are 18 different uses of virtual worlds identified in UK higher and further education - medical sciences, mathematics and art & design feature prominently<sup>185</sup>. In the UK, 63% of secondary schools and 22% of primary schools are using virtual learning platforms<sup>186</sup> (Eduserve, Insight School, BBC)
- **Virtual Worlds Lessens Importance of Geography**<sup>187</sup>: In the autumn of 2008, the IBM Academy of Technology held two major events in Second Life. With an initial investment of roughly \$80,000, IBM estimates that they saved over \$250,000 in travel

and venue costs and more than \$150,000 in additional productivity gains as since participants were already at their computers and could go back to work immediately. This yielded a total saving of \$320,000 when compared to the potential expense if the event had been held in the physical world. (Virtual Worlds News)

- **Rise of the Immersive Web<sup>188</sup>**: The next generation of the web could be shaped by immersive technology that delivers sensation, experience and emotion in rich online worlds, building upon early virtual worlds such as Second Life. (Global Futurist)
- **Augmented Reality Expansion<sup>189</sup>**: Augmented reality involves using visors, mobile phones and heads up devices to overlay digital information onto physical world objects e.g. buildings. This could give them what futurist Ian Pearson calls a 'dual architecture'. 55% of Internet experts surveyed by Pew believe that by 2020 many lives will be touched by the use of augmented reality or spent interacting in artificial spaces. 'SixthSense' is a wearable gestural interface prototype that augments the physical world around us with digital information and lets us use natural hand gestures to interact with that information. (Canwest News Service)
- **Intelligent Software Assistant<sup>190</sup>**: Search is the gateway to the web for most people; it has become second nature to distil a task into a set of keywords that will lead to the required tools and information. However, Adam Cheyer, cofounder of start-up Siri, envisions a new way for people to interact with services available online: a "do engine" rather than a search engine. Siri is working on an 'interactive aide' or virtual personal-assistant software tool, which would help users complete tasks rather than just collect information. Siri traces its origins to a military-funded artificial-intelligence project called CALO (cognitive assistant that learns and organises). (DNA India)
- **Interactive Data Eyeglasses<sup>191</sup>**: A team of scientists at the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden, Germany, is working on a device that incorporates eye tracking to influence the content presented to the viewer. Without having to use any other devices to enter instructions, the wearer can display new content, scroll through a menu or shift picture elements simply by moving her eyes or fixing on certain points in the image. (ZDNet)
- **Touchable Holographs<sup>192</sup>**: A 'touchable holograph' display has been developed at the University of Tokyo. It adds tactile feedback to 3D images hovering in space in front of a concave mirror using an ultrasound device positioned below the LCD and mirror. (ZDNet)

## Artificial Intelligence (AI)

- **Application of AI to Global Trade and Logistics<sup>193</sup>**: The application of artificial intelligence to commerce is likely to make trade and logistics more efficient. Trading systems such as stock markets already use AI to take buy and sell decisions. In coming years they could also be used to allocate aircraft, ships and vehicles more effectively. Today's airline scheduling systems leave empty seats equivalent to several 747s flying the Atlantic with no passengers every day. AI systems that take on scheduling could reduce this waste without a significant reduction in passenger choice. (Sigma Scan)

- **AI in UK Policing**<sup>194</sup>: Looking at how AI techniques can boost digital forensics, the UK government-funded Cyber Security Knowledge Transfer Network (KTN) will examine the potential use of AI in web counter-terrorism surveillance, fighting internet fraud, masking identities online and data mining. Nigel Jones, director of the KTN, said: "In today's age of distributed networks and with moves towards cloud computing, there is a lot more information out there that might be useful in terms of evidence." "There is a problem in handling that mass of data, in storing it, routing it, tracing it and in finding patterns." (ZDNet)
- **Self-teaching AI**<sup>195</sup>: Stanford computer scientists have developed an artificial intelligence system that enables robotic helicopters to teach themselves to fly difficult stunts by watching other helicopters perform the same manoeuvres. (Robotics Trends)
- **Intelligent Interface**<sup>196</sup>: Advances in speech recognition, artificial intelligence (AI), and computer power suggest the old computer interface (keyboard, mouse, etc.) may yield to an "intelligent interface" in which we simply converse with smart computers. The possibilities are vast. Humans could rely on "intelligent agents" or "virtual assistants" to serve as secretaries, tutors, salespeople, and almost all other routine work roles. (TechCast)
- **Self-Replication**<sup>197</sup>: Self-replicating and even self building AI systems are already in the offing. DARPA, the US military bureau plans to initiate a programme called Self-Explanation Learning Framework (SELF), which they explain thus: DARPA seeks to construct systems that can participate in their own construction. The system might know the requirements for various tasks in its repertoire, and it may try to perform those tasks to verify functionality. (The Register)



## Robotics

- **The Robots Have Landed**<sup>198</sup>: The World Robotics Report estimates the world robot population at 4.5 million, with 3.5 million domestic robots and 1 million industrial robots. (TechCast)
- **Robotics Taking off as a Global Industry**<sup>199</sup>: NextGen Research forecasts worldwide demand for all-purpose service robots will reach \$15 billion by 2015, or roughly 5 million robots per year. (CNET News 5/27/09)
- **Healthcare Robots**<sup>200</sup>: One area particularly ripe for robotics is healthcare, according to Arjan Rensma of the Dutch innovation agency TNO, which he says could be worth anywhere from €40 billion upwards depending on which study you read. The Japanese are leading by example with the launch this year of a five-year “life-support” robotics project – with funding of €12 billion in the first year alone – aimed at helping carers in their daily tasks. Rensma says the Japanese will also launch a robotics programme aimed at helping the elderly at home, worth €4 billion in the first year. (Rathenau Instituut in Science Daily)

## Transportation

- **The End of the Car?**<sup>201</sup>: Futurist Thomas Frey suggests that the car’s says as ‘King of the Road’ may soon be over. He argues that more powerful wireless communication that reduces demand for travel, flying delivery drones to replace trucks, and policies to restrict the number of vehicles owned in each household are among the developments that could thwart the automobile’s historic dominance on the environment and culture. If current trends were to continue, the world would have to make way for a total of 3 billion vehicles on the road by 2025. (World Future Society)
- **Hybrid and Electric Cars Gaining Traction**: While on the campaign trail, President Obama said he hoped to see 1 million plug-in hybrids on the road by 2015. Since Obama took office, the federal government has implemented a broad range of consumer and industry incentives to promote production and sales of plug-in vehicles<sup>202</sup>. Many<sup>203</sup> envisage the tipping point for electric cars around the year 2022. (TechCast)
- **Fuel Cells Nearing Commercial Maturity**<sup>204</sup>: Hybrids and fuel cell autos both use electric motors to drive the wheels, batteries to store energy, regenerative braking to conserve it, and may in time use composite bodies that are lighter. TechCast estimates fuel cell cars will enter the commercial market by 2015, eventually creating global demand that may reach several \$ trillion.
- **Carbon Nanotubes and Lighter Vehicles**<sup>205</sup>: Carbon nanotube composites promise to enable the creation of lighter and stronger transportation vehicles. (Sigma Scan)
- **Dirigibles**<sup>206</sup>: With military prototypes planned for 2014, giant blimps may be about to make a comeback for mass transportation suggest Julian Barnes of the Chicago Tribune and TechCast.

- **Maglev Trains**<sup>207</sup>: The world's first "maglev" train service began on January 1, 2003 cruising between Pudong and Shanghai, China reaching speeds over 300 mph. Trials are currently underway in Germany and Japan. US groups have proposed Los Angeles-Las Vegas and Boston-New York-Washington DC routes. (TechCast, Memebox)
- **Hypersonic Scram Jets**:<sup>208</sup> Hypersonic jets are defined as highly supersonic, with Mach 5 being the generally excepted defining speed. Highly supersonic designs like Reaction Engines Skylon claim to be capable of reaching Mach 5.5 within the atmosphere, before activating a rocket engine and entering orbit. The jet would later re-enter the atmosphere and land back on the runway it took off from. There is also a very long distance supersonic/hypersonic transport version of Skylon, the A2, being evaluated by the European Union as part of the LAPCAT project, which would travel at Mach 5 and would be capable of travelling from Brussels to Sydney in 4.6 hours. (Reaction Engines)
- **Increasing use of Unmanned Aerial Vehicles in Non-Combat Situations**<sup>209</sup>: Border patrols, rescue teams and various security concerns are starting to use of UAVs in their respective environments. (KVOA)

## Space

- **Emergence of a Global Space Market**<sup>210</sup>: It is anticipated that many innovations will be developed by space enterprises that will accelerate the establishment of a global space market. (Global Futurist)
- **Renewed Interest in Moon/Mars Missions**<sup>211</sup>: With an international base on the moon and vital technologies like in-space refuelling, Buzz Aldrin envisions an ambitious series of expeditions to send astronauts on a deep space mission to visit the asteroid Aphophis when it swings near Earth in 2021. A temporarily manned base on the Mars moon Phobos could follow according to Aldrin. "By that time, we'd be ready to put people in a gradual permanence on Mars by 2031," Aldrin said. "That, in a nutshell, is what I really think we should be doing." (Space.com)
- **21<sup>ST</sup> Century Space Race**<sup>212</sup>: Extremely valuable assets, from materials and drugs to minerals and innovations, could create a space race among global companies. (Global Futurist)
- **Space Tourism**<sup>213</sup>: Virgin Galactic has broken ground on their \$300 million Spaceport America launch facility in New Mexico, and tested the mother ship that will carry the space ship itself to launch. The first space tourism flight is scheduled to launch in 2011, and will take tourists paying \$200,000 each into suborbital flight. (TechCast)
- **Space Hotels**<sup>214</sup>: There is growing interest in the concept of developing orbital hotels. In 2007, CNN reported that "Galactic Suite", the first hotel planned in space, expects to open for business in 2012 and would allow guests to travel around the world in 80 minutes. Its Barcelona-based architects say the space hotel will be the most expensive in the galaxy, costing \$4 million for a three-day stay. (CNN)
- **Miniature Spacecraft**<sup>215</sup>: It is predicted that miniaturised cost-effective spacecraft could explore the stars long before humans are capable of venturing out into deep space. (Global Futurist)

- **Space Mining<sup>216</sup>**: It is predicted that mining of asteroids and planets could yield new resources, elements, and materials that will enhance the quality of life on our planet. (Global Futurist)
- **Terraforming<sup>217</sup>**: Space experts anticipate that humans will learn to leave their home planet of Earth, terraform faraway planets, and colonize space. (Global Futurist)
- **Astrobiology and Life Beyond Earth<sup>218</sup>**: Multidisciplinary efforts by astrobiologists may increase our understanding of the origins of life on this planet and could result in finding life beyond Earth. This research may yield numerous benefits by enhancing our understanding of life on Earth. However, its real importance is that if we discover life elsewhere, there will inevitably be widespread changes in humanity's view of itself, especially affecting our religions and belief systems. (Sigma Scan)

## Demographics

- **Population Booming**: The UN estimates (11/03/09) that the global population will rise from 6.8Bn in 2009 to 9.1Bn by 2050. The organisation also predicts global fertility will fall from 2.5 children per woman, to just over two in 2050. The population of developing countries is projected to rise from 5.6Bn in 2009 to 7.9 Bn in 2050, while more developed regions change minimally, from 1.23Bn to 1.28Bn. Net migration from poor to rich countries is forecast at 2.4 million annually from 2009 to 2050<sup>219</sup> (UN)
- **Key UN Population Forecasts to 2030 (Million) Medium Variant Scenario<sup>220</sup>**

Year	UK	Europe	World
2005	60 261	729 421	6 512 276
2010	61 899	732 759	6 908 688
2015	63 528	734 000	7 302 186
2020	65 090	732 952	7 674 833
2025	66 601	729 264	8 011 533
2030	67 956	723 373	8 308 895

