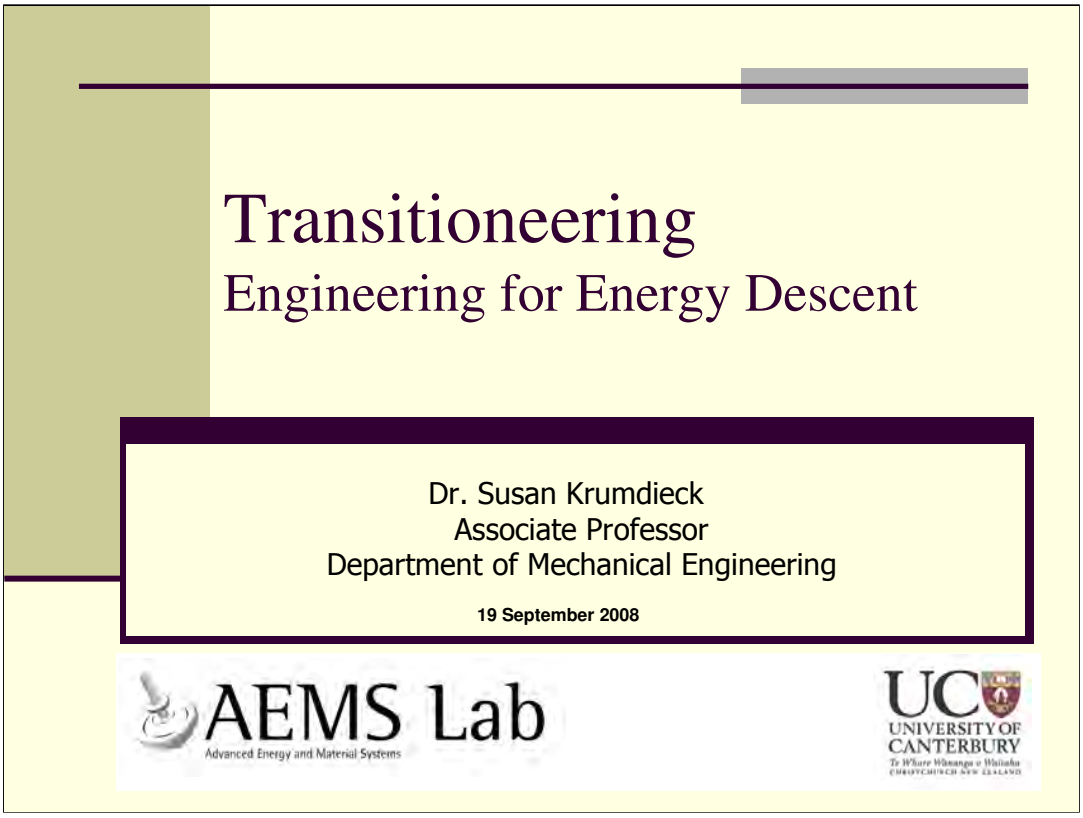


Presentation at Earthsong Cohousing eco-neighborhood, Ranui, Auckland 7:30 19 September

A Vision of the Future:

Transportation tomorrow's world

What do you think of the current soaring oil prices? Have you watched a movie or read a book about global climate change? Are you worried about the changes that are coming? Are you finding that the changes in society since your grand-parent's time have left people alone and isolated in an urban sea of humanity?

Do you want to work for change? Change is an interesting topic, and it should be something we are very comfortable with as it's been the way of life for the past hundred years. But finding how to transition to a lower energy and lower material consumption way of life is making some people very nervous. This talk will explain why there will be major changes whether we are ready for them or not. The range of responses to the changing circumstances will be explored. The main focus of the presentation will be to share some of the research from the research group at the University of Canterbury who have looked into the future and seen good reasons to work for change.

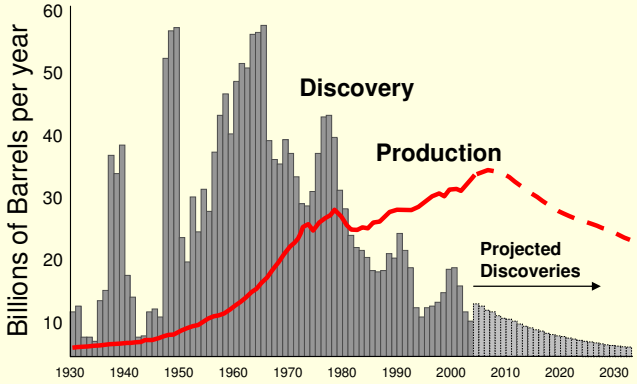
Dr Susan Krumdieck is an Associate Professor in the Department of Mechanical Engineering at the University of Canterbury. She completed her Bachelors and Masters degrees in mechanical engineering with concentration in energy systems engineering and control systems at Arizona State University. She earned the

Engineering Academic Job Description

Fundamentals: Know what is known
Research: Discover new knowledge
Innovation: Create new ideas and solutions
Development: Contribute useful “things”

