

BUILDING CONSTRUCTION TECHNOLOGY ROADMAP

APPENDIX D

Roundtables 1, 2 and 3 Reports

Roundtable 1

The Future of Residential Housing to 2025

22 April 2004

University of Sydney

by Professor Ron Johnston¹

Executive Director

Australian Centre for Innovation

Roundtable 2

The Future of 'last kilometre' Infrastructure Services-to-Property to 2025

5 May 2004

AI Group Headquarters, North Sydney

by Professor Ron Johnston

Executive Director

Australian Centre for Innovation

Roundtable 3

Key Enabling Technologies for Residential Housing to 2025

20 May 2004

AI Group Headquarters, North Sydney

by Professor Ron Johnston

Executive Director

Australian Centre for Innovation

¹With much valued contributions from Jan Lee Martin, Carl Masens and Rob Johnson.

APPENDIX D: Roundtable 1

The Future of Residential Housing to 2025

1. Introduction

The **objective of the project** is to identify broad trends and emerging technologies in the building construction industry, and implications for the copper industry stakeholders within Australia over the next 15-20 years, specific to:

a) residences, including:

- structures and installations
- fixtures and fittings
- appliances and furniture

b) 'last-kilometre' services to property/infrastructure.

This **roundtable was designed to explore** the future distribution, character and essential features of residential housing, to 2025, given the challenges of:

- changing demography – population growth, aging, fertility decline
- changing preferences and possibilities for residential location
- new technology capable of making homes very 'smart'
- resource availability and price – energy, water, clean air
- sustainable environmental assets
- integrated building systems and design
- emerging technologies.

The **process** involved the development of a number of scenarios of Australia in 2025, exploration of their implications for the characteristics of residential housing, and the challenges these would mount.

2. Establishing the Framework

In addition to the factors affecting residential housing included in a preliminary 'Discussion Trigger' document, participants identified as significant factors:

- changing settlement patterns
- performance of the national economy
- connectedness of housing with all other aspects of economic and social life
- incorporation of sustainability requirements into market needs
- move to 'true' pricing – no more externalities
- drive for a reduced 'footprint' of all buildings
- government regulations
- availability of land for development
- loss of social capital through declining human and community interaction
- changes in value of various services as values change.

In order to provide the basis for the different scenarios, a range of 'uncertainties' were constructed. These were:

- impact of the development of China
- security of food supply
- reversal of the trend from real to virtual/digital
- price of housing
- significant climate change
- a shift in the Australian culture through immigration, new patterns of trade
- stability of the world economy
- adequate provision of health and aged care
- universal access to the basic requirements of life
- availability of resources – energy, water
- new disruptive technologies
- performance of existing infrastructure
- state of the Australian economy
- national vision
- job outsourcing overseas
- relative importance of the individual versus the community in the sharing of costs
- commoditisation of technology
- global and regional epidemics.

3. Scenarios of the Future of Residential Housing to 2025

Scenario 1 – An Emerging China

Parameters – *emergence of China as the dominant global power, with implications for the Australian economy, labour market and housing affordability; in addition, there have been regular major epidemics.*

The Chinese culture has become more important to us as we try to understand better the Chinese market and government. Our children are learning to speak and read Chinese, many more Chinese books, films and television programs are available. Indeed, China now rivals Hollywood as a source of visual content, now delivered by a new Chinese-developed technology.

There will be a substantial boost in Chinese tourism and temporary immigration to obtain an Australian education. There will be some other additional immigration to Australia from China, but it is more likely to be wealthier folks wanting to holiday or retire here.

The growth in the Chinese economy would fuel growing exports of basic Australian commodities, but would probably lead to a sharp decline in manufacturing in Australia. Australia will look to niche products and services based on ideas, know-how, intellectual property.

The risk of infection has made travel more risky, and lead to dramatic improvements in sensing, screening and diagnostic technologies. Detector devices are common-place in public buildings and spaces, residential housing, and even for individuals to wear.

However, settlement patterns have not been greatly influenced by this scenario. The more dominant influences locally will be the physical constraints of the Sydney Basin, and analogous factors in other regional capitals. In the capital cities, housing density will continue to increase, with areas to build in remaining essentially static.

The shift to knowledge work allows us to contemplate whether we need to be in the same physical space and how that might relate to being more distributed spatially, that is, working at home and interconnecting virtually with colleagues. Ease of information transport means you don't have to trek all the way into the heart of the metropolis to do your business. With improved local infrastructure and governance, there is a possibility people can remain in their local communities if they wish.

