The Biospheric Project - Manchester International Festival 2013


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Food and the city

[the best way to predict the future is to design it!]

richard buckminster fuller

Prof Greg Keeffe
Director of Research [Architecture]
Queens University Belfast

Design team leader –[aquaponic systems] at the biospheric project.

g.keeffe@qub.ac.uk
How sustainable are we…….? 

Professor Greg Keeffe
ants

- More biomass than people
- Handle their waste and others
- Grow and harvest food
- Construct houses, farms, dumps, cemeteries etc., from recyclable materials
- Create disinfectants and medicines that are healthy, safe and biodegradable
London needs around 120 Londons to feed it

The ecological footprint of Londoners is 293 times the size of London. The area of London and the UK are superimposed for a clearer comparison.
Ecological big hitters
In London

- Meat eating: 5800
- Pet food: 3100
- Milk drinking: 2500
- Cars: 2100

In ‘000’s of gha
Source: City Limits 2005.
www.citylimits.org

10 million

Professor Greg Keeffe
Ration book city

The above table shows the dramatic differences between the amount of CO2 required to produce lamb compared to chicken for example. The average person has a food carbon footprint of around fifty four pounds of CO2 per week by cutting this to forty pounds a twenty percent reduction could be achieved. This could easily be achieved by choosing foods with lower CO2 levels and would not require people to reduce food intake.
Professor Greg Keeffe

ALASKAN POLLOK:
From sustainable fisheries off the coast of Alaska, Alaskan Pollock is shipped to McDonald's processing sites to make the infamous 'Fillet-o-Fish'.

WHEAT:
Of the 13,700 tonnes of wheat used annually by McDonalds, some of this is sourced from North America.

DEHYDRATED ONIONS:
McDonalds UK sources its dehydrated onions all the way from California to use on its burgers.

CHERRY TOMATOES:
Depending upon availability, cherry tomatoes are sourced from either Morocco or Spain.

GERKINS:
The gherkins, found on some burgers, are grown in Turkey.

CHICKENS:
Of the 14.6 million chickens slaughtered each year, only 4.7 million of these are from British farmers. The other 9.9 million are sourced from Brazil and Thailand.

CHICKENS:
Depending upon availability, some of the chickens are sourced from Thailand.

HOIKI:
From a sustainable source, Hoki is fished off the coast of New Zealand. The fish are frozen and then shipped to Poland or Denmark to be processed. They are then flown to the UK and sold as fish fingers.

THE JOURNEY OF HOIKI FISH:
- Fishing off the coast of New Zealand
- Transport to processing in Denmark or Poland
- Transport to distribution centres around the UK
- Transport to served at local restaurants

TOMATOES and CUCUMBERS:
Sourced from Holland.

CHEESE SLICES:
Milk is sent from England to Ireland, to be processed and turned into cheese slices.

CARROTS:
For 1 month of the year they are sourced from France.

TOMATO KETCHUP:
Sourced from Portugal.

CHERRY TOMATOES:
Sourced either from Morocco or Spain depending on availability.

LETTUCES:
For 8 months in the year lettuces are sourced from Spain.