Facts about Oil Resources

Global Oil Production has Peaked and Will Decline



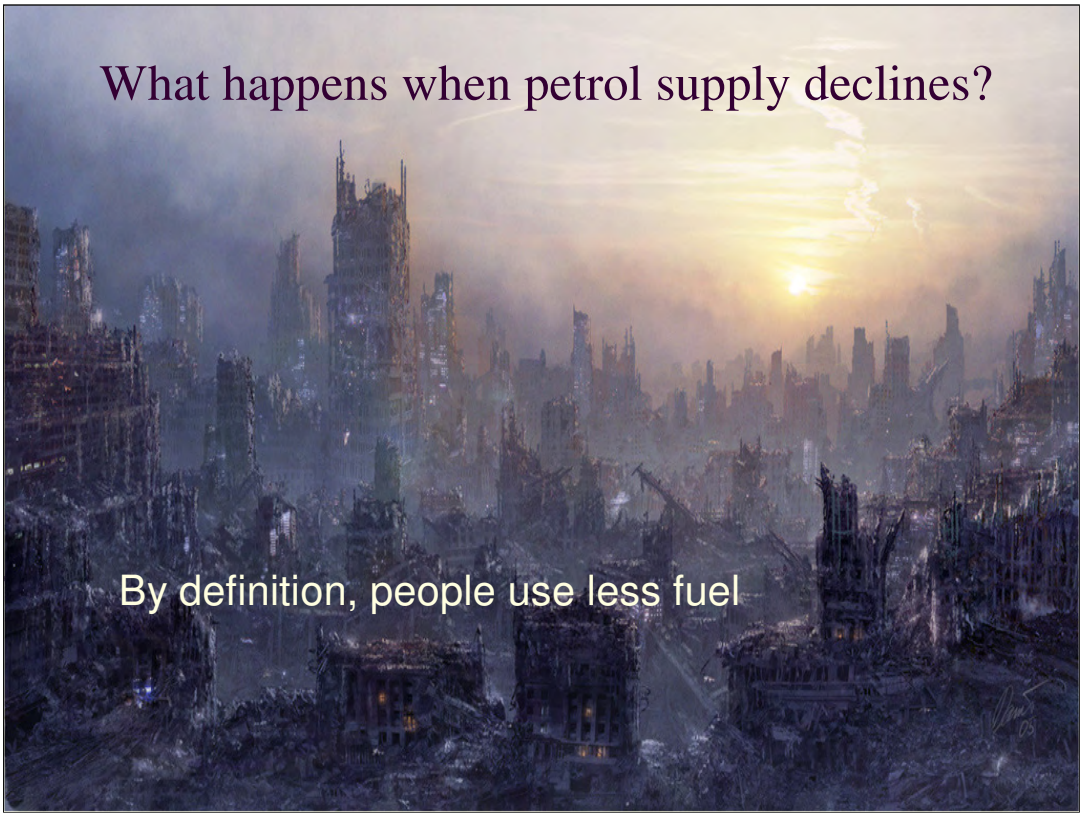
Analytical Model Future Oil Supply

Probability that the supply reduction will have occurred

Supply Situation	2005	2010	2015	2020	2025	2030
Peak Production	0%	50%	80%	95%	99%	100%
7% Reduction*	0%	4%	52%	88%	98%	100%
10% Reduction	0%	0%	29%	78%	96%	99%
15% Reduction	0%	0%	2%	46%	86%	98%
20% Reduction	0%	0%	0%	7%	59%	91%

*** Below 2005 Production Rate**

A. Dantas, S. Krumdieck and S. Page, LTNZ Report 311 (2007)


What happens when petrol supply declines?
By definition, people use less fuel

Is less fuel a problem?

No rational person would say we don't use enough oil!

In fact, we did it just last year and everyone managed.

Using less fuel is not a problem

- It's been proven, it's been done before!

2009 260 PJ — NZ did this in 2007

2010 (10% reduction 234 PJ). — NZ did this in 2004

2012 (20% reduction 208 PJ). — NZ did this in 1995

Atmospheric Chemistry Facts

IEA Optimistic Target 2030
550 ppm

CO_2 History of the World

Current level:
385 ppm and
rising

Source: J. R. Petit *et al*. Nature, Vol 399, June 1999

There is no up-side

CO_2 550ppm
½ of species committed to extinction

History of "Global Warming"

- 1896: Arrhenius (Chemist) "Global Warming" due to CO_2 released from burning coal." *CO_2 = 286 ppm*
- 1948: Earth and Oceans are "self regulating" Natural Balance will take care of Human CO_2
- 1958: 1st continuous measurement CO_2
- 1976: CH_4 and NO_x also identified as GHG *CO_2 = 315 ppm*
- 1985: UN Conference ICSU consensus: "warming is inevitable due to existing CO_2 rise." *CO_2 = 345 ppm*
- 1990: Appeal by 49 Nobel prize winners *CO_2 = 352 ppm*
- 2007: IPCC 4th Report – Human activity is causing global warming *CO_2 = 385 ppm*

An unstable climate is a problem

http://blogs.warwick.ac.uk/images/richardwinskill/2005/08/12/spaghetti_junction.jpg

http://www.soulofamerica.com/images/photosca/la4/110-105_Fwy_interchg.jpg

http://www.westcoastroads.com/california/images101/ca-110_nb_exit_022_00.jpg

www.nasa.gov/vision/earth/everydaylife/climate_class.htm

http://news.bbc.co.uk/2/hi/science/nature/4720536.stm

•What we have done – extracted and burnt sequestered oil

•This has provided movement of people and goods – we have benefited

•Have permanently changed the atmospheric chemistry –

•Link – what will the future hold, how do or are we planning for it

The last two generations of humans in an elite group of the world's communities have removed 780 billion barrels of oil from permanent sequestration in the Earth's crust, have burned it to move themselves and their goods, and have permanently changed the atmospheric chemistry of the planet.