This could lead to a few different models of communities interwoven with each other, comprising: the isolated, single dwelling where you try to do everything at home, some needing to go and talk to each other, and another stratum who may not actually be able to make these choices and so they would be recipients of welfare and limited infrastructure and services.

Buildings would need to be energy efficient, harvesting energy across a number of modalities in an integrated fashion. Also with sensor technology to determine the condition of the buildings and also in terms of security and biological security.

The way of constructing buildings might have to be more cost effective in order to seriously address affordability issues. However, it maybe we are looking at a future where the actual ownership of the structure you inhabit is not the dominant model. People may enter into service relationships with dwelling/habitation providers, at an individual or community level.

In addition, house structures should be very flexible in their ability to be remodelled quickly and easily and cheaply as people's needs and wants change throughout their lives – you can pull out bits you don't want any more and send them back to the manufacturers for recycling and re-use.

If each dwelling has an intelligent system coordinating use of all the resources and optimising those in an active, smart way, we might find small communities all plug their intelligent houses together to form an intelligent community so there is a second level of optimisation and self regulation. That might then become a bargaining chip for community use, e.g. in bidding for scarce resources such as potable water.

Scenario 2 – A Climate for Better Housing

Parameters – *significant climate change, with impacts on the Australian economy and food security, complicated by the emergence of a major disruptive technology.*

We will have increased El Nino effects, more dramatic and more frequent severe storm events, more reliable rainfall north of latitude 35, less reliable south of that. The south-east corner of Australia including Sydney and Melbourne will suffer from irregular rainfall which may then impact on the city as far as its water management strategies are concerned, and probably change some aspects of agricultural production. But with more reliable rainfall and slight temperature rise in the north, Queensland will become the centre of agricultural and food production in Australia. This will put a premium on specialised high-value, low resource requirement crops – food rather than cotton.

Population shifts would continue to the coastal zone and northwards, but still at present rate. But we will have to build in a different way if we are having more frequent storm events, cyclones moving further south to Brisbane and other places. Will have to cyclone-proof our dwellings – extra cost but something we have to assume. By moving housing production into factories and mass customising to get closer fits and tolerances so we don't have leakage – thermal or air.

In this scenario there are less employment opportunities. Some can't cope with technologies. There are already signs in our community of an underclass developing and we see that as being a major problem in 2025. That has great economic effect because they won't be good economic consumers. Also puts pressure on how we are going to house these people. What is the need for public housing and how will we go about it?

Disruptive technologies: biotechnology, where we can convert/grow food in our microwave by irradiating a biotech modified seed. Nanotechnology coatings can control the thermal environment in houses.

Populations will continue to grow in the cities. The form of the built environment would be one in which we are looking at smaller footprints, increased density, more green space, improved landscaping, group housing, row housing, townhouses and some high density, carefully mixed.

Scenario 3 – Housing for a Lean, Mean World

Parameters – *high levels of geo-political instability, continuing patterns of terrorism and security concerns, dramatic decline in availability of water and petroleum.*

In the continuing conflict in the Middle East, the use of tactical nuclear weapons has decimated oil production in Saudi Arabia and Iraq. The droughts in Australia at the turn of the century have continued, confirming the likelihood of the 2003 CSIRO prediction of a 40-year drought. Water and energy have been transformed over the first decade of the 21st century into rare and expensive luxuries. Personal safety is an ever-present concern, particularly when concentrated in groups or buildings.

Direct consequences are that²:

- alternative energy is far more economically viable, given the high price of oil (but so is oil extracted from fossil fuels), emphasising decentralised energy generation
- the expectation of individual car ownership and use has been priced out of reach – reduced mobility of people, but not information
- a huge increase in awareness of the need to work and live within environmental constraints
- emergence of a diversity of settlement patterns, depending on choice, such as:
 - the virtual workplace – working from home
 - working closer to home
 - sleep/work, e.g. secure dormitories attached to work, returning to home for leisure (a flow-on effect is the need to provide for social interaction and other social needs in the workplace)
 - transport oriented development – regional cities dependent on fast, safe public transport to capital cities.

However, despite the threats of geopolitical instability and terrorism, government policies and land prices are still the strongest drivers of residential housing.

With regard to infrastructure-based services, the development pattern is based around the need to capture/generate, use efficiently, and recycle precious resources. Key features are:

- Energy smart:
 - automation/BMS with links to regulate supply control at site
 - also up scale to regional system (e.g. to cope with peak loads)
 - lighting, thermostat, ventilation, appliances, all equipped to over-ride inappropriate use.
- Water smart:
 - on-site capture and treatment
 - re-use (or modular)
 - community water harvesting
 - water storage used for thermal mass, cooling
 - reduce, re-use, recycle, capture, e.g. 1,000 tanks with off-peak refilling.