- **Aging Global Population<sup>221</sup>**: Globally, the population over 65 is projected to rise from 5% in 1950 and 7% in 2000 to 16% in 2050. The proportion of the developed world's population over 60 is expected to rise from 22% to 33% between 2009 and 2050, and the developing world's to grow from 9% to 20% over the period. Eurostat predict that deaths in Europe will overtake births by 2015. Globally, the number of older people should exceed the number of children by 2047 – this happened in the developed world in 1998. (UN)
- **Rising Life Expectancy<sup>222</sup>**: Biogerontologists like Aubrey de Grey of Cambridge believe that extreme life extension is possible, more than doubling current average life spans within a decade or so. Caloric restriction and drugs like resveratrol are proposed as emerging mediums through which life extension could occur; other more radical methods are also being researched. (BBC)
- **Changing Racial Mix<sup>223</sup>**: Eurostat reported the EU's total population was up by 2.39M (0.48%) in 2007, reaching 497.5M inhabitants - 80% of the growth came from a 16.4%

rise in new migrants to 1.9M. The Pew Research Center estimate that, based on current trends between 2020 and 2025, the foreign-born population will account for 15% of the American population by 2025 and 19% by 2050. In the UK, Leicester is expected to be the first location where whites will fall below 50% of the population by 2020, followed by Birmingham in 2024, and Slough and Luton soon afterwards. (Barrow Cadbury Trust, Eurostat)

- **Boomers Delaying Retirement<sup>224</sup>**: In a US AARP survey of workers aged over 45 (09/08), 20% had stopped pension contributions, 34% contemplated putting off retirement and 27% had trouble paying rent or mortgages. The Center for Economic and Policy Research (02/09) says the US housing collapse has left the majority of those around retirement-age almost completely reliant on entitlements. The net worth of median US households aged 45 to 54 has dropped more than 45% since 2004, to just over \$80,000. (Wall Street Journal)
- **The Rise of Generation Z<sup>225</sup>** This a generation for whom expectations are set by the immediacy of the digital world. A Habbo survey (05/09) found Generation Z (born 1994 – Present) to be altruistic, with a strong sense of values, concerned about the environment, social justice and humanitarianism, less interested in fame and fortune than Generation Y (1981-1990) and favouring technology platforms they can mould. (MCN)
- **Increasing Prospect of Generational Conflict<sup>226</sup>**: 51% of baby boomers (born 1946-1964) and 66% of the generation that preceded them reported having little to no interaction with colleagues from Generation Y (1981-1990). Generation Y is considered the most self-indulgent, Generation X (1964-1980) the most innovative, Boomers are the most productive, and those over 63 are the most admired. The EU warns that the economic downturn "could make the challenges creating by ageing more acute" and lead to intergenerational conflict. The EU ratio of workers aged 15-64 to those over 65 is forecast to fall from 4:1 to 2:1 by 2060. (Randstad, Harris Interactive, EU Commission)

## Culture and Leisure

- **Technology an Increasing Part of Daily Lives<sup>227</sup>**: Baby boomers (1946-1964) are adopting technology at nearly 20 times the rate of younger generations notes Accenture, and although this largely represents growth from a much lower base, it does indicate the upward spread of technology through generations. (Accenture)
- **Declining Credibility of all Sources of Information<sup>228</sup>**: Edelman's 2009 Trust Barometer shows trust is down in most types of news outlet and spokesperson from 2008. Corporate or product advertising is least trusted – down from 20% in 2008 to 13% in 2009. In the US, trust in information from a company's top leader is at a six-year low at 17%. Outside experts at 59% remain the most trusted purveyors of information about a company. Only 29% and 27% view information as credible when coming from a CEO or government official respectively, declining from 36% and 32% in 2008. (Edelman)
- **Junk Science? The Importance of Public Trust in Science<sup>229</sup>**: The monopoly that science has over the 'truth' may face significant challenges from cultural relativism, postmodernism and declining trust in authority figures. The growing influence of spirituality in the public sphere may also be a factor in undermining conventional views of

the value of scientific research. People may become increasingly unwilling to leave decisions about science to professionals or even legislators; declining public trust in science has the potential for significant impact on public policy. (Sigma Scan)

- **Broadening Amateur Participation in Science<sup>230</sup>**: We are seeing more and more opportunities for amateur participation in research, ranging from donating resources, through becoming involved in observation, to collaborative research between professionals and amateurs. The involvement of members of the public and interest groups in research takes us towards new sorts of 'citizen science'. (Sigma Scan)
- **The Advent of Molecular Archaeology<sup>231</sup>**: The advent of archaeology at the molecular level thanks to advances in genetics, chemistry, and physics is expected to lead to a new level of precision in archaeological research and enable better understanding of past events and cultures. (Delta Scan)

## Politics, Economics and Commerce

- **Increasing Need for Multilateralism<sup>232</sup>**: With Globalisation, nations are more involved and interdependent, many issues are more complex, requiring multilateral solutions, but consensus is harder to achieve. The consensus at the recent G20 summits offers hope for the future. Consensus enabled the G20 to allocate the IMF \$250Bn in Special Drawing Rights and triple its lending capacity to \$750Bn. The Managing Global Insecurity project says in order to tackle key global challenges, the UN needs a legally binding climate change agreement, a counter-terrorism commissioner, and a 50,000 peacekeeping force. (FT, IMF, Harvard Crimson)
- **A Shortage of Trust<sup>233</sup>**: Edelman's 20-country 2009 Trust Barometer shows a 3:1 margin which says government should intervene to regulate industry or nationalise companies to restore public trust. Political trust is declining fast globally – only 14% in Europe trust politicians. (Edelman)
- **Increasing Levels of Political Instability<sup>234</sup>**: 35 countries are on the highest risk 'alert' status in the 2008 Fund for Peace failed states index – a four year high, with 127 countries in 2008 at Alert or Warning status compared to 76 in 2005. A new status of 'Very high risk' is proposed on Aon's Political Risk Map to cover Afghanistan, Congo DRC, Iran, Iraq, North Korea, Somalia and Zimbabwe. Eighteen countries were downgraded to higher risk level – including Greece, Malaysia and Thailand. The Vision of Humanity project reports that levels of peace drop during recessions, whilst a more peaceful world could add \$4.8 trillion to the global economy. (Vision of Humanity)
- **Rise in E-Government<sup>235</sup>**: Across the globe countries are pursuing e-government projects in order to provide better services to citizens, improve internal communications and cut costs. In Thailand the Information and Communications Technology Ministry announced plans in April 2009 to launch an E-Government Road Map, as a framework for e-government developments from 2010 to 2014. According to the Thai press, the roadmap consists of four stages: Connected Government (c-Government), Mobile and Multi-Channel Government (m-Government), Ubiquitous Government (u-Government) and Transformed Government (t-Government) The first stage - c-Government - that will begin this year - aims to establish collaboration among all government agencies in the provision of public e-services. The second stage - m-

Government - is scheduled for 2010 and 2011 – a period in which the e-government concept will be expanded and made accessible via mobile devices. The u-Government stage, scheduled to start in 2012, aims at providing government e-services to the public around the clock, through various channels that include websites, mobile devices and future technology. The final stage aims for a complete transformation of government services to an electronic basis, providing e-services 24 hours a day, seven days a week, via a variety of channels, along with interchanged e-services among government agencies. (World Bank)

- **There may not be World Law in the Foreseeable Future, but the World's Legal Systems will be Networked<sup>236</sup>:** The Global Legal Information Network (GLIN), a database of local and national laws for more than 50 participating countries, will grow to include more than 100 countries by 2010. The database could lay the groundwork for a more universal understanding of the diversity of laws between nations and could create new opportunities for peace and international partnership. (World Future Society)
- **Rising Western Indebtedness<sup>237</sup>:** The rich G20 countries' debt is projected to grow from 83.3% of Gross Domestic Product (GDP) in 2008 to almost 100% in 2010. Japan's debt burden could be 225% of GDP in 2010 whilst developing G20 economies debt is expected to rise from 35.7% to 37.8% by 2010. The US Congressional Budget Office estimates the cumulative deficit from 2010 to 2019 will total \$9.3Tn, and public debt would rise to 82% of GDP by 2019. The average personal debt in the US amounted to more than 130% of after-tax income in 2008. (Economist)
- **Economic Power Decentralises<sup>238</sup>:** A number of factors suggest that economic power is shifting from developed to emerging economies. 2009 saw the first joint communiqué by BRIC economies at the G20 summit. The US share of global output fell from 31% to 27% between 2000 and 2008. This fall is demonstrated partially through the number of US / UK banks in the top 20 by market capitalisation falling from 17 to 4 between 2003 and 2009. China and India accounted for 58% of the growth in global output in 2007 and the BRICs are forecast to deliver 40% of all global output growth in the 2009-2018 period. (FT, UN, Washington Post, Hispanic Business)
- **More Accurate Modelling of Complex Economic Systems<sup>239</sup>:** Advances in simulation tools and behavioural analysis may facilitate innovation in economic research methods. (Sigma Scan)
- **A Greener Recovery?<sup>240</sup>:** 81% of South Korea's recovery package is earmarked for green initiatives, as is 34% in China, but nothing in India. The UN projects the global market for "green" products and services will double to \$2.74 billion by 2020. Japan, for example, aims to double green sector jobs to 2.8M between 2008 and 2020. However, VC investment in clean technology was down 48% to \$1Bn in Q1 2009. (Economist)
- **Increasing Economic Power of Women<sup>241</sup>:** Over 80% of consumer purchasing decisions internationally were influenced by women in 2007. 84% of female wealth in the UK came from earnings & business ownership in 2007. 40% of UK wives who work full time earned more than their husbands in 2007. In 2006 it was forecast that 53% of the UK's millionaires will be women by 2020. (Womenomics)
- **Professional Knowledge will Become Obsolete Almost as Quickly as it's Acquired<sup>242</sup>:** An individual's professional knowledge is becoming outdated at a much faster rate than ever before. Most professions will require continuous instruction and

retraining. Rapid changes in the job market and work-related technologies will necessitate job education for almost every worker. At any given moment, a substantial portion of the labour force will be in job retraining programs. (World Future Society)

- **Growing Talent Shortage<sup>243</sup>** : 31% of employers worldwide have difficulty filling positions due to lack of available talent in their markets. Those facing the most difficulty were in Romania (73%), Japan (63%) and Hong Kong (61%). More than 50% of employers in five of the eight countries in Asia Pacific reported difficulty in finding suitable talent. The least problematic were India (12 %), the UK (12%) and Ireland (14%). Countries need over 3.5Bn people by 2010 to fill knowledge worker positions – rising to over 4Bn by 2020 – a shortage of 32M-39M is predicted. The US will have the biggest shortfall—needing up to 14M. The shortage of talent is particularly acute at the management level. (Manpower, Business Week)
- **IT Could Become Major Force in UK Economy<sup>244</sup>**: An E-Skills report estimates that, depending upon levels of technological uptake amongst businesses and consumers in general, the converged IT/ telecoms industry could generate an additional £35 billion for the UK economy over the decade to 2018. The sector already contributes £51.7Bn to the economy – representing around 5% of both jobs and employment. (E-Skills)

## Appendix 3 - The Science and Technology Timeline 2010 – 2030

Wherever possible, we have adopted the timescale forecasts provided by the sources from which the data was taken. Where there are conflicting views, we have used our judgement to select the most appropriate date. In many cases the developments are at such an early stage that a date range rather than a precise year is offered.