What is the vision of the future? If only we had unlimited energy and we had 12 lanes in each direction? City planners, transport planners, what is the vision of the future? How much energy will that take? How much energy do you think will be available?

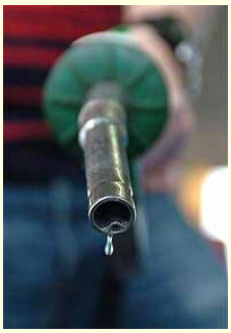
Transition Engineering

Two Projects

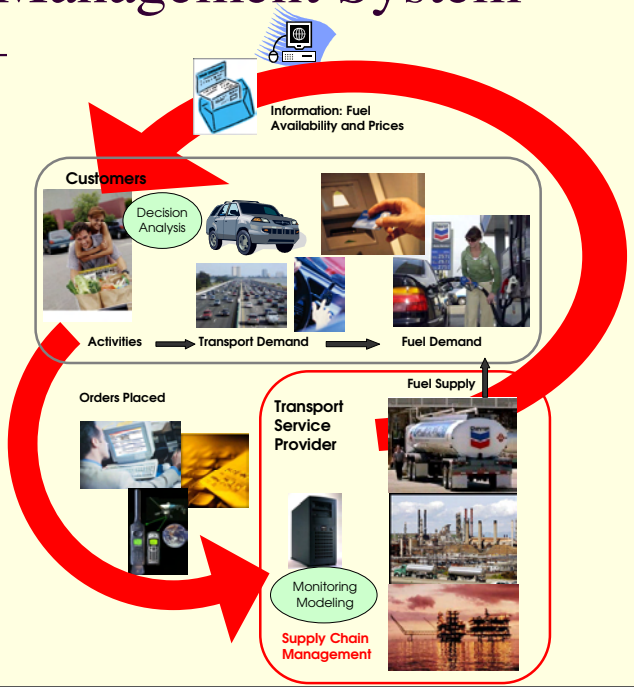
Adaptation
To mitigate RISKS to wellbeing

Transformation
Of existing investments to a system with low environmental and supply RISKS