Scenario 4 – Housing for All

Parameters – a significant shift in culture towards anti-materialism and anti-globalisation, a strong inward focus on the community, and a national vision to provide equitable access to essential goods and services to all.

The government will be looking at maintaining economic growth at 2-3% pa. To underpin that growth, particularly when factoring in the aging of the population, we will need to continue to increase our productive population base by a similar rate. The natural birth rate will not support this population increase so we will be looking at targeted immigration to support economic growth.

The bulk of immigration would be from Asia and the Middle East – based on the assumption that Australia will be increasingly attractive as a relatively safe and open country, with a relatively sound environmental track record. This will lead to changing cultural norms, and an increasingly multi-cultural society. People from these regions are frequently more accustomed to living in more integrated communities, with a greater emphasis on extended families providing a support network for each other.

The aging population, combined with increased immigration will result in a shift to more compact, village type, communities. We envisage a village green, closely surrounded by shops and services³ and accommodation for the aged and infirm. The broader community would ring the inner circle in a mix of medium density and stand alone (relatively small) dwellings. Also the lower birth rate leads to smaller families, which will result in a requirement for smaller, more flexible dwellings.

People are more likely to work from home, which will drive demand for greater interaction in the community – again promoting the notion of a return to a village type community with a pub for each hub.

Increasing population places greater pressure on already stretched resources. To manage those resources we will need a sound national vision to develop a consistent strategy to encompass amongst other considerations:

- water conservation, including consideration of rainwater harvesting, grey and black water usage, regulation of water efficient devices
- efficient energy consumption with particular consideration being given to the use of energy and thermally efficient products and the development of alternative energy sources
- use of recyclable materials.

² A 'mindmap' was generated by Neil Davidson which is reproduced at Attachment 1.

³ Mention was made of a 'euthanasia centre'.

4. Characteristics of Residential Housing to 2025

Each group was asked to identify the key characteristics of residential housing to 2025, under their scenario, against seven factors:

- location – settlement patterns
- density
- services provided – water, energy, electronics/communications, fresh air, waste removal
- amenity-transport, green space, recreation, connection
- materials and systems
- design features
- cost.

The responses showed a very high degree of convergence, so the responses have been consolidated into a single picture.

Location/Density

- settlement patterns – progressive, with urban concentrations moving northwards up the eastern coast
- decentralised – self-sufficient village concept, satellite cities, with mixtures of densities of dwelling as a function of demand of space and availability of work; mixtures of diverse, but interacting density are the key
- fast efficient public transport connecting distributed nodes the basis for concentrated residential housing location, with non-car mobility within the nodes
- redevelopment of inner/middle city 'brownfield' sites to medium, mixed density; government still a key player
- more effectively planned and managed (the 'Metropolitan strategy for Sydney' may be an exemplar).