Fields of Study	Possible Year of Realisation	Description
<b>Science Policy, Strategy and Funding</b>		
<ul style="list-style-type: none"> <li>Growth of Chinese Science and Technology<sup>245</sup></li> </ul>	2010+	PhD production in China increased fiftyfold between 1986 and 1999, from less than 200 to more than 7,000 degrees granted annually. By some estimates, China now graduates more engineers than the rest of the world combined. Peking already appears as a top institution in the THE/QS World University Rankings, at 50 in 2008, and there are six Chinese and four Hong Kong universities in the top 200 (SigmaScan)
<ul style="list-style-type: none"> <li>Global standards for global science<sup>246</sup></li> </ul>	2012-2019	Developing economies will play an increasing role in the establishment of global science and technology standards. (SigmaScan)
<ul style="list-style-type: none"> <li>Increasing public role in science decision making<sup>247</sup></li> </ul>	2013+	The monopoly that science has over the 'truth' may face significant challenges from cultural relativism, postmodernism and declining trust in authority figures. The growing influence of spirituality in the public sphere may also be a factor in undermining conventional views of the value of scientific research. People may become increasingly unwilling to leave decisions about science to professionals or even legislators; declining public trust in science has the potential for significant impact on public policy. (SigmaScan)
<ul style="list-style-type: none"> <li>Broadening Amateur Participation in Science<sup>248</sup></li> </ul>	2014+	We are seeing more and more opportunities for amateur participation in research, ranging from donating resources, through becoming involved in observation, to collaborative research between professionals and amateurs. The involvement of members of the public and interest groups in research takes us towards new sorts of 'citizen science.' (SigmaScan).
<ul style="list-style-type: none"> <li>Global diffusion of science<sup>249</sup></li> </ul>	2015+	Over the next 50 years, the long US dominance of a wide range of fields in science and technology is likely to end as the global scientific playing field becomes flatter and more diverse (SigmaScan).
<ul style="list-style-type: none"> <li>More Accurate Modelling of Complex Economic Systems<sup>250</sup></li> </ul>	2015-2020	Advances in simulation tools and behavioural analysis may facilitate innovation in economic research methods (SigmaScan)



Fields of Study	Possible Year of Realisation	Description
<ul style="list-style-type: none"> <li>Brazil: A Potential Scientific Leader<sup>251</sup></li> </ul>	2025	Brazil could emerge as one of the world's leading scientific powers by 2025, if it pursues a policy of intelligent investment and maximises the benefits of international collaboration (SigmaScan).
<ul style="list-style-type: none"> <li>Convergence on a Theory of Everything<sup>252</sup></li> </ul>	2020-2030	The goal is a Grand Unified Theory, a 'theory of everything' that offers a single equation or expression that explains the nature and behaviour of all matter. Building such a theory, Einstein suggested, would be like 'reading the mind of God'. This theory of everything could illuminate some of the biggest mysteries at the heart of physics, from the origins of space and time to the secrets of black holes to the cause of the universe's accelerating expansion (SigmaScan)
<b>Medicine, Biology and Biogenetics</b>		
<ul style="list-style-type: none"> <li>NBIC convergence to revolutionize life<sup>253</sup></li> </ul>	Ongoing	NBIC-convergence is the ongoing unification of nanotechnology, biotechnology, information technologies and cognitive science. The fields are gradually merging into one (Fontela and de Castro)
<ul style="list-style-type: none"> <li>Synthetic biology market grows at 59.8% annually<sup>254</sup></li> </ul>	2009+	The global market for synthetic biology generated \$233.8 million in 2008. This is expected to increase to \$2.4 billion in 2013, for a compound annual growth rate (CAGR) of 59.8% (BCC Research)
<ul style="list-style-type: none"> <li>Biomechatronics leads to cyborg creations<sup>255</sup></li> </ul>	2010+	Biomechatronic scientists attempt to make devices that interact with human muscle, skeleton, and nervous systems with the goals of assisting or enhancing human motor control that can be lost or impaired by trauma, disease or birth defects (HowStuffWorks)
<ul style="list-style-type: none"> <li>Context sensitive cyber-drugs appear<sup>256</sup></li> </ul>	2011-2015	Neild & Pearson believe context specific drugs and personalised medicine will start to appear in the next five years
<ul style="list-style-type: none"> <li>Growing Market for 'Lifestyle' Drugs<sup>257</sup></li> </ul>	2012-15	In the future, enhancement through lifestyle drugs may well become the norm, thanks in part to a wealth of drugs currently being developed to counter Alzheimer's Disease and other problems connected with age and cognitive function. We may be able to manage our lives with delicate precision, controlling our mental acuity, emotions and sensations. Sleep researchers predict we will be able to sleep and wake on demand, thanks to subtle drugs that concentrate a refreshing night's sleep into a few hours or allow us to skip bed with no ill effects even in the long term. Cognitive drugs (cognitiveceuticals) are likely to improve not just memory and the ability to learn - but also our decision-making abilities. They may help the ageing population remain flexible of mind and able to absorb new facts and ideas. Emoticeuticals (triggered to act, for example, by

Fields of Study	Possible Year of Realisation	Description
		changing hormone levels in the body) may mediate our responses not just in our private lives but also in challenging work situations, such as those that demand high motivation (Sigma Scan)
<ul style="list-style-type: none"> <li>Application of Evolutionary Psychology in medical practice<sup>258</sup></li> </ul>	2012-2019	Evolutionary psychology (the contention that many aspects of our behaviour and emotions are evolutionary adaptations) may merge with cognitive neuroscience to produce a new understanding of how the mind and brain evolved and thus a platform for deeper understanding of human behaviour (Sigma Scan)
<ul style="list-style-type: none"> <li>Practical application of Synthetic Chemical Cells in the invention, discovery, synthesis and production of molecules and materials<sup>259</sup></li> </ul>	2012-2022	As opposed to synthetic biology strategies, where scientists use the naturally available molecular building blocks (DNA, RNA, proteins, and lipids) to try to find new applications, synthetic chemical strategies involve synthesising and assembling chemical cells. The scope of synthetic chemical cells is much greater than what we can do with natural materials. (PACE Report)
<ul style="list-style-type: none"> <li>DNA sequencing takes 30 minutes<sup>260</sup></li> </ul>	2013-2015	Pacific Biosciences plans to develop a chip that can record the entire DNA sequence in 30 minutes with 99.99% accuracy at a cost of less than \$1000 (TechCast)
<ul style="list-style-type: none"> <li>Genetic basis of 90% of all diseases identified<sup>261</sup></li> </ul>	2015-2020	Neild & Pearson estimated in 2005 that we are around a decade away from genetically mapping most diseases we know of.
<ul style="list-style-type: none"> <li>Telemedicine begins to radically reduce costs<sup>262</sup></li> </ul>	2015+	Telemedicine refers to medical information being transferred through the net or digitally. Progressive hospitals are embracing various forms of telemedicine. TechCast thinks these advances could enter the mainstream about 2015 to save hundreds of billions of dollars, greatly improve health care, and provide more convenient service.
<ul style="list-style-type: none"> <li>Gene Therapy market approaches \$500m<sup>263</sup></li> </ul>	2015	The global market for gene therapy is projected to reach \$484 million by 2015 (BlissTree)
<ul style="list-style-type: none"> <li>Personal Medicine to revolutionize care and save the industry billions<sup>264</sup></li> </ul>	2015-2025	Now that the human genome is being analyzed carefully, researchers are moving toward genetic tests to determine differences and thereby permit precise medical treatments that are more effective and produce fewer side effects. TechCast estimates these advances could enter the mainstream saving hundreds of billions of dollars and greatly improving health care.
<ul style="list-style-type: none"> <li>Growth and Further Development of Bioinformatics<sup>265</sup></li> </ul>	2015+	The field of bioinformatics will continue to grow in importance over the next two decades, as biological data becomes increasingly abundant and more complex biological processes are being investigated. Developing a suitably trained cohort of research scientists and staff versed in the use of bioinformatics tools is crucial for future development in all branches of the life-sciences and biomedical applications. In

Fields of Study	Possible Year of Realisation	Description
		particular the need for data integration will continue across all sectors employing bioinformatics areas, including industry and healthcare (Sigma Scan)
<ul style="list-style-type: none"> <li>Synthetic life created<sup>266</sup></li> </ul>	2018-2025	Created by scientists in a lab, synthetic life is the design of cell chromosomes (often via bacteria) that could be used to perform functions such as digesting bacterial material to produce fuel. (TechCast)
<ul style="list-style-type: none"> <li>Systems biology begins to solve common diseases<sup>267</sup></li> </ul>	2018+	Systems biology seeks to understand the complex interactions between biological systems and hence provides insights into the causes and possible cures for a range of diseases. (Institute for Systems Biology)
<ul style="list-style-type: none"> <li>iHealth allows checkups 24/7<sup>268</sup></li> </ul>	2019	New wearable devices and information applications will empower consumers with real-time information customised to monitor and track the health status of individuals, measuring risks and downloading customized personal health information (Canton)
<ul style="list-style-type: none"> <li>Body monitoring gives 24/7 real time info<sup>269</sup></li> </ul>	2019+	Biomedicine, smart sensors, and wireless communication are coming together to create the ability to monitor the body 24x7. Predicted market size of about \$510 billion (TechCast)
<ul style="list-style-type: none"> <li>The Advent of Molecular Archaeology<sup>270</sup></li> </ul>	2020-2030	The advent of archaeology at the molecular level thanks to advances in genetics, chemistry, and physics is expected to lead to a new level of precision in archaeological research and enable better understanding of past events and cultures (SigmaScan)
<ul style="list-style-type: none"> <li>New flora and fauna engineered<sup>271</sup></li> </ul>	2020s	Neild & Pearson believe developments in genetic engineering will lead to new forms of animal and plant life by the 2020's
<ul style="list-style-type: none"> <li>Nanotech to defeat cancer<sup>272</sup></li> </ul>	2023 +/- 8 years	Scientists at the University of California are using nanotechnology and microbiology to build "cargo ships" 50 nanometres wide that flow through the bloodstream. Plans are underway to "zip-code" the ships so they will seek out specific types of cancer. TechCast estimates cancer patients will approach normal life spans by 2023
<ul style="list-style-type: none"> <li>Reverse engineering of the brain<sup>273</sup></li> </ul>	2030+	Futurist Ray Kurzweil argues that "we can have confidence of reverse-engineering the brain in twenty years or so. The reason that brain reverse engineering has not contributed much to artificial intelligence is that up until recently we didn't have the right tools. If I gave you a computer and a few magnetic sensors and asked you to reverse-engineer it, you might figure out that there's a magnetic device spinning when a file is saved, but you'd never get at the instruction set. Once you reverse-engineer the computer fully, however, you can express its principles of operation in just a few dozen pages." (Kurzweil)
<ul style="list-style-type: none"> <li>The first ever GM</li> </ul>	2030+	The aim is to use GM techniques to engineer a disease

Fields of Study	Possible Year of Realisation	Description
humans <sup>274</sup>		resistant designer human. (InOurFuture.com)
<ul style="list-style-type: none"> <li>Life expectancy reaches 120<sup>275</sup></li> </ul>	2039	Those with access to advanced technologies can expect a healthy life beyond 120 years (Institute for Alternative Futures)
<ul style="list-style-type: none"> <li>Bioengineered organs on demand<sup>276</sup></li> </ul>	2039	Bioengineering is used to create replacement organs whereby directed combinations of humeral agents stimulate the body to rebuild damaged hearts and brains (Institute for Alternative Futures)
<b>Energy</b>		
<ul style="list-style-type: none"> <li>Mobile energy source revolution<sup>277</sup></li> </ul>	2012-2015	A serious increase in mobile device power (and therefore, its use) will be achieved by employing next-generation technologies such as fuel cells that could provide for up to 500x the usage time that we have today. This could become a reality in 3-5 years and will revolutionize how we use - and how much we rely on - our mobile devices, especially in countries where there the fixed-line power infrastructure is much less developed or non-existent (Gerd Leonard).
<ul style="list-style-type: none"> <li>Development of the smart grid<sup>278 279</sup></li> </ul>	2015-2025	Smart grid advancements will apply digital technologies to the grid, enabling two-way communications and real-time co-ordination of information from both generating plants and demand-side resources. This will improve the efficiency of the bulk-power system and ultimately achieve long-term savings for consumers. It will also help promote wider use of demand response and other activities that will enable consumers to control their electricity costs (Economist)
<ul style="list-style-type: none"> <li>Dark Matter and Dark Energy understood<sup>280</sup></li> </ul>	2015-2025	Physicists speculate that dark matter (hypothetical invisible matter impacting physics) and dark energy (hypothetical energy that could explain expansion of universe) are somehow related to gravity itself. New work will continue to be done in this area, and new observations are likely to advance human understanding of this conundrum (SigmaScan).
<ul style="list-style-type: none"> <li>The Rise of Green Chemistry Practices<sup>281</sup></li> </ul>	2015+	Green Chemistry offers the potential for development of new ways of preparing useful chemical feed stocks from biomass (SigmaScan).
<ul style="list-style-type: none"> <li>Controlled nuclear fusion harnessed for power generation<sup>282</sup></li> </ul>	2019-2035	The US. Lawrence Livermore National Lab has created the most powerful laser ever built, and expects to use 192 of these to ignite a fusion explosion of 3 million degrees Celsius in 2-3 years. Researchers estimate we could see a commercial fusion reactor operating in about one decade. (TechCast)
<ul style="list-style-type: none"> <li>Point of 'Peak Oil' extraction reached<sup>283</sup></li> </ul>	2020	Fatih Birol, chief economist of the International Energy Agency says (August 3 <sup>rd</sup> 2009) that "peak oil" is a lot closer than most governments realise. Crunch time, he said, is now set for 2020. (Independent)
<ul style="list-style-type: none"> <li>30% of all global</li> </ul>	2023 +/- 5	TechCast has completed different studies that