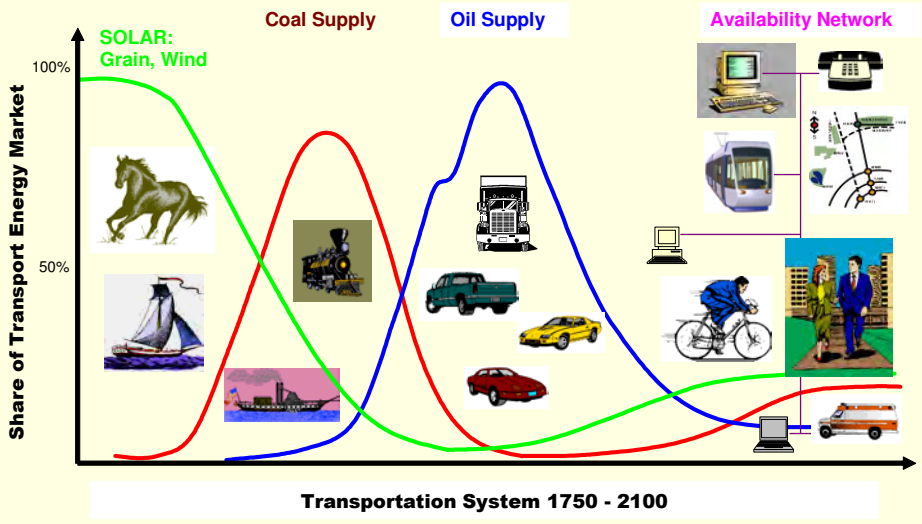
Fuel Retail Management System

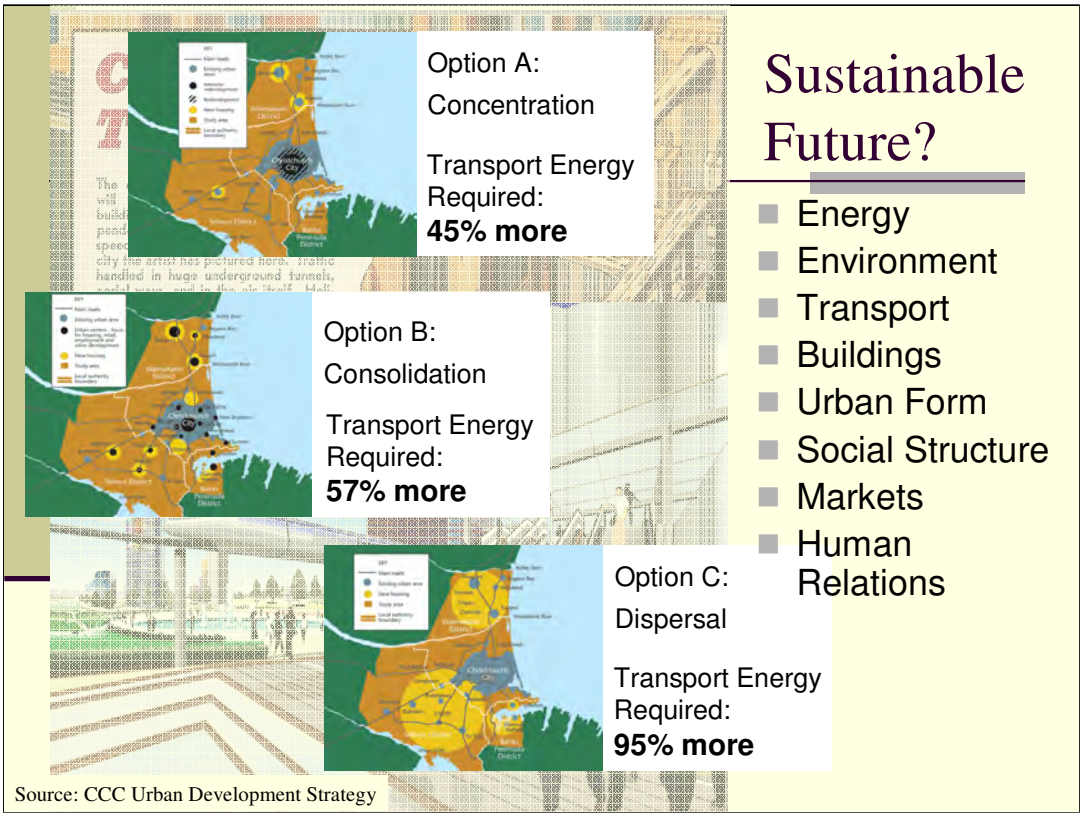


How do you sell 10% less fuel next year?



Transition Vision of the Future





•Interesting to look at past visions – old vision of what today's city would be like

•A more recent view –

•Common theme – unlimited energy

•The most recent and realistic view of the future – CCC Urban develop – each case more fuel – future dictated by growth

•The debate is on – cost of roads – congestion -

•Link – So, what if we don't find more - what if we have less – what do we do

Transport and Energy are the core issues for any settlement of any size, and they always have been. In this image of a future city from 1939, we see that buildings dominate the space, traffic speeds around at unheard of rates. The air is clean. Engineers have found new sources of energy so vast that there is always more. And, people never have to go outside or even touch the ground. <click>

A more recent vision of a future city allows for a bit of green space, and a bit of assisted walking, but the implication is still unlimited energy.

My notes: This theme of unlimited future fuel (or energy) still continues, look at the CCC plans of future city growth, all of which require more fuel than we have today. Really, the question is not is there going to be enough fuel at 2030, but 50 years on from that as well, that is how long this urban form will be around.

So how do we deal with this, on one hand we "know" that things are set to change, on the other, we still seem to be planning as though they will not, which can't really be a good thing

Feasible Sustainability Concept

- Define the constraints
  - Energy and material resources
  - Environmental impacts
- Define the Objectives
  - Community and Individual Wellbeing
  - Environmental Wellbeing
- Feasibility Engineering
  - Infrastructure and technologies and systems

A new approach

Objective

•Figure out what we actually want, transport is really a means to an ends, we concentrate on the transport for transport sake, when we should be concentrating on services, communities, wellbeing.

Constraint

•What resources have we got available, and what technology is available. (we shouldn't be building our transport system we a known problem (i.e. fuel?) without a solution. The fact that we are "researching" or making some biofuel, is not good enough, a partial solution to a problem is not a solution

•Engineering Constrained systems is commonly carried out – these are examples

•These are examples – (state examples, i.e. there are limits to the human body)

•No room for error – clear objective – consideration is given to the whole system, you do not ….and then …. You design for that constraint

•These are complex systems –

•The same energy constraints considered – must examine the whole system

•Research at UoC asks – can we use this same approach

•Link – lets look at some of that research

The Silke Concept Project

Sustainable Christchurch – A project of vision

The Northwest limit of Christchurch – October 1957

Beyond Greers Road lies mainly farmland. The shopping centres are yet to be built. Lake Bryndwr can be seen in the distance Russley Golf Course is among the trees at the top of the photograph. Visible behind the line of trees in the centre left is Wayside Avenue where the houses were exhibition homes. In the top left corner is Memorial Avenue (then Burnside Road). St Aidan's hall and vicarage is at bottom centre.
Acknowledgements: Parish of Burnside

Burnside High School Zone – a community in Christchurch

I'm now going to show you a project we have done which we call the Silke project (that's the name of one of the students who worked on the project).

It's not meant to be

My notes:

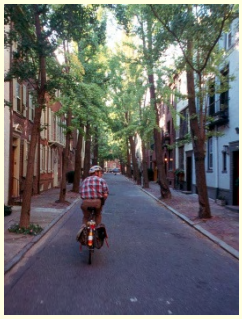
Imagine you are an archaeologist, or a paleo-anthropologist. You are looking at the remnants of an ancient society and trying to re-construct what life was like then. You can't impose your own society's ideas or assumptions on the evidence you are looking at. You have to let those people tell you about themselves through the evidence. What were their environment, trading partners, resources, materials technology?

That is the kind of thinking we did to develop a feasible sustainability model of a city of 300,000 people on the Canterbury plains, using the assets of the current built environment. They know everything we know about science and technology. They like to work for a profit, and they consider the wellbeing of all in the society. They use only renewable energy. They use other minerals and resources in ways that sustain value. Their city is not growing.

What is life like there? How are they getting around? Where are they going? What kind of work are they doing?