Services/Amenity

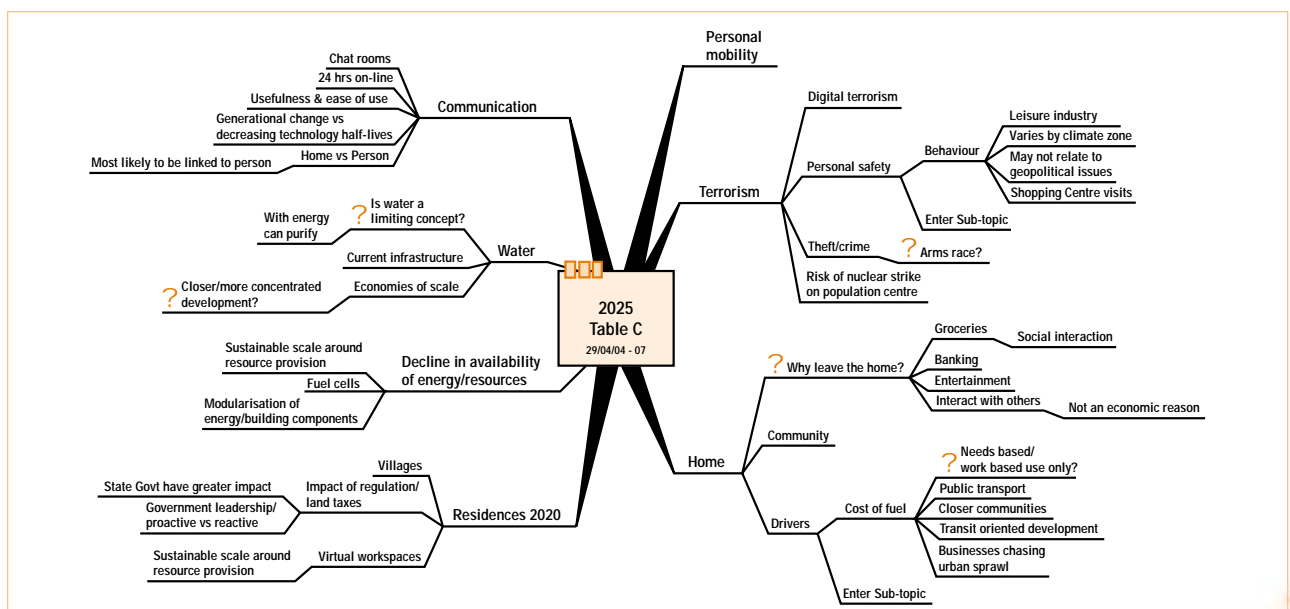
- smart housing, managing energy and water consumption and re-use, temperature control, security (e.g. 'central locking'), access to key information and contacts, self-cleaning; the devices are embedded, invisible ('the switch that turns off the fridge light')
- water harvesting, grey and black water usage
- local power generation, connected to grid, e.g. methane co-generation from waste
- health monitoring and diagnostics, government, financial, communication, entertainment services all accessible from home via advanced Internet
- proximity to safe, efficient public transport
- access to green space, exercise, informal community interaction.

Materials and systems/Design features

- modularised manufacture to agreed standards, incorporating infinite connection, storm-proofing, and customised nano-coating for desired properties, with full flexible replacement, addition and recycling components
- leasing your current 'habitation dream' instead of 'owning your home'
- effective standards regime and rating of systems and services.

Cost

- too difficult to provide guidance; manufactured housing could reduce costs by 50%, but land costs still dominate.



Attachment 1, Scenario Mindmap, Generated by Neil Davidson.

APPENDIX D: Roundtable 2 The Future of 'last kilometre'

Infrastructure Services-to-Property to 2025

1. Introduction

The **objective of the project** is to identify broad trends and emerging technologies in the building construction industry within Australia over the next 20 years, specific to:

a) residences, including:

- structures and installations
- fixtures and fittings
- appliances and furniture

b) 'last-kilometre' services to property infrastructure.

This **roundtable was designed to explore** the future of 'last kilometre' infrastructure services to property, including electricity, gas, water, information, communication and entertainment to 2025, given the challenges of:

- changing demography – population growth, aging, fertility decline
- changing preferences and possibilities for residential location
- new technology capable making homes very 'smart'
- resource availability and price – energy, water, clean air
- sustainable environmental assets
- integrated building systems and design
- emerging technologies.

The process involved the consideration of expert views on the future challenges shaping the supply of energy, water, waste removal and telecommunications under each of the scenarios developed in Roundtable 1, and identification of the key capabilities required to address the challenges and opportunities under all scenarios.

The program of the roundtable is at

<http://www.warren.usyd.edu.au/bctech/rt1/program2.pdf>

The list of participants is at

<http://www.warren.usyd.edu.au/bctech/rt1/participants2.pdf>.

2. Major factors shaping the future of service infrastructure for the 'last kilometre'

Water – John Stevens

- Great pressures arising on water supply, as a result of:
 - Rainfall contracting to the south, particularly in winter, leading to low storage levels across Southern Australia
 - In the Sydney region, deteriorating health of the Hawkesbury-Nepean system, requiring 25% of water budget for flushing
 - Population increase (in Sydney) of 20% (1 million) over next 20 years
 - Budgeted water for 2003 – 600 Gl; actual consumption – 603 Gl.

- Government response – requirement that new housing be 40% more water efficient, 25% more energy efficient (rising to 40%) – requires 'third pipe' solution (for non-potable water)
- Need for comprehensive solution – on-site water treatment for grey and black water, cheap and efficient recycling systems, stormwater capture, 'zeroscaping' (low water demand landscapes), control of water contaminants, nutrient capture.

Electricity – Jeff Fry

- The electricity network will continue to be the most efficient way to deliver energy in the foreseeable future
- Major capital investment already made in infrastructure limits competitiveness of alternatives
- Key factor is maximum demand – greenhouse-related initiatives are reducing average, but not peak demand
- Demand side management – rests on efficient communications through broadband
- Capability exists for designing and building homes that are highly thermally efficient – 8° variation around 22°.