Fields of Study	Possible Year of Realisation	Description
energy derived from alternative sources. <sup>284</sup>	years	converge on 2023 +/- 5 years as the serious beginning of this transition period, when 30% of all global energy is most likely to be derived from alternative sources.
<ul style="list-style-type: none"> <li>Increasing Role for Liquefied Natural Gas<sup>285</sup></li> </ul>	2030-2050	If construction of LNG transportation infrastructure accelerates along with demand, natural gas could, within the next 50 years, join oil as the second essential energy commodity. Natural gas (methane) is by far the cleanest-burning fossil fuel. Given its global abundance and cleaner emissions, it has become the power generation source of choice for industrialised nations (SigmaScan).
<ul style="list-style-type: none"> <li>Hydrogen Economy established<sup>286</sup></li> </ul>	2033	TechCast forecasts that a hydrogen economy is possible in the long term, with potential use of hydrogen as a means of storing, carrying, and delivering energy. (TechCast)
<ul style="list-style-type: none"> <li>Wave energy providing up to 20% of UK requirements<sup>287</sup> <sup>288</sup></li> </ul>	2040s	In 2008, it was stated that the UK is the global leader in marine energy, with both the government policies and natural resources to derive 20 percent of its energy needs from wave and tidal power, according to a new study from industry analysts Frost & Sullivan. It could take five to six years (from 2008) for full commercialisation of marine energy, according to research analyst Gouri Nambudripad. TechCast envisage this trend strengthening through the 2040's. (TechCast)
<b>Environment</b>		
<ul style="list-style-type: none"> <li>Rise of Green Business<sup>289</sup></li> </ul>	2010- 2015	Rising investment, coupled with public as well as market demand could lead to a new era of Green Business (TechCast)
<ul style="list-style-type: none"> <li>Vertical Farming leads food revolution<sup>290</sup></li> </ul>	2015+	Vertical farming, in hydroponic skyscrapers, could allow food to be grown locally and sustainably (Time Magazine)
<ul style="list-style-type: none"> <li>Planetary climate control becomes possible<sup>291</sup></li> </ul>	2015-2035	"Cloud ships" are favoured among a series of schemes aimed at altering the climate that have been considered by The Royal Society. The project, which is being worked on by rival US and UK scientists, would see 1,900 wind-powered ships ply the oceans sucking up seawater and spraying minuscule droplets of it out through tall funnels to create large white clouds. (Daily Telegraph)
<ul style="list-style-type: none"> <li>Precision Farming widely adopted<sup>292</sup></li> </ul>	2016	"Precision farming or precision agriculture is an agricultural concept relying on the existence of in-field variability. It requires the use of technologies such as global positioning (GPS), sensors, satellites or aerial images, and information management tools (GIS) to assess and understand variations. Collected information may be used to more precisely evaluate



Fields of Study	Possible Year of Realisation	Description
		optimum sowing density, estimate fertilizers and other inputs needs, and to more accurately predict crop yields. It seeks to avoid applying inflexible practices to a crop, regardless of local soil/climate conditions, and may help to better assess local situations of disease or lodging. <sup>293</sup> (TechCast)
<ul style="list-style-type: none"> <li>Sustainable Aquaculture models developed<sup>294</sup></li> </ul>	2020	Aquaculture is the farming of aquatic organisms such as fish, shellfish and even plants. (TechCast)
<ul style="list-style-type: none"> <li>Recycling Society<sup>295</sup></li> </ul>	2021	The goal is to render refuse collection redundant and more to a model where 100% of household waste is recycled. In a bid to cut down on the amount of waste going to landfill and to reduce carbon emissions, people and organisations may have to sift through all their rubbish for any items that can be recycled. (TechCast).
<ul style="list-style-type: none"> <li>30% of world's arable land becomes saline. <sup>296 297</sup></li> </ul>	2020s	Land degradation adversely affects the ecological integrity and productivity of about 2 billion ha, or 23 percent of landscapes under human use. Up to 40 percent of the world's agricultural land is seriously degraded. TechCast envisages increasing salinity by the 2020's.
<ul style="list-style-type: none"> <li>Organic Farming considered mainstream practice<sup>298</sup></li> </ul>	2023	Organic farming techniques are expected to be increasingly adopted by mainstream farmers due to a combination of customer pressure and regulatory controls on chemical fertilisers. (TechCast)
<ul style="list-style-type: none"> <li>GM Food widely available<sup>299</sup></li> </ul>	2023	The GM debate rumbles on, but the expectation is that the needs of the planet's population will drive the increased adoption of GM – particularly in developing countries. (TechCast)
<ul style="list-style-type: none"> <li>Nano-Desalinisation options help avert water crisis<sup>300</sup></li> </ul>	2024	Nanofiltration lowers the cost enough for desalinization to be a mass viable option outside of the Gulf (TechCast).
<ul style="list-style-type: none"> <li>Quantum Chemistry for Pollution Abatement<sup>301</sup></li> </ul>	2026-2055	Recent developments in quantum mechanical computer codes have significantly improved our ability to model chemical reactions in the aqueous phase. As a result, the possible effects of introducing a catalyst into a reaction can now be predicted accurately, to a degree of precision that complements experimental measurement. A significant benefit of this approach is the ability to map out complex interacting chemical pathways, to determine whether there is coupling between different steps, which may result in uncontrolled acceleration /deceleration of a particular step. (SigmaScan).
<b>Nanotechnology</b>		
<ul style="list-style-type: none"> <li>Smart Sensors reach</li> </ul>	2015	Smart sensors will increasingly be nanoscale "sensors

Fields of Study	Possible Year of Realisation	Description
commercial maturity <sup>302</sup>		and instrument packages that are microprocessor driven and include features such as communication capability and on-board diagnostics that provide information to a monitoring system and/or operator to increase operational efficiency and reduce maintenance costs." <sup>303</sup> (Control Engineering)
<ul style="list-style-type: none"> <li>Designed Materials enter the market<sup>304</sup></li> </ul>	2018	Within a decade it is expected that advances in nanotechnology will enable designers to specify the precise properties they want in a particular nonmaterial.
<ul style="list-style-type: none"> <li>Nanotechnology to disrupt many industries<sup>305</sup></li> </ul>	2020+	The "nanosphere" consists of objects measured in one billionth of a meter, and is now undergoing a revolution as research increasingly yields control over this tiny world. Beyond simply being smaller, objects behave differently at the nano level, introducing bold new possibilities. Nanotechnology is used in 30% of commercial products (TechCast)
<ul style="list-style-type: none"> <li>Micro Machines in widespread use<sup>306</sup></li> </ul>	2021	Micro Machines are nanoscale devices engineered to perform particular task such as subcutaneous operations on humans, or repairs of deep well pipelines.
<ul style="list-style-type: none"> <li>Nanofood eliminates food supply/ security concerns<sup>307</sup></li> </ul>	2040+	Futurist Ray Kurzweil predicts that by 2050, the common use of nanoproducted food, which has the correct nutritional composition and the same taste and texture of organically produced food, would mean that the availability of food is no longer affected by limited resources, bad crop weather, or spoilage. (Kurzweil)
<b>Manufacturing</b>		
<ul style="list-style-type: none"> <li>Millimetric radar detects miniature objects at high resolution<sup>308</sup>.</li> </ul>	2009	We are now able to study the flight of small insects, and hence potentially design new generations of small UAV's (Horizon Scanning Centre)
<ul style="list-style-type: none"> <li>'Ethical' food genetically produced<sup>309</sup></li> </ul>	2015	Thanks to genetic engineering, pigs can now be 'grown' in factory farms with certain key components missing - like the animal's brain. A new 'ethical meat' industry has sprung up, and this industry claims to be offering a 'suffering free' approach to meat consumption. (InOurFuture.com)
<ul style="list-style-type: none"> <li>Emergence of Smart Materials: clothes to deliver vitamins<sup>310</sup></li> </ul>	2015+	The key to these future smart materials is our growing understanding of the world at the molecular level and our ability to manipulate it at that level. Understanding how molecules cross membranes could allow us to design materials that can function as delivery platforms (a T-shirt that delivers vitamins through the skin over an 8-hour period) or filters (a biofilter that protects a water or air supply from bacteria). Eventually, it is possible that we could develop smart materials that are able to sense our DNA and respond to our genotype for both diagnostic and drug delivery purposes. Smart materials

Fields of Study	Possible Year of Realisation	Description
		for use in the body, such as oxygen-absorbing materials for damaged lungs, or artificial retinas, are a high-value application that could lead the way to other uses of the technology (SigmaScan).
<ul style="list-style-type: none"> <li>Mass Customisation available for high street products<sup>311</sup></li> </ul>	2016	Flexible manufacturing techniques are expected to evolve such that the cost of producing ultra-low volume production runs will continue to fall. This will enable small scale production facilities to be located on a retailer's premises.
<ul style="list-style-type: none"> <li>Manufacturing with Programmable Materials<sup>312</sup></li> </ul>	2020-2030	Nanoscale physical materials that can be automatically assembled into useful configurations by computer instructions could usher in a new era in manufacturing, including the production of replacement body parts and implants (SigmaScan).
<ul style="list-style-type: none"> <li>Modular Homes take increasing share of new build market<sup>313</sup></li> </ul>	2021	The modular home concept will evolve such that developers and individuals will be able to specify precise designs and material properties to meet the particular performance characteristics they desire for their homes. Mass customisation approaches will be adopted to ensure such units can be produced at very low cost.
Personal fabricators allow manufacturing anywhere, anytime <sup>314</sup>	2025	The prospect of a machine with the ability to manufacture anything has long been considered pure science fiction. However, MIT physicist Neil Gershenfeld believes it's not too early to think about this possibility of such a machine, known as a personal fabricator (API)
<ul style="list-style-type: none"> <li>New Quantum Materials and Devices<sup>315</sup></li> </ul>	2040+	Quantum devices will revolutionise sensor technology long before quantum computers become available. As well as improved law enforcement, this could mean more efficient energy generation and use, better-regulated manufacturing processes, and better pollution detection (SigmaScan)
<b>Information and Communications Technology</b>		
<ul style="list-style-type: none"> <li>Digital convergence of electronic devices<sup>316</sup></li> </ul>	2010	TechCast thinks adoption of convergence devices should grow rapidly to reach mainstream use by about 2010 and produce global demand in the \$ trillions.
<ul style="list-style-type: none"> <li>Entertainment goes online<sup>317</sup></li> </ul>	2010-2011	A Forrester analyst said, "Once customers try online entertainment, they never go back." TechCast estimates 30% adoption levels in a year or two.
<ul style="list-style-type: none"> <li>Intelligent Interfaces lead to seamless computer-human interaction<sup>318</sup></li> </ul>	2012+/- 2 years	Advances in speech recognition, artificial intelligence (AI), and computer power suggest the old computer interface (keyboard, mouse, etc.) may yield to an "intelligent interface" in which we simply converse with smart computers. The possibilities are vast. Humans



Fields of Study	Possible Year of Realisation	Description
		could rely on “intelligent agents” or “virtual assistants” to serve as secretaries, tutors, salespeople, and almost all other routine work roles (TechCast)
<ul style="list-style-type: none"> <li>Smart Phones established as dominant computing device<sup>319</sup></li> </ul>	2012	In 2008 Smart Phone sales exceeded those of laptops. By 2012 Smart Phone sales could reach over 700 million units, accounting for 65% of all handset sales. This will represent a market worth nearly \$200 billion (Gartner)
<ul style="list-style-type: none"> <li>Web content grows 75 fold<sup>320</sup></li> </ul>	2012	By 2012 the internet could be 75 times its size in 2000 with over 400 times the traffic due to the rise of online video (Silicon Republic)
<ul style="list-style-type: none"> <li>New approaches to measure and control the growth of internet data<sup>321</sup></li> </ul>	2012-2020	Between 1999 and 2002, the volume of stored information in the world doubled. In 2008, a new attempt to measure the quantity of information began, but this will be complicated by the spread of different sorts of information - words, picture and video are less easy to measure than numbers (SigmaScan).
<ul style="list-style-type: none"> <li>Rapid rise in E-tailing<sup>322</sup></li> </ul>	2014-2020	The web currently accounts for approximately 10% of the total UK retail sales, and this is set to rise to 40% by the year 2020 (uSwitch, TechCast)
<ul style="list-style-type: none"> <li>Mobile phones as a key advertising medium<sup>323</sup></li> </ul>	2015	The promise is that of completely targeted and personalised advertising, delivered largely on totally customised mobile computing & communication devices. This could boost the global value of advertising-content by more than 100% by 2015 (Media Futurist)
<ul style="list-style-type: none"> <li>Cloud Computing hits critical mass<sup>324 325</sup></li> </ul>	2015	Cloud computing refers to the trend towards delivering hosted services over the Internet in a manner transparent to the end user. The vision is that all of the applications we use will be hosted in the ‘cloud’ and we need have no knowledge of the infrastructure that supports us. Globally by 2015 cloud computing could represent a \$45 billion market (TMC Net)
<ul style="list-style-type: none"> <li>Widespread adoption of Grid Computing<sup>326</sup></li> </ul>	2015	Grid computing is the application of the resources of many computers in a network to a single problem at the same time - usually to a scientific, technical or business problem that requires a great number of computer processing cycles or access to large amounts of data. <sup>327</sup> A well-known example of grid computing in the public domain is the ongoing SETI (Search for Extraterrestrial Intelligence) project. By 2015 it may become a widely adopted approach to dealing with computationally intensive requirements.(Techcast)
<ul style="list-style-type: none"> <li>Video Conferencing becomes mainstream<sup>328</sup></li> </ul>	2015	While video conferencing has been available for many years, the market has received a big boost from telepresencing systems. These make use of ultra-high definition video to give the impression of being in the room with the person at the other end of the line.