Define Resources Available

- Oil and Coal are useful minerals
- Biofuel (renewable) for Transport
  - *That's about 5% of what we use now*
- Renewable Energy for Electric Trolleys
- Environment healthy, productive
- Microclimate stabilized

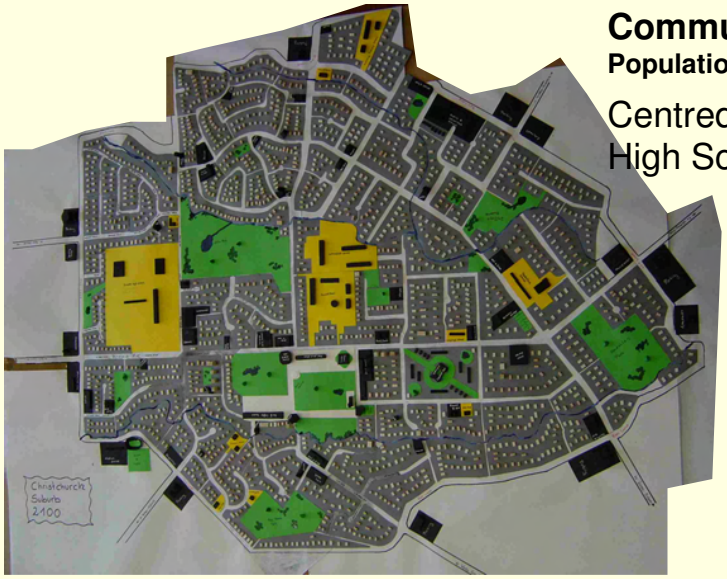


•(constraints

•Resources – Fossil free future – fossile fuels avalible for capital investment

•Have a some bio fuel – but not much

Burnside High Zone Community



Community Unit
Population: 9000-10000

Centred around
High School

•Take a place that is known –

•We decided to start with a place we know, and transition the infrastructure and technology and land use and economy to meet the requirements of only renewable energy for transportation.

•The high school provides a definition of a community group with a common tie to each other and the future through education of their children. Rural towns are often centered around the high school. The Burnside High School zone is shown in the map.

Transition Design

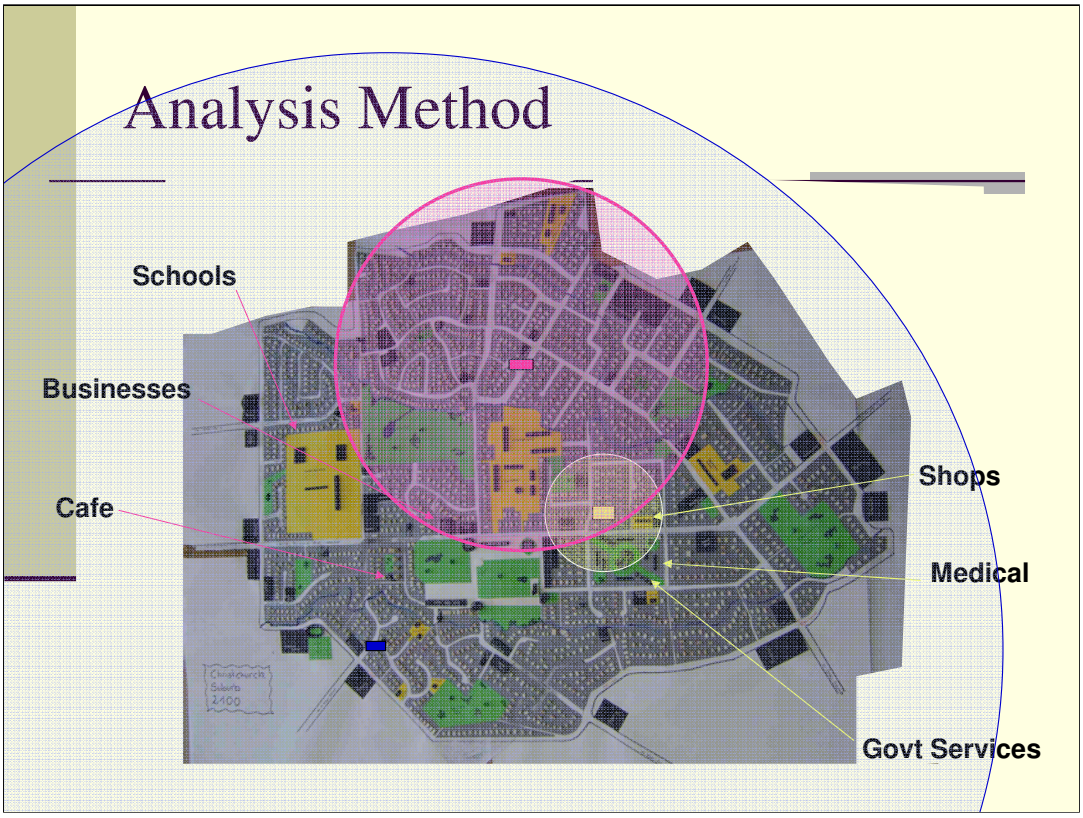
- Inventory homes, schools, destinations
- Inventory services, markets, employment
- Calculate travel distances
- Calculate paved, built, soil and natural areas

First – Gather all of the evidence about the existing land use and urban form. We will only be changing what is necessary.

Where in this area do people work? Go to the market? Produce goods? Provide and receive services?

How is the land being used? I other words, what are the human functions taking place in the current built environment, and how do they provide for the wellbeing of the people in the zone?

We also make a list of all of the services and jobs that people would NEED for wellbeing of individuals and community.



Transport is such an underpinning factor of the ability of the people in this zone to achieve a high level of wellbeing, that the study is focused on finding out how they organise their urban form to achieve a high quality of life using only renewable energy for transport.