Gas – David Athonisz

- Significant new NSW Government approach to improving practice – BASIX: <http://www.basix.nsw.gov.au>
- Peak demand issue – 30% of capital is used to provide power 1% of time
- Implications of different basis for charging of electricity and gas services over last kilometre
- New technologies – co-generation, micro co-generation to generate electricity from gas, through a kitchen cupboard size appliance, but still not competitive – more effective at community than individual house level.

Telecommunications – Dennis Cooper

- Unlike above, no sustainability issues
- Note: last mile for telco is first mile for customer
- Three services, which through digital convergence are identical:
 - voice, delivered through twisted pair and increasingly, wireless
 - data through wires or optical fibre, mainly to businesses
 - entertainment, requiring high bandwidth via cable or satellite.
- Optical fibre good for trunk connections, but not yet suitable for home
- Potential for houses to be wired with 'blue wire' (GT5) – access in any room
- 'Always on' data communication allows remote appliance monitoring and control

- Present infrastructure is aging – lot of copper wire in ground need to be replaced
- Potential for home-based building management system, in charge of appliance, supply and purchase.

3. Development of future infrastructure services for the 'last kilometre' under each scenario

Scenario 1 – An Emerging China

Parameters – *emergence of China as the dominant global power, with implications for the Australian economy, labour market and housing affordability; in addition, there have been regular major epidemics.*

- Chinese culture – strong demand for latest and greatest technology as status symbol; need for learning Chinese through internet and instant translation
- Need to control movement of people, given disease issues, leads to more gated communities, incorporating:
 - Motion and bio-sensors (if someone doesn't move for 12 hours inside a house can sound an alarm) but would need to be able to turn off if you didn't want to be monitored
 - Resource management at community level by body corporate – e.g. buy telephone infrastructure and have free internal phone calls, the Telco may then come to you to rent excess phone/data capacity
 - Similarly for water, have holding tank, encourage low use and then use this as a bargaining tool for interactions with centralised water authority as you have less impact on system.
- Home office inside house – work from home a few days a week, increased bandwidth needed for the home office – interact electronically with colleagues
- For infrastructure – secure hard-wired to community that you trust, then wireless within community; community manages data, you have smart card for operating everything; could have fibre-optic to door; home needs provision of energy, water, light, air, food
- Size of community – 150-800 people. Noting that for electricity generation, they need one transformer for about 150 homes, so any unit less than this won't impact their planning (thinking, if community can show self-generation for electricity to some extent, maybe provider could install smaller transformer and share benefit).

Scenario 2 – A Climate for Better Housing

Parameters – *significant climate change, with impacts on the Australian economy and food security, complicated by the emergence of a major disruptive technology.*

- Electricity – key driver of consumer behaviour is pricing and information, with 'Binning meter' for different time periods, variable charges, and potential for control by supplier; more effective information and pricing to encourage and reward saving
- Increasing government intervention, requiring coordination and common standards between Federal, State and local governments
- Home/building design to include energy efficient materials, low energy use requirements, local and community storage of rainwater (parks double as stormwater holders)
- Local disinfection of grey water, but need for efficient systems to ensure no public health risks.
- Battery and fuel cell technologies to reduce peak demand
- All new housing developments subject to highest requirements
- Under-house water storage can be used as an anchoring device in cyclones.

Scenario 3 – Housing for a Lean, Mean World

Parameters – *high levels of geo-political instability, continuing patterns of terrorism and security concerns, dramatic decline in availability of water and petroleum.*

- 'Mad Max Meets 1984' – short term winter followed rapidly by galvanisation and search for alternatives; coal-based networked electricity as the base energy platform; priorities are security, health, transport to work and basic services, less funding for sustainability
- Energy – community scale co-generation, micro-generation in individual houses
- Fortress mentality, leading to polarisation in community: people with choice live in spatially and digitally gated communities; people without choice housed in high-density around existing infrastructure
- Transport – focus on public transport, less smaller cars, tele-commuting
- Water – pricing, driving capture, reduce, re-use; leak-proof technology
- Social change – new behaviours – jumpers rather than switches (Energy Australia and Women's Weekly Knitting Competition); inward focus on family and home, periodic water and power outages, leading to self-sufficiency for those with choice
- Improved systems – increased efficiency and minimised loss, safety management of voltage, water re-use, and shared community water treatment.