Fields of Study	Possible Year of Realisation	Description
		Markets for telepresence video conferencing equipment were estimated to be worth \$764.8 million in 2008 and are anticipated to reach \$4.7 billion by 2015, growing in response to demand for this more effective and efficient mode of communication. It is also expected to receive a boost as organisations seek to cut travel costs but maintain high quality interaction. (Winter Green Research, Techcast).
<ul style="list-style-type: none"> <li>Advanced sensing improves surveillance<sup>329</sup></li> </ul>	2015-2020	Sensors will be developed for detection, controlling, monitoring and tracking dangerous materials (Horizon Scanning Centre).
<ul style="list-style-type: none"> <li>Terahertz technologies improve public safety<sup>330</sup>.</li> </ul>	2015-2020	Terahertz, CCTV and other remote sensing technologies will evolve for the detection of explosives, weapons and drugs (Horizon Scanning Centre).
<ul style="list-style-type: none"> <li>Real time modelling software enables quicker security response times<sup>331</sup>.</li> </ul>	2015-2020	Secure software applications will combine pattern recognition, analysis of emergent behaviour, risk identification, stability modelling, threat identification and management (Horizon Scanning Centre).
<ul style="list-style-type: none"> <li>Wireless computing the norm<sup>332</sup></li> </ul>	2015-2020	Emergence of the MANET– a collection of mobile computing devices co-operating to form a dynamic network with no fixed infrastructure. In MANETs, devices can access the Internet even where there is no direct wireless connection between the device and the Internet access point (Horizon Scanning Centre).
<ul style="list-style-type: none"> <li>SWARM technology solves complex problems<sup>333</sup></li> </ul>	2015-2020	Swarm Intelligence (SI) is the property of a system whereby the collective behaviours of (unsophisticated) agents interacting locally with their environment cause coherent functional global patterns to emerge. SI provides a basis with which it is possible to explore collective (or distributed) problem solving without centralised control or the provision of a global model (Horizon Scanning Centre).
<ul style="list-style-type: none"> <li>Optical Computers in widespread use<sup>334</sup></li> </ul>	2017	By applying some of the advantages of visible and/or Infrared networks at the device and component scale, a computer might someday be developed that can perform operations 10 or more times faster than a conventional electronic computer by transmitting photons or light particles instead of electrons. (Techcast).
<ul style="list-style-type: none"> <li>Smart Systems predominate in houses, businesses, public spaces<sup>335</sup></li> </ul>	2018	Ubiquitous Internet nodes connect all the appliances, vehicles, etc. within a business, home or community. (socialtechnologies.com).
<ul style="list-style-type: none"> <li>Teleworking</li> </ul>	2019	Mobile and remote working technologies have become

Fields of Study	Possible Year of Realisation	Description
considered routine <sup>336</sup>		reliable and widespread enough to allow most jobs to be completed away from the office, signalling potential shifts in the built form and social organisation of cities (TechCast).
<ul style="list-style-type: none"> <li>Surveillance Society becomes possible<sup>337</sup></li> </ul>	Early 2020s	Ubiquitous, unseen nanodevices could provide seamless communication and surveillance among all people everywhere. Humans could have nanoimplants, facilitating interaction in an omnipresent network. Everyone could have a unique Internet Protocol (IP) address. Since nano storage capacity is almost limitless, all conversation and activity could be recorded and recoverable. (World Future Society)
<ul style="list-style-type: none"> <li>Quantum Computing stores data on atoms<sup>338</sup></li> </ul>	2022	Quantum mechanics offers a possible successor to silicon in which information is stored and managed using atomic particles. The strange behaviour of matter at the quantum level makes this computational technique complex. For instance, two or more atoms can become “entangled” so that a change in one instantaneously produces a like change in the other regardless of distance, offering the possibility of instantaneous “teleportation” of information. Because of the Heisenberg uncertainty principle, individual electrons can also coexist in two places simultaneously, and this feature of “superimposition” allows a single electron to carry two bits of information – or two “cubits.” (TechCast).
<ul style="list-style-type: none"> <li>Room temperature ferromagnets: new materials for data storage in next generation computing<sup>339</sup></li> </ul>	2040+	Spintronics, or spin based electronics, are a new generation of devices that rely upon the spin of an electron to facilitate transfer of information, rather than the traditional electron charge that is used in conventional electronics (SigmaScan)
<ul style="list-style-type: none"> <li>Relative decline of IT transformatory potential<sup>340</sup></li> </ul>	2040	The transformative role of information technology could diminish between 2010 and 2040 (socialtechnologies.com).
<ul style="list-style-type: none"> <li>The Singularity: The worlds' first ultra intelligent machine<sup>341</sup></li> </ul>	2045	The Singularity refers to the idea that accelerating technology will lead to superhuman machine intelligence that will soon exceed human intelligence <sup>342</sup> . (Kurzweil)
<b>Internet and Virtual World</b>		
<ul style="list-style-type: none"> <li>The Intelligent web enters mainstream use<sup>343</sup></li> </ul>	2013 +/- 2 years	Trends show the Web is evolving into an intelligent system that understands spoken inquiries, gathers relevant information, and forms meaningful, focused answers. More intelligent search engines are appearing, and intelligent agents being developed by DARPA and others are able to infer context as they link users and information. The Intelligent Web is forecast to enter mainstream use (30% adoption) about 2013 +/-

Fields of Study	Possible Year of Realisation	Description
		2 years, and to produce a \$680 billion market in the US (TechCast).
<ul style="list-style-type: none"> <li>E-Government becomes the norm<sup>344</sup> <sup>345</sup></li> </ul>	2013	In Thailand, for instance, the Thai business daily, The Nation, talks about how the <i>Information and Communications Technology Ministry</i> announced plans in April 2009 to launch an E-Government Road Map, as a framework for e-government developments from 2010 to 2014. According to the Thai press, the roadmap consists of four stages: Connected Government (c-Government), Mobile and Multi-Channel Government (m-Government), Ubiquitous Government (u-Government) and Transformed Government (t-Government).
<ul style="list-style-type: none"> <li>Broadband coverage expands - the Net reaches 60-80% of the planet<sup>346</sup></li> </ul>	2014-2017	Very cheap or free wireless broadband - at fairly high speeds, i.e. at least 2MB / sec - will be available in most places, particularly in the booming new economies of Asia, India, Russia and South-America, and then in Africa. Funded by the likes of Google and by the future 'telemedia' conglomerates, governments, cities and states, wireless broadband could reach 3-4 out of 5 people on the globe within 5-8 years (Media Futurist)
<ul style="list-style-type: none"> <li>The End of Cyberspace<sup>347</sup></li> </ul>	2015+	Pervasive computing technologies like flexible displays, smart dust, sensors, and wireless offer an alternative to immersion. The experience of using devices designed to be socially unobtrusive, to require little of a user's attention, and to operate anywhere will change the experience of being online. Users capable of accessing the Internet anywhere will discover "real space" information-- information about the places that they are, accessed in that space-- that complements "real time" information. Rather than requiring users to focus exclusively on either the digital or physical, new devices will allow users to attend to both simultaneously (SigmaScan)
<ul style="list-style-type: none"> <li>Virtual education part of every student's curriculum<sup>348 349</sup></li> </ul>	2016-2020	Michael B. Horn author of <i>Disrupting Class</i> predicts that by 2019, nearly half of all public high school courses will be taught online. Nationwide in the US 700,000 kids attended virtual schools as of January 2008.
<ul style="list-style-type: none"> <li>Augmented Reality part of daily lives<sup>350</sup></li> </ul>	2019	Augmented reality is a direct or indirect view of a physical real-world environment whose elements are merged with computer images to 'augment' the experience. (Kurzweil).
<ul style="list-style-type: none"> <li>Virtual Reality a main form of communication<sup>351</sup></li> </ul>	2019	Three-dimensional virtual reality displays, embedded in glasses and contact lenses, as well as auditory "lenses," are used routinely as primary interfaces for communication with other persons, computers, the Web, and virtual reality. (Kurzweil)

Fields of Study	Possible Year of Realisation	Description
<ul style="list-style-type: none"> <li>Embedded 'invisible' IT<sup>352</sup></li> </ul>	2019	By 2019, computers are largely invisible and embedded everywhere-in walls, tables, chairs, desks, clothing, jewellery, and bodies. (Kurzweil)
<ul style="list-style-type: none"> <li>Intelligent brain-computer interface<sup>353</sup></li> </ul>	2019	TechCast forecasts that intelligent brain-computer interfaces enabling people to communicate mentally with distant objects and people are likely to arrive commercially in about a decade (TechCast).
<ul style="list-style-type: none"> <li>The Semantic web expands the internet's capabilities<sup>354</sup></li> </ul>	2020 onwards	The Semantic Web is the extension of the World Wide Web that enables people to share content beyond the boundaries of applications and websites (Semantic NLP Blog)
<ul style="list-style-type: none"> <li>Virtual Reality lessens importance of geography<sup>355</sup></li> </ul>	2030	Virtual reality will allow any type of interaction with anyone, regardless of physical proximity (Ray Kurzweil)
<b>Artificial Intelligence</b>		
<ul style="list-style-type: none"> <li>AI replaces numerous human jobs<sup>356</sup></li> </ul>	2013-2017	Neild & Pearson believe AI will start being noticed as a source of redundancy in the middle of the coming decade, possibly leading to a Neo-Luddite movement.
<ul style="list-style-type: none"> <li>Application of AI to Global Trade and Logistics<sup>357</sup></li> </ul>	2020-2030	The application of artificial intelligence to commerce is likely to make trade and logistics more efficient. We already accept that trading systems such as stock markets use Artificial Intelligence to take buy and sell decisions. In the coming years they could also be used to allocate aircraft, ships and vehicles more effectively. Today's airline scheduling systems leave empty seats equivalent to several 747s flying the Atlantic with no passengers every day. AI systems that take on scheduling could reduce this waste without a significant reduction in passenger choice (SigmaScan).
<ul style="list-style-type: none"> <li>AI completing routine mental tasks<sup>358</sup></li> </ul>	2023	TechCast forecasts AI will increasingly automate the routine mental work now occupying so much human time. Think of it as "AI that is good enough to replace people," what some call "weak AI." TechCast estimates good AI will replace routine mental tasks about 2023 (TechCast).
<b>Robotics</b>		
<ul style="list-style-type: none"> <li>Service robots permeate work and play<sup>359</sup></li> </ul>	2015	NextGen Research forecasts worldwide demand for all-purpose service robots will reach \$15 billion by 2015, or roughly 5 million robots per year
<ul style="list-style-type: none"> <li>Human knowledge exceeded by machine knowledge<sup>360</sup></li> </ul>	2016-2020	Machines with the inherent capability of learning are reckoned to be lurking in the not too distant future. Given man's reliance on machines for data storage, an additional learning capability would give the machine a superior knowledge base (Neild & Pearson)
<ul style="list-style-type: none"> <li>Smart Robots<sup>361</sup></li> </ul>	2024	The vision is that future generations will have the capacity to learn, make complex decisions, and even reprogram themselves.
<b>Transportation</b>		