There will always be a small segment of the society that has limited mobility. For them, all of the goods and services and participation in activities that they require must be very close to their residence. We set 500m as the travel distance for 90% of activities for 10% of the population. This is represented as the yellow circle.

There is a large group of people who can walk 1.5km to a destination. We set the requirement that 90% of goods and services, destinations and access to regional transport, needed to be within 1.5km of 70% of homes. This is represented by the pink circle.

There is a group of people who can easily cycle 5km to access work or markets or activities. We set this portion of the population at 20% and their travel distance is represented by the blue circle.

Method:

Identify all of the residences and the destinations in the zone.

For each home, assess the distance to the list of destinations to meet the target access.

Start moving the required destinations into the zone and placing them so that the criteria set out above are met.

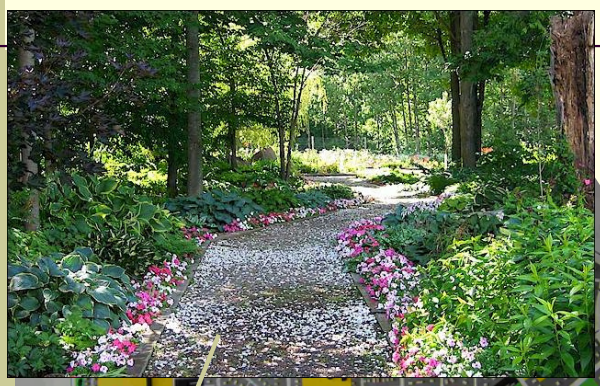
Each time a business or service is moved into the zone, place that job on the “in zone” list.

Activity Model

- Motorized transport available for
  - Goods
  - Emergency Services
  - Public Transport
- 95% of Activities accessible without motive power
- 95% of goods and services present in the zone
- 85% of employment in the zone

Prioritize the activities and goods movements according to wellbeing. Use the available energy for transport of the most essential then the necessary transport activities.

Urban Form Transition #1



Opened up Fencing for pedestrian accessibility

Now the results:

What had to be changed about the urban design, the land use pattern, the transport network or technology in order to have a feasible, sustainable town. What is Silke like? Let's take a visit.

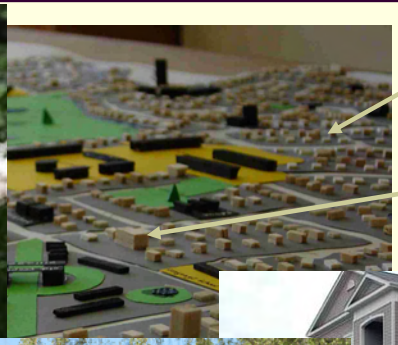
Local Organization and Services

10% of homes moved to make room for Town Center

The pre-transition Burnside High School Zone had a library and a recreation centre, but very few other civic services, and very few businesses, and only a few production facilities. There were no food production operations in the zone, pre-transition.

In order to meet the requirements, 10% of pre-transition homes were removed, and in that space a new town centre was built. This campus has office parks, medical facilities, government services, and some community assets like open space and an open-air concert venue.

Housing and Community



1/4 Acre family housing density

10% high density housing

Integrated Communities

The homes that were removed, were re-built as high density housing. This provides appropriate living environments for young people and older people. The rest of the pre-transition housing pattern of detached single family homes remains unchanged. We also found that the current pattern of a mixture of high value and low value properties in the zone would remain as it was the best way to ensure that people could locate within the human powered transport distance to their primary destinations.

30% of land area Native Species

We had discussions with environmental experts to determine the optimal form for green land use. Their specifications for stabilized microclimate, optimal growing conditions, pest management and soil moisture stabilization are listed below:

10% hard surface limit, allows storm surges to be absorbed, rather than having to be drained away

eliminates the need of watering surrounding vegetation

20m buffer around streams and waterways (queens chain)

Whole area 30% green space, in climate-adapted species required for micro climate stabilization, and the natural areas need to be connected together for biodiversity.

Around peoples houses, there will be some gardening, and some native plantings (these are the most able to live in this environmental conditions) The placement and proportion of these plantings will be optimised for climate stabilization and for food production.