Scenario 4 – Housing for All

Parameters – *a significant shift in culture towards anti-materialism and anti-globalisation, a strong inward focus on the community, and a national vision to provide equitable access to essential goods and services to all.*

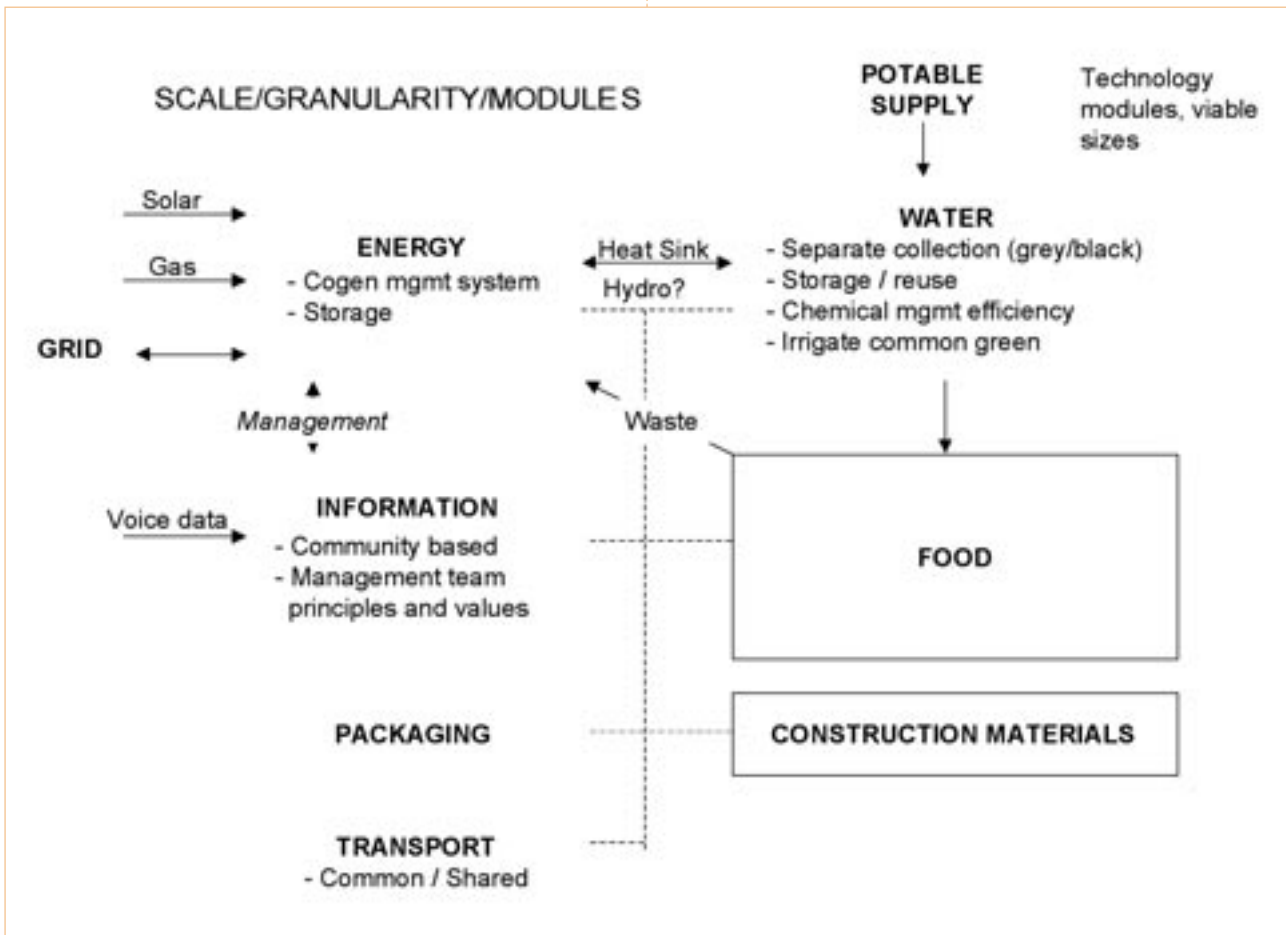
ROUNDTABLE 2... continued

- Shaped by community good dominant over individual, common principles and values, strong central management, competent operations and maintenance, mandated efficiency targets; service guarantees
- Dwellings: group housing, shared facilities
- Infrastructure: 'the last kilometre is inside' – community based external services procurement; peak levelling demand management.