Fields of Study	Possible Year of Realisation	Description
<ul style="list-style-type: none"> <li>Carbon Nanotubes yield lighter vehicles<sup>362</sup></li> </ul>	2012-2019	Carbon nanotube composites promise to enable the creation of lighter and stronger transportation vehicles (SigmaScan).
<ul style="list-style-type: none"> <li>Hybrid Cars affordable<sup>363 364</sup></li> </ul>	2014	While on the campaign trail, President Obama said he hoped to see 1 million plug-in hybrids on the road by 2015. Since Obama took office, the federal government has implemented a broad range of consumer and industry incentives to promote production and sales of plug-in vehicles (TechCast)
<ul style="list-style-type: none"> <li>Dirigibles provide mass eco friendly transportation<sup>365</sup></li> </ul>	2014 onwards	With military prototypes planned for 2014, giant blimps may be about to make a comeback for mass transportation (Chicago Tribune, TechCast)
<ul style="list-style-type: none"> <li>Fuel Cell Cars enter the market<sup>366</sup></li> </ul>	2015	Hybrids and fuel cell autos both use electric motors to drive wheels, batteries to store energy, regenerative braking to conserve it, and may in time use composite bodies that are lighter. TechCast estimates fuel cell cars will enter the commercial market by 2015, eventually creating global demand that may reach several \$ trillion.
<ul style="list-style-type: none"> <li>Intelligent Cars control speed and navigation<sup>367368</sup></li> </ul>	2015-2018	A driverless vehicle can essentially navigate itself, alert the human driver to possible collisions and blind spots and may eventually even align with other vehicles (more like the cars of a train) on a freeway to maximally utilize the space. GM plans to test drive these vehicles by 2015 and get them on the road by 2018. TechCast concurs with the timing.
<ul style="list-style-type: none"> <li>Electric Cars<sup>369 370</sup></li> </ul>	2022	TechCast / Paul Scott envisage the tipping point for electric cars around the year 2022.
<ul style="list-style-type: none"> <li>Eco-Bikes popular in cities<sup>371</sup></li> </ul>	2022	Eco-bikes offer the promise of self powered two-wheel transport, without the need for human exertion (TechCast)
<ul style="list-style-type: none"> <li>Small Aircraft<sup>372 373</sup></li> </ul>	2026	In numerical terms, Airbus forecasts that 16,620, or 68 percent, of the new mainline aircraft required by 2026 will be small single-aisle passenger jets and small jet freighters. This could represent a shift in aviation markets and pricing models (Airbus, Techcast).
<ul style="list-style-type: none"> <li>Automated Highways control traffic flow<sup>374</sup></li> </ul>	2026	A logical progression from intelligent cars would be a system to manage them (TechCast)
<ul style="list-style-type: none"> <li>Maglev Trains revolutionise personal long distance transport<sup>375</sup></li> </ul>	2030	The world's first "maglev" train service began on January 1, 2003 cruising between Pudong and Shanghai, China reaching speeds over 300 mph. Trials are underway in Germany and Japan, and U.S. groups have proposed Los Angeles-Las Vegas and Boston-New York-Washington DC routes. (Memebox)
<ul style="list-style-type: none"> <li>Hypersonic Planes link Europe and Australia in a few hours<sup>376</sup></li> </ul>	2030	Scramjets capable of flying Mach 4-6 could make the journey from Brussels to Sydney in less than five hours. (New Scientist)

Fields of Study	Possible Year of Realisation	Description
<b>Space</b>		
<ul style="list-style-type: none"> <li>Microsatellites to uncover more 'space'<sup>377</sup></li> </ul>	2010-2020	Building upon programmes planned for the 2010 to 2020 timeframe, scientists hope to be able to construct 3D maps of the galaxy, gain a better understanding of the origins of the universe, and search for Earth-like planets. Microsatellites, launched for less than \$10 million each (for example, Canada's MOST space telescope), could play an important role in these discoveries by allowing astronomers more time for otherwise low-priority experiments. Upon its launch around 2011, NASA's James Webb Space Telescope will study the origins of the universe using infrared sensors, if its progress is not hampered by further budget cuts and downsizing (SigmaScan).
<ul style="list-style-type: none"> <li>Space tourism takes off<sup>378</sup></li> </ul>	2011+	Virgin Galactic has broken ground on their \$300 million Spaceport America launch facility in New Mexico, and tested the mother ship that will carry the space ship itself to launch. The first space tourism flight is scheduled to launch in 2011, and will take tourists paying \$200,000 each into suborbital flight (TechCast).
<ul style="list-style-type: none"> <li>Space hotels launched<sup>379 380</sup></li> </ul>	2012-2024	In 2007, CNN reported that "Galactic Suite", the first hotel planned in space, expects to open for business in 2012 and would allow guests to travel around the world in 80 minutes. Its Barcelona-based architects say the space hotel will be the most expensive in the galaxy, costing \$4 million for a three-day stay. (ABC/ CNN)
<ul style="list-style-type: none"> <li>Miniaturized Space craft reduce cost of space launches<sup>381</sup></li> </ul>	2015+	NASA hopes that carbon nanotube wires will miniaturise spacecraft, reducing weight and size compared to vehicles made with traditional copper wires. One possibility is that nanoscale wires made from a combination of silicon and metal could connect nanoscale and macro scale electronics together, allowing for hybrid electronic components. In another, more revolutionary application, it is envisaged that wires made entirely of carbon nanotubes could conduct electricity many times farther and more efficiently than copper wires and weigh only a fraction as much. It is possible that these wires would be able to conduct electricity with little or no resistance and without dissipating electricity as heat. (SigmaScan).
<ul style="list-style-type: none"> <li>Asteroid mining<sup>382 383</sup></li> </ul>	2024	It is anticipated that mining of asteroids and planets will yield new resources, elements, and materials that will enhance the quality of life on our planet. (Wired, Dr Canton).
<ul style="list-style-type: none"> <li>Establishment of a space market<sup>384</sup></li> </ul>	2030's	Extremely valuable assets, from materials and drugs to minerals and innovations, could create a space race among global companies (Canton)
<ul style="list-style-type: none"> <li>Humans on Mars<sup>385</sup></li> </ul>	2031	With an international base on the moon and vital technologies like in-space refuelling, Buzz Aldrin

Fields of Study	Possible Year of Realisation	Description
<sup>386</sup>		envisions an ambitious series of expeditions to send astronauts on a deep space mission to visit the asteroid Aphophis when it swings near Earth in 2021. A temporarily manned base on the Mars moon Phobos could follow according to Buzz Aldrin. (Space.com) "By that time, we'd be ready to put people in a gradual permanence on Mars by 2031," Aldrin said. "That, in a nutshell, is what I really think we should be doing."
<ul style="list-style-type: none"> <li>Start of construction of manned Mars laboratory<sup>387</sup></li> </ul>	2040s	Neild & Pearson believe that a manned laboratory on Mars will shortly follow the first landing on the planet.
<ul style="list-style-type: none"> <li>Astrobiology and Life Beyond Earth<sup>388</sup></li> </ul>	Ongoing	Multidisciplinary efforts by astrobiologists may increase our understanding of the origins of life on this planet and could result in finding life beyond Earth. This research may yield numerous benefits by enhancing our understanding of life on Earth. However, its real importance is that if we discover life elsewhere, there will inevitably be widespread changes in humanity's view of itself, especially affecting our religions and belief systems (Sigma Scan)



## Appendix 4 - *The shape of jobs to come* – Long List

The list of the top 20 jobs presented in section five above was selected from the long list presented below. The list was compiled through initial desk research, consultation with futurists and future thinkers around the world and an online survey.

Medicine, Biology and Biogenetics	
1. <b>Genomics Developer / Architect / Baby Designer</b> <sup>389</sup>	With the unravelling of the human genome, new roles could emerge to design personalised enhancements and select the genetic make-up of your unborn child.
2. <b>Body Part Maker</b> <sup>390</sup>	Due to the huge advances being made in bio-tissues, robotics and plastics, the creation of high performing body parts - from organs to limbs - will soon be possible, requiring body part makers, body part stores and body part repair shops.
3. <b>Personal Enhancement Advisors</b> <sup>391</sup>	Advances in new materials and nanotechnology, cognitive science, natural therapies and pharmaceuticals will offer an increasingly broad range of legal (and illegal) personal enhancements. These could be used to give sports people a competitive edge, enhance our memory capacity when studying for exams or increase the strength and endurance of soldiers in the field. Roles could emerge for professionals who take a holistic approach advising across a full range of possible enhancements.
4. <b>Nano-Medic</b> <sup>392</sup>	Advances in nanotechnology offer the potential for a range of sub-atomic 'nanoscale' devices, inserts and procedures that could transform personal healthcare. A new range of nano-medicine specialists will be required to administer these treatments.
5. <b>Synthetic Life Designer / Scientist / Engineer</b> <sup>393</sup>	Synthetic Life focuses on recreating biochemical life from non-living (abiotic) substances. An increasing range of roles are emerging for those working to creating synthetic life forms that could be used in applications as diverse as tissue repair and bacteria programmed to digest biological material and produce energy. <sup>394</sup>
6. <b>Chief In-Company Health Enhancement Officer</b> <sup>395</sup>	To be stationed in every company and responsible for the health of employees. These officers would apply the very latest medical advances from nutritional supplements to memory enhancements to ensure the company's employees deliver superior performance. Those employees who register for these programmes could receive higher salaries, increased bonuses and other perks.
7. <b>Telemedicine Technician</b> <sup>396</sup>	Telemedicine will increasingly be used both in developed and developing markets – for example adopting video links to help treat people in remote locations where there are no local medical staff. A new class of IT technicians with some medical training will emerge to help design and implement appropriate solutions.
8. <b>Farmer of Genetically Engineered Crops and Livestock</b> <sup>397</sup>	New-age farmers will raise crops and livestock that have been genetically engineered to improve food yields and 'grow' therapeutic proteins, pharmaceuticals and chemicals.
9. <b>In-Company Gene Screener</b> <sup>398</sup>	Employers will need technicians to collect and analyse DNA from potential hires and existing staff. The goal is to screen out workers with a propensity for drug abuse or other conditions that could interfere with productivity.
10. <b>Biometric Identification Specialist</b> <sup>399</sup>	Experts developing the technology to identify people based on an eye, palm or voice scan. Today most such technology requires the

individual to present themselves to be scanned for verification. The experts' challenge is to develop next generation solutions that scan us without interrupting us as we pass through airports, buildings and other areas requiring biometric identification.
<b>11. Bioinformationists</b> <sup>400</sup> Scientists who work with the rising volumes of genetic information to help analyse the data and draw out key patterns and insights that could help in treatment of medical conditions and diseases.
<b>12. Geomicrobiologists</b> <sup>401</sup> . Specialists combining geology, microbiology and the environmental sciences to study how microorganisms can help in applications as diverse as medicine, cleaning up environmental damage, and breaking down waste.
<b>13. Experimental Therapy Experts</b> <sup>402</sup> The explosion of new natural and synthetic therapies will create demand for specialists working holistically to select the right mix of therapies for each person.
<b>14. Old Age Wellness Manager / Consultant Specialists</b> <sup>403 404</sup> Drawing on a range of medical, pharmaceutical, prosthetic, psychiatric, and natural fitness solutions to help manage the various health and personal needs of the aging population.
<b>15. Personal Body Weight / Obesity Consultant</b> <sup>405</sup> As weight and obesity threatens to severely hinder future GDP, consultants may be appointed by the state, insurance companies, employers and individuals to design personalised solutions.
<b>16. Memory Augmentation Surgeon</b> <sup>406</sup> - A new category of surgeons whose role is to add extra memory to people who want to increase their memory capacity. A key service would be helping those who have literally been overloaded with information in the course of their life and simply can no longer take on any more data - thus leading to sensory shutdown.
<b>17. 'New Science' Ethicist</b> <sup>407</sup> As scientific advances accelerate in new and emerging fields such as cloning, proteomics and nanotechnology, a new breed of ethicist may be required. These science ethicists will need to understand a range of underlying scientific fields and help society make consistent choices about what developments to allow. Much of science will not be a question of 'can we?' but 'should we?'
<b>18. Genetic Hacker</b> <sup>408</sup> These will be people that hack human, animal and plant DNA to create viruses. Some Genetic Hackers will do useful work and will be admired in the same way that we admire software engineers. They may create viruses that enhance crops, protect humans from particular illnesses and prevent the spread of disease from animals to humans. Others will be feared and loathed because their objectives are considered unsavoury or illegal.
<b>19. Longevity Providers</b> <sup>409</sup> Consultants, who after seeing your genome, provide advice on the best ways to prolong your life, and then implement the changes.
<b>20. Cryonics Technicians</b> <sup>410</sup> For the temporary freezing of those wishing to be cryogenically frozen to wait for scientific breakthroughs or new technologies to solve their condition. Others may be frozen before embarking on lengthy space travel.
<b>21. End-of-Life Planner:</b> a person who helps people plan and manage their own death - combating the fact that medicine/technology will be able to keep most people technically alive pretty much forever.
<b>Energy</b>
<b>22. Biorefinery Operative</b> <sup>411</sup> A Biorefinery is a portable bio-generator developed for military applications that can turn food, paper, plastic, and other waste into electricity. Not only will this help troops stay mobile, but it will also increase their security by eliminating telltale information in a unit's waste. Operatives will need sufficient scientific