Local Food Production

- Reclaimed paved space

55% of fresh produce, dairy & poultry grown within the urban form

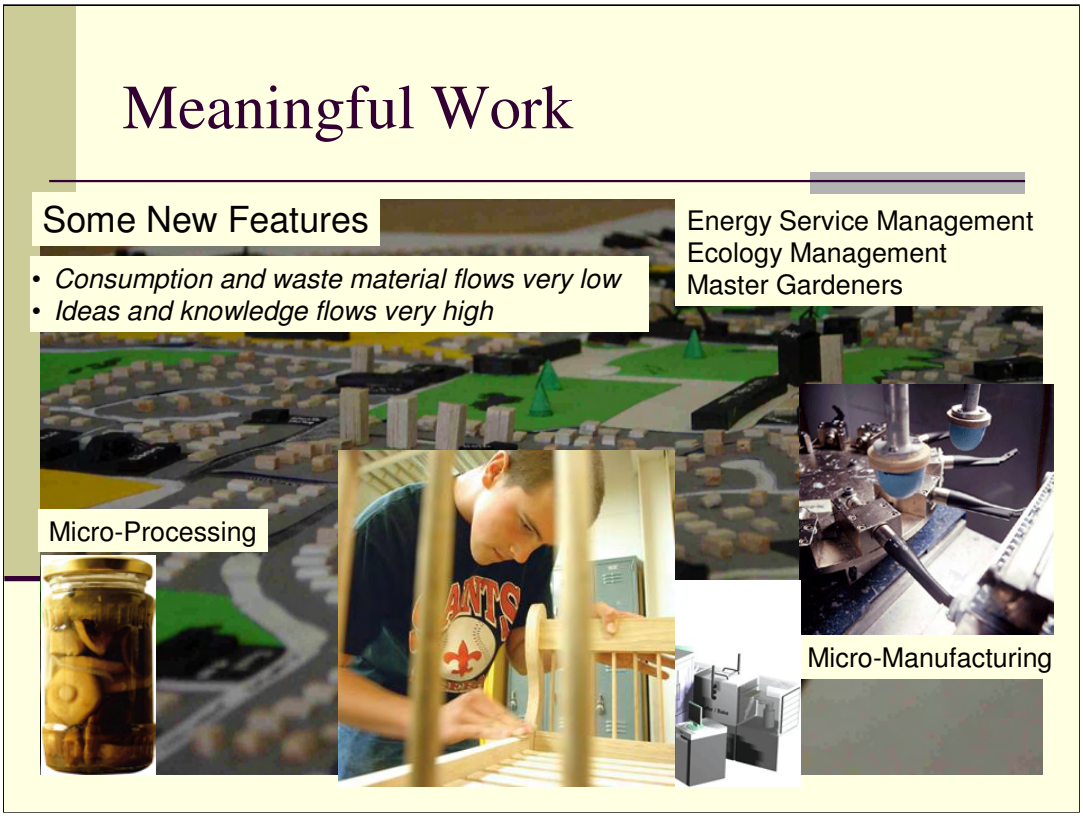
Zero Food Miles

With renewable energy only, 55% of the fresh food in the diet of people in Silke needed to be produced inside the zone. In our opinion, this couldn't be done effectively by homeowners – so a profession must exist – that of master gardener. The master gardener is an expert in horticulture. The person also interfaces with the retail market for fresh foods, so knows what people in the zone prefer. The master gardener has the important jobs of optimising the production from the arable land in Silke, but deciding where different plantings will be made, and by deciding the best locations and species for fruit and nut bearing trees and hot-houses. A good deal of the paved space is used for hot houses and poultry barns. The master gardeners also manage the care of these assets by the professional gardeners, who in-turn hire the local high-schoolers as tenders and harvesters.

The master gardener may actually be a horticultural systems engineer!

Meaningful Work

The number of jobs in Silke is nearly equal to the number of working age adults.



There are some new jobs in Silke. We have already mentioned the master gardeners. There are also ecology keepers – people who work on maintaining those important climate-adapted or native species corridors, streams, lakes and ponds (including fish production ponds), and sea shores, and keeping them flourishing.

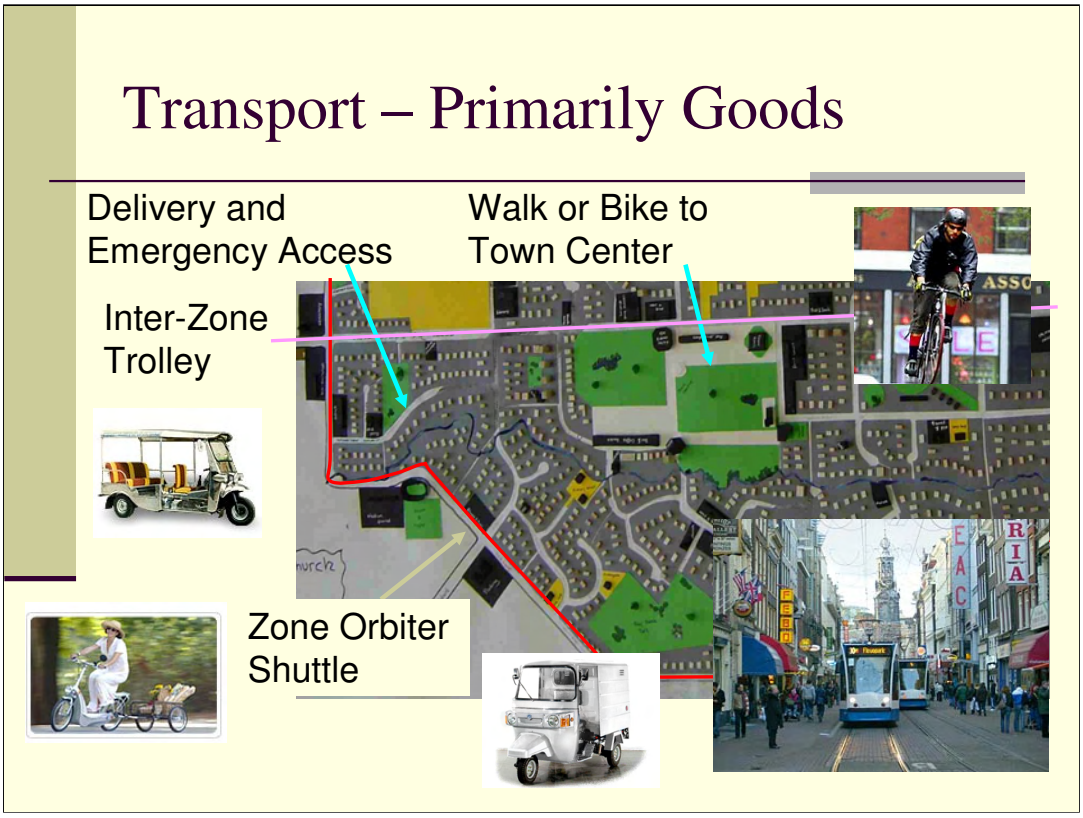
There are also energy service managers, and the market place is a lot smarter than the pre-transition supermarket system. There is very little waste from the Silke market place. Silke doesn't have the transport energy for the kind of trash collection system of the pre-transition zone.