‘just how big is a shop?’
### McDONALDS: The ‘Size’ of each restaurant

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Conditions</th>
<th>No. of UK McDonalds Restaurants 1225</th>
<th>No. or Kg per day</th>
<th>No. or Kg per restaurant</th>
<th>Yield tonnes per acre</th>
<th>Feed  tonnes per year</th>
<th>Space Required per animal (m²)</th>
<th>Space Required per food (m²)</th>
<th>Space Required (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td></td>
<td>33,000</td>
<td>0.67 Kg</td>
<td>1.386</td>
<td>33</td>
<td>12.74</td>
<td>6107.5</td>
<td>2,668.875</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>Freedom Foods</td>
<td>14,600,000</td>
<td>11.06</td>
<td>1.386</td>
<td>33</td>
<td>12.74</td>
<td>6107.5</td>
<td>71,224</td>
<td>71,323</td>
</tr>
<tr>
<td></td>
<td>Free Range</td>
<td>14,600,000</td>
<td>11.06</td>
<td>1.386</td>
<td>33</td>
<td>12.74</td>
<td>6107.5</td>
<td>95,910</td>
<td>97,912</td>
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<tr>
<td></td>
<td>Organic</td>
<td>14,600,000</td>
<td>11.06</td>
<td>1.386</td>
<td>33</td>
<td>12.74</td>
<td>6107.5</td>
<td>137,593</td>
<td>143,182</td>
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<tr>
<td>Eggs</td>
<td>Freedom Foods</td>
<td>81,000,000</td>
<td>175</td>
<td>63.875</td>
<td>269 eggs</td>
<td>10.22</td>
<td>0.25 hens/m²</td>
<td>12,545</td>
<td>12,545</td>
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<tr>
<td></td>
<td>Free Range</td>
<td>81,000,000</td>
<td>175</td>
<td>63.875</td>
<td>269 eggs</td>
<td>10.22</td>
<td>0.25 hens/m²</td>
<td>12,545</td>
<td>12,545</td>
</tr>
<tr>
<td>Pork</td>
<td>50% organic diet</td>
<td>4,600</td>
<td>657,000</td>
<td>1.5</td>
<td>548</td>
<td>564</td>
<td>363,872</td>
<td>945,848</td>
<td></td>
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<tr>
<td></td>
<td>100% Organic</td>
<td>4,600</td>
<td>657,000</td>
<td>1.5</td>
<td>548</td>
<td>1726</td>
<td>945,848</td>
<td>363,872</td>
<td></td>
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<tr>
<td>Fish</td>
<td>Alaskan Pollock</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Fish Substitute</td>
<td>Trout</td>
<td>10 Kg</td>
<td>3,650 Kg</td>
<td>10.11</td>
<td>1,456</td>
<td>10.11</td>
<td>1456</td>
<td>10.11</td>
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<tr>
<td>Wheat</td>
<td></td>
<td>13,700</td>
<td>11,200 Kg</td>
<td>3.08</td>
<td>10,014</td>
<td>3.08</td>
<td>10,014</td>
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<tr>
<td>Potatoes</td>
<td></td>
<td>176,000</td>
<td>143,810 Kg</td>
<td>11.30</td>
<td>51,800</td>
<td>11.30</td>
<td>51,800</td>
<td>11.30</td>
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<tr>
<td>Lettuce</td>
<td></td>
<td>16,000,000</td>
<td>41</td>
<td>14,955</td>
<td>121,410 Kg</td>
<td>14</td>
<td>121,410 Kg</td>
<td>14</td>
<td>121,410 Kg</td>
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<tr>
<td>Gritiskin</td>
<td></td>
<td>13,6 Kg</td>
<td>4,927 Kg</td>
<td>4</td>
<td>2,000</td>
<td>4</td>
<td>2,000</td>
<td>4</td>
<td>2,000</td>
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<tr>
<td>Tomatoes</td>
<td></td>
<td>15 Kg</td>
<td>2,475 Kg</td>
<td>4.55</td>
<td>1,435</td>
<td>4.55</td>
<td>1,435</td>
<td>4.55</td>
<td>1,435</td>
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<tr>
<td>Onions</td>
<td></td>
<td>34 Kg</td>
<td>12,410 Kg</td>
<td>6.4</td>
<td>7,851</td>
<td>6.4</td>
<td>7,851</td>
<td>6.4</td>
<td>7,851</td>
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<tr>
<td>Carrots</td>
<td></td>
<td>180</td>
<td>0.4 Kg</td>
<td>147 Kg</td>
<td>8.85</td>
<td>8</td>
<td>8.85</td>
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<td>8.85</td>
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<tr>
<td>Oil (Rapeseed Oil)</td>
<td></td>
<td>4,000 metric</td>
<td>8.9 Kg</td>
<td>3265 Kg</td>
<td>10,927</td>
<td>1.25</td>
<td>10,927</td>
<td>1.25</td>
<td>10,927</td>
</tr>
<tr>
<td>Cheese Slices</td>
<td></td>
<td>614,000,000</td>
<td>1373</td>
<td>501,145</td>
<td>4,000</td>
<td>4</td>
<td>4,000</td>
<td>4</td>
<td>4,000</td>
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<tr>
<td>Abattoirs</td>
<td></td>
<td>3,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,000</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,232,808</td>
</tr>
</tbody>
</table>

**The Space Required:**
The boxes below represent the spaces required for each different food source.

**McDONALDS FOOD CONSUMPTION:**
There are approximately 1225 McDonalds Restaurants up and down the UK. Each one has food deliveries 3-5 times a week. Nationwide McDonalds serve almost 2,000,000 people daily. Each person orders their food but is blissfully unaware of the amount of energy and resources that have gone into providing them with their meal. The last column in the table opposite shows how much space goes into providing food for one restaurant for a year. The figures for fish could not be calculated as they would require a small portion of the ocean.