Attachment 2



Attachment 3



4. Key Capabilities required to address challenges and opportunities of all scenarios

Technologies

- Better metering – resolution, real-time, more points of measurement, better sensors e.g. toxins
- Remote monitoring of all appliances and resource use
- New energy sources – nuclear without waste, hydrogen, solar
- Standardisation – commoditisation of equipment (for different services), quality/health levels, cabling
- Integration of technologies – common metering, integrated management, common low voltage DC
- Chipped appliances, houses, networks
- Desalination/water treatment – methods/energy losses
- Self-diagnosis, simpler repair, restoration
- Power generation – efficiency, scale, losses
- Recycling technologies
- Use of low-grade heating/ventilation/air conditioning e.g. geothermal
- Co-generation
- Leak and loss-proof networks.

Systems

- Integrated systems and management, at the level of appliance, house, community and city
- Standardisation of telecommunication protocols
- Storage of water/energy/heating/cooling
- Integrated community transport
- Recycling systems
- 'Smart' dwellings with sensor information management
- Community intranet
- Residential medical monitoring
- Variable demand-based billing
- Market bidding utility procurement
- Improved community interaction (e.g. real time referenda)
- Modularity
- Single trench common services.

Materials

- Smart, intelligent, high performance, embedded
- Durability
- Multi-purpose, e.g. windows, roofs, walls
- Re-usable
- Higher capacity (bandwidth, thermal, strength)
- Lower embodied energy
- Lifecycle and recyclability assessment
- Conservation (lowering leakage of resources from system)
- Lower weight and higher strength
- Bio-degradable/bio-compatible.

Market Mechanisms

- Real-time price (load/demand sensitive) acts as a peak leveller
- Real cost pricing (including externalities and resource depletion)
- Rebates for efficiency measures
- 'Star' rating for built environment
- 'Bundled' market offers, e.g. dwelling and services, fully serviced/leased
- Incentives for reparability.

Regulations

- Standards for technology, quality of service and efficiency
- Coordination of all systems – pipes, power, gas, water, telecomms
- Efficiency targets – inefficient houses are unsellable
- Recycling
- Pricing
- Chipping on new appliances
- Mandatory labelling and minimum performance standards for new appliances and fittings
- Operator training and accreditation
- Community infrastructure and resource use and management
- Health, safety and environment
- Aesthetics
- Education and awareness
- NO 4WDs or SUVs.

Value Systems

- A more critical view of consumerism, pursuit of economic growth.

APPENDIX D: Roundtable 3

Key Enabling Technologies for Residential Housing to 2025

Introduction

The **objective of the project** is to identify broad trends and emerging technologies in the building construction industry within Australia over the next 20 years, specific to:

- a) residences, including:
 - structures and installations
 - fixtures and fittings
 - appliances and furniture
- b) 'last-kilometre' services to property infrastructure.

This **roundtable was designed to explore** the future of key enabling technologies for residential housing to 2025, given the challenges of:

- changing demography – population growth, aging, fertility decline
- changing preferences and possibilities for residential location
- new technology capable making homes very 'smart'
- resource availability and price – energy, water, clean air
- sustainable environmental assets
- integrated building systems and design
- emerging technologies.

The **process** involved the consideration of the key enabling technologies which will have the potential to deliver the characteristics of residential housing identified as necessary or desired through the earlier Roundtables. The characteristics identified are:

- flexibility/modularisation
- a 'haven' for family/social networks
- a place of work
- a centre for communication
- an entertainment facility
- supported by smart services
- providing high security
- effectively managed.

The **program of the roundtable is at** <http://www.warren.usyd.edu.au/bctech/>

The **list of participants is at** <http://www.warren.usyd.edu.au/bctech>

Key Capabilities

Roundtable 2 identified the following capabilities that will be required to underpin the required/desired future features of residential housing:

- *Technologies* – effective metering, remote monitoring, modularity, chipped 'everything', co-generation, loss-proof
- *Systems* – integrated at house and community, recycling, smart, 'single trench', standardised protocols
- *Materials* – smart, intelligent, multi-functional, re-usable, life-cycle assessed

- *Market forces* – real cost pricing, bundled
- *Regulations* – high mandatory standards, performance.

To this list was added:

- changing demographics leading to smaller 'families' and hence houses
- importance of education in driving take-up of new technologies
- the need to build more effective 'strategic conversation'
- impact of the NSW BASIX requirements – will lead to progressively higher standards for water, stormwater, comfort and energy
- declining water availability
- revolution arising from advance and convergence of developments in nanotechnology, artificial intelligence, biotechnology and cognitive sciences
- the progressive formation of heat domes over major cities leading to shifts in location of rainfall, generally away from storage areas.