Also, a very high percentage of packaging is re-used or composted. There are specialist food preservers, and more bakeries, restaurants and cafes than in the pre-transition zone.

The economy in Silke is thriving. And it is doing it without huge freight movements. The pre-transition global market in low-priced labour and access to resources has given way to a true knowledge economy. Ideas, solutions, designs, education… These are being moved instead of finished goods. Manufacturing is small-scale and steeped in craft and art and deep value. But people are re-learning old ways of doing things, so much as experimenting and developing new ways, which they can then teach to others for economic return. A majority of the production and business is for local customers. But it is the knowledge contact with the rest of the world that ensures quality. Trade in high value goods across long distances is as active as every, it is the happy meal toy that no longer exists.

For high quality of life the production and waste management systems in Silke must be optimal. This means a high degree of specialisation and education, and profession. This optimisation also requires new kinds of markets where customers are guided in their choices by availability and producers are guided in their production by customer desires. This leads to minimal waste and highest efficiency. This new "connected" market, provides sustained value and quality of life as the pre-transition economists dreamed the "free" market would.

Silke is not a place where people are self-sufficient. On the contrary they are highly dependent on each other for the individual's knowledge, experience and capabilities.

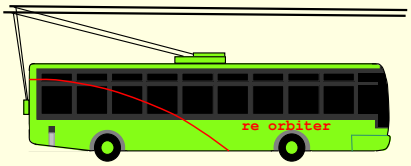


Silke has an obiter type bus route that goes around the centre, each location is within walking distance of an access point to this motorised transport network.

There is an inter-zone trolley, that links within adjunct zones and other areas perhaps of larger scale manufacturing and other more specific service type towns. The inter-zone light rail lines also link up with local agricultural areas and rural centres.

Although Silke is hypothetical, the processes involved are not substantially different from current planning and urban design. However, the transport network and street-level design is not aimed at accommodating cars and trucks, because there is no replacement energy source for fossil fuels that is anywhere on a scale with vehicle movements in the past 50 years.

Renewable Obiter



- Renewable Energy Assessment
  - Wind turbines, Solar
  - Pumped hydro for energy storage
- Modelling
- Service – Investment (cost) trade off

The electric trolley system is run off a transport power grid. The transport system is highly adaptive. This means when the wind is blowing steadily, trolleys are dispatched. As most people can get to their normal destinations by human power, the trolleys are actually carrying mostly goods. There are collection and distribution stations at different points on the trolley lines. The remaining distance for urban goods movements is covered by small battery electric delivery van.

There is a possibility for production of biofuel from some waste products and some crops. We estimate that the Canterbury region could supply less than 5% of pre-transition liquid fuel demand. We asked people what one journey they would prize above others. The answer is regional trips out of town to visit family or to “get to the mountains”. Thus, most of the biofuel in Silke is used in a fleet of rental cars that people can book into for their rural journeys.

Krumdieck, S., A. Hamm, A. Dantas and S. Minges, “Performance-Objective Design for a Renewable Energy Transportation Circuit of Christchurch”, New Zealand, in Proceedings of the World Renewable Energy Congress VIII (Denver, Colorado, 29 Aug-3 Sept 2004).

We hope that this engineering look at feasible sustainability for a people that are very similar to ourselves has provided a vision of the future. We discovered that we don't need to be thinking so much about pre-car urban forms, as post car urban forms. We found that there is no reason why cities can't be designed for human wellbeing, rather than property development and vehicle flows. Every civilization needs a shared cultural vision of its future. Our civilisation may be one of those that are looking at the end of our way of life. There have been others before us. Maybe the Silke model of feasible sustainability allows us to envision a transition of our way of life into something much better, more humane, and much lower risk. If Silke really is feasible, then we have a revolutionary new vision of who we are, what we really need, what a sustainable quality of life is, and what is possible.

Our multidisciplinary research group at the University of Canterbury is working on developing ways to provide local transition communities with the power of systems engineering to create feasible sustainability in their own neighborhoods.

Thank you from our research group

AEMS Lab
Advanced Energy and Material Systems

www.aemslab.org.nz

Sustainability is a delicate balance of dynamic energetic systems

Advanced Energy and Material Systems Lab

Associate Professor Susan Krumdieck, Director

(Back row): Mik Dale – Transition Engineering, Stacy Rendall – Transition Engineering, Sohel Mohammed – Geothermal Power Plant Modelling, Andy Hamm – Strategic Analysis of Complex Systems (Remote Communities), Shannon Page – Strategic Analysis of Complex Systems (CO2 Reduction and Energy Constrained Transport),

(Front Row): Montira Watcharasukarn – Transport Activity Constraint Adaptation, Muavi Mohamed – Strategic Analysis of Remote Island Energy Systems, Aline Lang – Energy Constrained Freight Movements

(Not Pictured): Samuel Gyamfi – Demand Response in the Residential Electricity Sector, Nick Yannakis – Green Building Design, Siti Masuri – Geothermal Power Plant Operations for Efficiency