expertise to understand how the system works and the limits of its capabilities.
<b>23. Wind Farmer</b> <sup>412</sup> These are the people who design and manage the turbines and farms that bring us wind energy. They take into account land areas and air speeds in order to determine turbine sizes, the pitch of the blades and the optimal farm layout.
<b>24. Battery Technician</b> <sup>413</sup> To help address rising demand, technologies for storage of energy will be essential, particularly energy generated from unpredictable renewable resources. This will drive an increase in the use of battery technology ranging from both large scale industrial devices to small scale home systems driven by solar roof technology for example. These batteries will be increasingly complex devices with their own control systems and will require skilled technicians to configure, deliver, install, fine-tune, maintain, refurbish and replace them.
<b>25. Insect-Based Food Developers, Chefs, Nutritionists</b> <sup>414</sup> As we advance our understanding of the health enhancing properties of different insects, specialist roles will emerge using insects to create new foods and dishes.
<b>26. Chlorophyll Technician</b> <sup>415</sup> Specialists applying a range of engineering, genetic and biological tools to enable plants to absorb more carbon.
<b>27. Fusion Engineers</b> <sup>416</sup> The next generation of nuclear power solutions could potentially require a new set of skills compared to modern day nuclear engineers.
<b>Environment</b>
<b>28. Resource Use Consultant</b> <sup>417</sup> As environmental awareness rises, roles could emerge for advisors who help individual citizens grade the impact of every action and purchase and manage down the ecological footprint of our lifestyles.
<b>29. Vertical Farmers</b> <sup>418</sup> There is growing interest in the concept of city based vertical farms, with hydroponically fed food being grown under artificial growth-enhancing lighting in multi-storey buildings. These offer the potential to dramatically increase farm yield and reduce environmental degradation. The managers of such entities will require expertise in a range of scientific disciplines, engineering and commerce.
<b>30. Climate Change Reversal Specialist</b> <sup>419</sup> As the threats and impacts of climate change increase, a new breed of engineer-scientists are required to help reduce or reverse the effects of climate change on particular locations. They need to apply multi-disciplinary solutions ranging from filling the oceans with iron filings to erecting giant umbrellas that deflect the sun's rays.
<b>31. Drowned City Specialist</b> <sup>420</sup> If climate change happens a lot more quickly than expected, new roles will emerge for experts who can help recover drowned cities or prepare for the consequences of submersion. Whole economic infrastructures will need to be transferred, belongings will need to be rescued, and houses must be moved to higher ground.
<b>32. Quarantine Enforcer</b> <sup>421</sup> If a deadly virus starts spreading rapidly, few countries, and few people, will be prepared. Doctors and nurses could be in short supply to prevent or treat the problem. Hence, quarantines could be imposed to keep people in or out of particular locations. Moreover, as mortality rates rise, and neighbourhoods are shut down, someone will have to guard the gates.
<b>33. Experimental Petrologist</b> <sup>422</sup> Rocks, which come to Earth via meteorite, can show petrologists the age of the material and the type of atmospheric gas the stone was exposed to. They can also be subject to experiment to determine where human life could be sustained. Studies thus far have shown potential for future human life on Mars.

<b>34. In-Company Sustainability Coordinator<sup>423</sup></b>	Specialists applying a range of scientific and social disciplines to ensure a company has a culture and operating practices that ensure environmental sustainability.
<b>35. Weather Modification Police<sup>424</sup></b>	The act of stealing clouds to create rain is already happening in some parts of the world, and is altering weather patterns thousands of miles away. Weather modification police will need to monitor and control who is allowed to undertake weather modification activities e.g. shooting rockets containing silver iodine into the air as a way to stimulate rainfall from passing clouds.
<b>36. Consumer Energy Analysts<sup>425</sup></b>	As better energy consumption monitoring tools become prevalent and energy grids are rolled out, analysts studying consumer energy use in real time will be needed alongside the services drawing on these measurements.
<b>37. Water Traders<sup>426</sup></b>	Water is possibly the key natural resource of the 21 <sup>st</sup> century and will attract traders and developers in the same way as oil has done.
<b>38. Desert Land Rights Trader<sup>427</sup></b>	Hitherto empty wastes are now huge potential solar energy repositories. Countries will increasingly sell the exploitation rights and a trading infrastructure could naturally emerge.
<b>39. Climate Change Compliance Auditor<sup>428</sup></b>	A role focused on checking if businesses and individual citizens are adapting well or not to increasingly stringent compliance requirements. The role will involve providing best practice advice as well as imposing sanctions on those who fail to meet key targets.
<b>40. Business Consultant for Climate Change Compliance<sup>429</sup></b>	The adaption to climate change may be more important than stopping it. Hence there will massive growth in consultants that can advise firms of all sizes on how best to do it.
<b>41. Recycling Analyst<sup>430</sup></b>	As environmental pressures grow, the number of firms employing recycling specialists will rise.
<b>Information and Communications Technology</b>	
<b>42. Complexity Analyst / Gaiantologist<sup>431</sup></b>	The world can increasingly be seen as a network of complex, interconnected systems. Roles will emerge for complexity specialists to study, analyse and attempt to control the behaviour of these systems.
<b>43. Personal Entertainment Programmers<sup>432</sup></b>	Designers of in-person or electronic activities that will meet the need for individualised services.
<b>44. Psycho-Customizer<sup>433</sup></b>	Future generations of mobile phones could offer a range of applications to help monitor and manage stress levels and counsel us on key decisions. A new set of roles will emerge for those who design and programme in a range of psychological support features. Tomorrow's retail assistant could perform behavioural assessments to help customise our devices to match our personality type.
<b>45. Human to Machine Interface Controller<sup>434</sup></b>	Advocates of the 'Singularity' believe that one day humans will be able to connect directly to computers and the internet in order to exchange information. While the monitoring role could be automated, roles will be required to determine what can be transferred and to check the integrity of the downloads, take action if one fails the integrity checks and protect the other people connected to the network.
<b>46. Narrowcasters<sup>435</sup></b>	As the broadcasting media become increasingly personalized, roles will emerge for specialists working with content providers and advertisers to create content tailored to individual needs. While mass-market customisation solutions may be automated, premium rate narrow casting could be performed by humans.
<b>47. Data Miner<sup>436</sup></b>	As the volume of electronically held information increases, specialist roles

are emerging for forensic data specialists who can sift and sort data using a variety of tools to extract key information, insights and patterns of interest.	
<b>48. Waste Data Handler<sup>437</sup></b>	Specialists providing a secure data disposal service for governments, corporations and those who do not want to be tracked, electronically or otherwise.
<b>49. Social Network Analysts<sup>438</sup></b>	Specialists who monitor both the external and internal networks to help the company maximise the benefits while minimising risks. Company analysts would determine how their brand is being portrayed, maximise their presence in the most relevant and popular networks and monitor the exchange of information by employees to ensure confidentiality is maintained. <sup>439</sup>
<b>50. In-House Simplicity Experts<sup>440</sup></b>	As internal systems and processes grow ever-more complex in businesses and government organisations, roles will emerge for those who can analyse and challenge complexity – encouraging the streamlining, simplification and elimination of rules, systems and processes.
<b>51. Global Work Process Coordinators<sup>441</sup></b>	Using databases, modelling and real-time interactive systems to coordinate work across employees who are distributed across the globe.
<b>52. Privacy Protection Consultants<sup>442</sup></b>	Because monitoring of individuals will be ubiquitous, Privacy Protection Consultants will help individuals decide on a number of social and technological decisions to maintain degrees of privacy.
<b>53. Complex Security Integrators<sup>443</sup></b>	Creators of ‘systems of systems’ to monitor and manage complex cyber threats.
<b>54. Chief Networking Officer<sup>444</sup></b>	As businesses become more global and increasingly tap into a range of electronic networks, senior roles are emerging to oversee the commercial, technical, legal and security implications of integration into an ever expanding universe of networks. Another version of the role would be to maximise the firm’s presence in and use of key physical and social networks.
<b>55. Virtual Clutter Organizer<sup>445</sup></b>	Specialists will help us organise our electronic lives. Clutter management would include effective handling of email, ensuring orderly storage of data, management of electronic ID’s and rationalising the applications we use.
<b>56. Machine Linguist<sup>446</sup></b>	As machines begin to create their own languages for communicating between each other, we might want to be able to eavesdrop a little.
<b>57. Off-the-Grid/off-the-Net Facilitator<sup>447</sup></b>	for those who want to disappear, either as a lifestyle or to avoid legal proceedings
<b>58. Mind Reading Specialist<sup>448</sup></b>	As the technologies for brain scanning improve and we develop deeper insights into the cognitive, biological and chemical basis of our behaviours, roles could emerge to help ‘read’ our minds. Customers could include individuals, law enforcement agencies, would-be employers, prospective spouses and parents.
<b>59. Quantum Computing Specialist<sup>449</sup></b>	Quantum computing is already creating roles for systems scientists, designers and engineers. Over time new opportunities will emerge for programmers, quantum network analysts and maintenance technicians.
<b>60. Media Ethicist<sup>450</sup></b>	As media becomes increasingly politically polarised an independent fact check organisation publishing daily reports on misinformation cases might be required. Equally, as more of the information we consume is delivered via the web, roles may emerge to help develop and promulgate appropriate media ethics for the digital age.

<b>61. Designer of Advanced Interfaces for Ambient Intelligence systems</b> <sup>451</sup>	Augmented Reality will use a variety of devices from visors to contact lenses to overlay additional layers of virtual information and imagery on the physical objects around us. Roles are emerging for headset designers, application designers and programmers.
<b>62. I Knowledge Guide</b> <sup>452</sup>	As the sheer volume of information available to us turns into an avalanche, we may increasingly seek out Knowledge Guides to 'curate' our journeys in cyberspace. These guides would build a deep understanding of our needs and interests and then configure a range of personalised tools, alerts, bots and web crawlers to collect and present the information we want in an easily accessible and digestible format.
<b>63. Knowledge Broker</b> <sup>453</sup>	The knowledge market may need a trading system of its own in the future. Brokers could emerge who help clients source the knowledge they desire and place a value on the knowledge others have to sell.
<b>Internet and Virtual World</b>	
<b>64. Professional VR Citizen</b> <sup>454</sup>	Professionals who inhabit virtual worlds on our behalf – representing our persona virtually while we carry on our physical existence.
<b>65. Virtual Lawyer</b> <sup>455</sup>	As more and more of our daily life goes online, specialists will be required to resolve legal disputes that could involve citizens resident in different legal jurisdictions.
<b>66. Virtual Property / Home Owners' Association (HOA) Managers</b> <sup>456</sup>	Home security and home servers are moving online to survey, control and manage the home environment. As these tools and environmental controls and devices become linked online, much of the property manager's duties and roles will be more efficiently managed via the internet.
<b>67. Intelligent Agent Designers and Managers</b> <sup>457</sup>	Specialists who customise our online business, leisure and shopping avatars to reflect our interests, preferences, wish lists, budgets and measurements.
<b>68. Avatar Manager / Devotees</b> <sup>458</sup>	Avatars could be used to support or even replace teachers in the elementary classroom, i.e., computer personas that serve as personal interactive guides. The Devotee is the human that makes sure that the Avatar and the student are properly matched and engaged <sup>459</sup> .
<b>69. Network Relationship Counsellors</b> <sup>460</sup>	As electronic networks develop the capacity to learn and self-organise, situations could emerge where some may refuse to talk with others. Specialists may be required who combine software networking skills with psychoanalytical expertise to resolve conflicts.
<b>70. Computer Sex Worker / Therapist / Designer</b> <sup>461</sup>	Specialists working in the virtual domain who cater for those who want an active sex life that resembles but may not include human contact.
<b>71. Virtual Police</b> <sup>462</sup>	The virtual world could become anarchic if there is no set of common behavioural standards, laws and citizen protections. The role of policing the virtual world is expected to be a major growth area as more of our lives and transaction move into the virtual realm.
<b>72. Virtual Personal Shopper/Shopping Assistant</b> <sup>463</sup>	An avatar designed to help you shop – advising on choices, showing you how you might look in particular clothes and even making purchases on your behalf.
<b>73. Cybrarians</b> <sup>464</sup>	Experts categorizing the mass of information on the internet for you, making search more intuitive along the lines of the semantic web.