Key enabling technologies identified for each required housing characteristic⁴

1. Flexibility/modularisation

- An individual building life cycle that can mimic or follow the human and family life cycle, e.g. different housing needs are met not by moving house, but by changing the house; walls become like furniture
- Fast factory fabrication and assembly, with smart services capacity (or capability to deliver thereof) built in at the factory, using 3-D CAD, rapid prototyping and rapid manufacture
- An agreed standard (perhaps ISO) and practice that a home carries with it a detailed documentation package specifying all components, changes, etc, in 3-D (just like a car)
- Design assisted by artificial intelligence-assisted virtual walkthrough of future house
- Universal joints for improved connectivity of line-based services – power, communications, water, gas
- Improved wireless technology for distributed smart embedded sensors
- More effective, lighter materials and close-tolerance fittings
- Interactive software systems that allow architects, designers, developers, planners/regulators, residents and the community to systematically interact and seamlessly store and transfer information to each other
- Ducting built into wall panels to allow for provision of future services
- Design for disassembly and recyclability, with agreed standards and protocols.

⁴ The list was modified in the light of responses, as some characteristics collapsed into others, and others emerged as important in their own right.

2. A Place of Work

- Ubiquitous holographic two-way video-conferencing, from the home or community centre
- Access via broadband to the Internet in your car
- Single centre for work and entertainment, but changeable (by the flick of a switch) to provide the appropriate ambience, lighting, etc
- Fast access to all information and people, as required.

3. A Place for Learning

- Use of video-conferencing system
- Learning packages provided as a subsidiary business by entertainment companies
- Digital tutors readily available
- Instant access to all databases, supported by personally customisable search engines.

4. An Entertainment Facility

- Essentially all forms of entertainment available, in very high quality, in the home.

5. Power, Water and Waste Management Services

- Water harvesting and waste management by osmosis and bio-filtration systems
- Water purifier as standard equipment
- DC bus around the home, separating high and low voltage supply
- Biological waste management of both kitchen and human waste.

6. Communications Services

- Digitisation of all forms of information, with improved seamless technology to deliver 'bits'
- Ultra-high bandwidth wireless, facilitating retrofit to existing homes/buildings
- Immediate access to all your information (your office) wherever you are
- Robust data storage of terabits of information
- Directional wireless systems
- Smart systems delivered at the community and at the individual home level
- Virtual 'tradesman's entrance' – secure delivery of goods while occupant away, e.g. doorbell signal sent to mobile, where cam picture allows identification and appropriate response
- Capability to avoid, or managing, a house 'crashing' – single button re-set/re-boot
- Data capture centres allowing secure access to those approved to provide remote services
- Family/social network intranets or area networks, for ease of communication
- Remotely automated operation of appliances and services
- Secure archiving of all house-related and generated information
- Self-installable broadband and digital services
- Deep fibre networks at the community level

- Self-diagnosis and repair systems
- Mode of delivery invisible to consumer.

7. Health Services⁵

- Sensors in houses to detect human activity, to safeguard elderly
- Sensors in clothing, for safety and health monitoring purposes
- Embedded sensors to monitor environmental conditions
- Need to reduce 'sick building' syndrome – effect of materials, climate control etc on health
- Possible negative health impacts of high level of exposure to pervasive EMF radiation
- Embedded chips that communicate very short distances, avoiding flooding rooms with EMF radiation
- Multiple devices operate as one, without complex system integration.

8. Security

- Smart devices that warn of any changes, upcoming events, etc
- Smart card and bio-metric security systems
- Wireless communications protected by quantum cryptography
- Sensors and smart wiring drive all home security functions
- Built-in bushfire security system.

9. Housing Management

- Real-time metering and read-out
- Energy, water and waste services generated, purchased and managed at small community level
- Provision of habitation services – big business.

A Copper Industry Perspective

A brief presentation on the perspective from the Copper industry was presented by Hal Stillman. The special fundamental characteristics of copper were identified as electrical and thermal conductivity, malleability, stability and bio-activity. A probability/impact matrix for new technologies with respect to copper lead to the identification of a range of potential new applications, including:

- hybrid electric vehicles
- heat pumps
- motors
- heat exchangers
- thermal management
- electronics
- metal forming technologies
- underground power transmission
- desalination
- carriage of information over power lines
- energy for the multiple sensors – inductive mechanism?

⁵ A number of these ideas were drawn from a presentation from CSIRO.

**BUILDING CONSTRUCTION
TECHNOLOGY ROADMAP**

APPENDIX D

END

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