<p><b>74. Holographer<sup>465</sup></b> Movies aren't a Saturday night staple anymore. A plethora of cheap entertainment options, including the Internet, DVDs and videogames, keep viewers in their living rooms. Holography could change this. Consumers won't be able to afford, operate or maintain the equipment at home, encouraging them back into cinemas for three-dimensional movies. Roles will emerge across the cinematic value chain for people to make, edit, and project holographic films.</p>
<p><b>75. Virtual-Reality Actors<sup>466</sup></b> Pay-per-view will become pay-per-play, allowing these actors to interact with you in cyberspace dramas.</p>
<p><b>Robotics</b></p>
<p><b>76. Robot Designers / Trainers<sup>467</sup></b> Specialists who design and build customised robots and teach them to perform roles in business and the home.</p>
<p><b>77. Robot Mechanic<sup>468</sup></b> The robots currently available for sale mostly clean carpets, filter pools or mow lawns. Eventually, these machines will drop in price, and middle-class families worldwide will be able to buy robotic personal assistants--or companions. Sony's Aibo, a robotic dog, was one of the first mass market offerings – retailing for about \$2,000. Although the market wasn't ready and the product was withdrawn in 2006, the concept was proven. The attraction is that these pets don't need a vet--but they might need the occasional tune-up.</p>
<p><b>78. Robot Counsellors<sup>469</sup></b> As robots develop the capacity to learn, they could acquire their own neuroses or pick up those of their owners / programmers. A new role combining robotic technician and psychotherapy skills could emerge.</p>
<p><b>Transportation</b></p>
<p><b>79. Hydrogen Fuel Station Manager<sup>470</sup></b> A Ford Motor Company study found that Hydrogen could be cost-competitive with gasoline if refuelling stations were mass-produced. The hydrogen would be produced on-site, so managers would need an entirely different set of skills than those required in today's gas stations.</p>
<p><b>80. Dirigible Pilot<sup>471</sup></b> Dirigibles (blimps) could revolutionise life in the developing world, according to futurist Joel Barker<sup>472</sup>. They're relatively cheap to operate, don't require expensive infrastructure like runways and can stop in midair to drop off passengers or deliver goods.</p>
<p><b>81. Alternative Vehicle Developers<sup>473</sup></b> Designers and builders of the next generations of vehicle transport using alternative materials and fuels. Could the dream of truly eco-friendly transport and cars that travel underwater or fly become a reality within the next two decades?</p>
<p><b>82. Teleportation Specialists<sup>474</sup></b> Teleportation is often seen as the holy grail of transport – moving people from one point to another almost instantaneously. Should it become a reality, a whole new industry sector will emerge creating opportunities for teleport designers, operators and mechanics.</p>
<p><b>83. Solar Flight Specialists<sup>475</sup></b> Solar flight offers the potential to fly for years on end, with only the sun as power once airborne. Opportunities could emerge for solar plane designers, engineers, technicians and pilots.</p>
<p><b>84. Infrastructure Specialists<sup>476</sup></b> Massive investment in sustainable infrastructure creation is required to help the developing world transition to higher standards of living. At the same time the developed world needs to transition to more sustainable infrastructure models. A new breed of multi-disciplinary experts is emerging to help design tomorrow's sustainable infrastructure solutions and facilitate the transition to non-carbon based</p>

transport fuels.
<b>85. Monorail Designer<sup>477</sup></b> Monorail is increasingly seen as a more sustainable transport solution for densely populated cities. Opportunities will increase for designers who can create environmentally sound, mechanically efficient rapid monorail transport solutions for the rising urban population of the planet.
<b>Space</b>
<b>86. Spaceline Pilots<sup>478</sup></b> With Virgin Galactic and others pioneering space tourism, space trained pilots will be needed. Would-be pilots can expect to undergo rigorous mental and physical examinations to ensure they are up to the psychological and physical rigours of space travel.
<b>87. Spaceport Designers<sup>479</sup></b> Space tourism will need its own Spaceports providing 'launch' facilities far different to that of an airport. For example, passengers may need to undergo 24 hours or more of acclimatisation training, psychological assessment and physical checkups before embarking on even the shortest sub-orbital flight.
<b>88. Space Tour Guides<sup>480</sup></b> A new role could emerge for specialists in astronomy who can guide us in exploring the cosmos whilst on vacation.
<b>89. Space Architect<sup>481</sup></b> Designers of physical solutions to enable the habitation of space and other planets. Current projects at SICSA (University of Houston) include a greenhouse on Mars, lunar outposts and space exploration vehicles. <sup>482</sup>
<b>90. Terraformer of the Moon and Other Planets<sup>483</sup></b> This role involves making a planet hospitable enough for colonisation / mining operations. Such roles will require expertise in atmospheric, geology, petrology, engineering, agriculture, environmental sciences and physiology.
<b>91. Astrogeologists, Astrophysiologists and Astrobiologists<sup>484</sup></b> A range of space-oriented physical and natural scientists will be required to fully explore, understand, and profit from the exploration of space.
<b>Demographics</b>
<b>92. Population Status Manager<sup>485</sup></b> A potentially controversial role - applying a range of incentives, educational measures and possibly medical interventions to reduce population growth.
<b>Culture and Leisure</b>
<b>93. Personal Learning Programmer.<sup>486</sup></b> A learning programmer would create ideal, personalized sequences of learning experiences from media libraries suited to the goals, interests, mind and mood of a learner. Tools that a learning programmer might use could include various kinds of brain imaging, psychological testing, DNA testing, neurochemical sensors, neurochemical supplements, knowledge of learner types and a vast indexed library of evidence based experience modules (media).
<b>94. Societal Systems Designer<sup>487</sup></b> Roles will emerge that combine complex systems theory with ethnographic, cultural, economic, political, environmental and educational insights to help design societies capable of surviving and thriving in the 21 <sup>st</sup> century.
<b>95. Social 'Networking' Worker<sup>488</sup></b> Social workers for those in some way traumatized or marginalized by social networking.
<b>96. Intelligent Clothing Designer / Engineer<sup>489</sup></b> An increasing range of roles will emerge in the development of clothing with built in technologies that enable the clothing to adjust



its properties to different weather and lighting conditions. A more commercial market will also emerge for fashion clothing that includes a range displays, changes colour according to the wearer's mood and can even change its form for different social settings.
<b>97. Ghost Experience Assistant<sup>490</sup></b> A service for the super rich, who, limited by time, are unable to do everything expected of them, and so outsource experience gathering to third parties. These third parties will match the physical and psychological profile of the customer and so are more likely to capture the essence of the experience in a customer friendly way. They would write up or in some way or other relay the experience such that the customer could vividly pretend that he/she himself had experienced it. At some point, memory download could enable the ghost to transfer the entire experience to the customer.
<b>98. Personal Branders<sup>491</sup></b> An extension of the role played by stylists, publicists and executive coaches –advising on how to create a personal ‘brand’ using social and other media. What personality are you projecting via your Blog, Twitter, etc? What personal values do you want to build into your image - and is your virtual image consistent with your physical world persona and your goals?
<b>99. Socialization/Culturalisation Therapists<sup>492</sup></b> Specialists trained to help us loosen the hold that socialisation has on people so they are able to live freer and happier lives.
<b>100. Enhanced Games Specialist<sup>493</sup></b> Developers of alternate specialist sports for people with body modifications or memory enhancements. Roles could include everything from coach to commentator and designer.
<b>101. Memetics Manager/Analyst/Trader/Generator<sup>494</sup></b> A meme is a set of ideas, cultural beliefs, customs or practices that can be transferred from one mind to another using speech, visual gestures or movements. A set of roles could emerge around creating, managing and analysing cultural information transfer based on the concept of the meme.
<b>Politics, Economics and Commerce</b>
<b>102. Director of Responsible Investment<sup>495</sup></b> An oversight role ensuring that a firm's investments are scientifically, socially and environmentally responsible and ethical.
<b>103. Executive VP Foresight, Oversight and Governance<sup>496</sup></b> Roles are emerging to ensure organisations are adopting a continuing long term, integral and systemic view of the whole operation and its context.
<b>104. Currency Designer<sup>497</sup></b> Someone who customises a currency system specific to a group's needs. Features that would need to be considered are the rules of exchange, who is involved and in control of the data, who has access to the currency, who controls the money supply e.g. who decides when more money should be ‘printed’, and the technology infrastructure that enables access to the currency for example mobile phones and open source platforms.
<b>105. Time Broker / Time Bank Trader<sup>498</sup></b> Alternative currencies will evolve their own markets – for example time banking already exists. Time Banks are community exchanges that enable individuals to earn time credits for performing services for the community and spend those credits on buying services from other community members.
<b>106. Scarce Metal Tracer<sup>499</sup></b> With the advancement of technology comes also the need for more globally scarce industrial metals. A trading infrastructure and trading roles are springing up around these markets.
<b>107. Non-military Defence Specialists<sup>500</sup></b> Experts in wielding non-military instruments of

power such as strategic management of perceptions and the use of moral authority.
<b>108. Unconditional Basic Income (UBI) Manager<sup>501</sup></b> Administering funds sufficient for living a life without paid work. Such a role would likely be a government or local authority employee and would draw on deep customer profiling to understand the absolute minimum each unique individual needed to survive.
<b>109. Black Swan Life Advisory<sup>502</sup></b> Black Swan events are those low-probability, high-impact, hard-to-predict events that can have a major positive or negative impact on our lives. The advisory role would help you map out categories of black swan events based on their impacts and then help you determine appropriate responses – on the basis that forewarned is forearmed.
<b>110. Authorised Narcotics Salesman<sup>503</sup>:</b> As drugs as legalised, and more ‘legal highs’ are available over the counter, a regulated class of authorised sales people could emerge.

## Appendix 5 – Geographic Breakdown of Survey Respondents

Country	No. of Respondents	% of total Sample
United States	145	30
United Kingdom	104	21
Australia	23	5
Canada	21	4
Germany	18	4
India	18	4
Netherlands	15	3
Portugal	12	2
South Africa	11	2
France	8	2
New Zealand	8	2
Sweden	8	2
Romania	7	1
Spain	7	1
Italy	6	1
Switzerland	6	1
U.A.E	6	1
Singapore	5	1
Brazil	4	1
Denmark	4	1
Israel	3	1
Argentina	2	<1%
China	2	<1%
Finland	2	<1%
Greece	2	<1%
Ireland	2	<1%
Japan	2	<1%
Latvia	2	<1%
Mauritius	2	<1%
Turkey	2	<1%
Ukraine	2	<1%
Algeria	1	<1%
Antigua and Barbuda	1	<1%
Austria	1	<1%
Belgium	1	<1%
Colombia	1	<1%
Guatemala	1	<1%
Guernsey	1	<1%
Iceland	1	<1%
Korea, South	1	<1%
Kuwait	1	<1%
Morocco	1	<1%
New Caledonia	1	<1%
Nigeria	1	<1%
Norway	1	<1%
Pakistan	1	<1%
Peru	1	<1%
Poland	1	<1%
Qatar	1	<1%
Russia	1	<1%
Saint Lucia	1	<1%
Saudi Arabia	1	<1%
Serbia	1	<1%
Slovenia	1	<1%
Suriname	1	<1%
Taiwan	1	<1%
Trinidad and Tobago	1	<1%
Uzbekistan	1	<1%

Total responses: 486

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