The average size of a McDonalds in the UK is approximately 381m², however each restaurants actual size is almost 4 million m². Nationwide McDonalds uses 913 tonnes of food each day, which is approximately 748 Kg of food per restaurant per day.

On a global scale, McDonalds uses 23,033 tonnes of food per day, which equals 8,407,046 tonnes annually.

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**Professor Greg Keeffe**
VERTICAL McDonalds: The average size of a UK McDonalds Restaurant is 381m². Using this as a basic footprint guide, the diagram below indicates what a self-sufficient McDonalds would look like.

**CHICKEN:**
To house all the broilers for chicken meat would require 376 levels at approximately 1.127 km high.

**PORK:**
To house all the pigs would require 2483 levels at a total of 7.448 km.

**BEEF:**
It would require approximately 6979 levels just for cows alone. This would account for 20.04 km of the overall structure.

A PASSAGNER JET:
To give an example of how high the structure is, a standard passenger plane flies at around 10.5 km.

30.39KM HIGH!

ISLINGTON McDonalds: The site in Islington is approximately 89,000m². If we use that as the footprint for our self-sustained McDonalds restaurant we get different results. The new building would be 43 stories tall, reaching 129 m high. The new ‘McDonalds’ would dominate the cityscape of Liverpool.

**CHICKEN:**
To house all the broilers for chicken meat would require 1.6 floors at approximately 4.8m high.

**PORK:**
To house all the pigs would require 10.6 floors at a total of 31.8m tall.

**BEEF:**
It would require approximately 29.9 floors just for cows alone. This would account for 89.7m of the overall height of the structure.

LIVERPOOL METROPOLITAN CATHEDRAL:
Possibly one of Liverpool’s most famous historic landmarks. Standing at approximately 85m tall, this building would be swamped by the new ‘Mega-restaurant’.

Professor Greg Keeffe
MacDonald’s drive thru true size - with goat meat saves 215 hectares

Professor Greg Keeffe

MacDonald’s drive thru true size - vegetarian saves 370 hectares
SELF SUFFICIENT MCDONALDS: Vegetarian

VERTICAL MCDONALDS:
The average size of a UK McDonalds Restaurant is 381m². Using this as a basic footprint guide, the diagram below indicates what a self sufficient McDonalds would look like.

ISLINGTON MCDONALDS:
The site in Islington is approximately 89,000m². If we use that as the footprint for our self sustained McDonalds restaurant we get different results. The new building would be just 2 stories tall, reaching 6m high. The new ‘Mega-McDonalds’ would fit nicely into the cityscape of Liverpool.

LIVERPOOL METROPOLITAN CATHEDRAL:
Possibly one of Liverpool’s most famous historic landmarks. Standing at approximately 85m tall, this building would be swamped by the new ‘Mega-restaurant’.

VEGGIE:
The overall structure would be easier to manage. Natural light would be able to penetrate the centre of the building allowing the vegetables to grow. Other parts of the building could be lit with artificial lighting to control temperatures. With this control the manager could almost trick the plants into thinking it is a different season than it actually is allowing year round growing.

A PASSENGER JET:
To give an example of how high the structure is, a standard passenger plane flies at around 10.5 KM.

POTATOES:
For all the potatoes for hash browns and chips would require 136 levels of the McDonalds tower which is approximately 408m.

LEGUMES, NUTS + SEEDS:
For all the meat alternatives it would require 112 levels of the McDonalds tower which is approximately 339m.

1.16KM HIGH
Coffee Demand 57.2 kg coffee per day
20.88 tonnes/year
20.88 hectares

Sugar Demand 17.16 kg sugar per day
6.26 tonnes/year
0.75 hectares

Water Demand 429 litres per day
160,000 litres/year
= 200 m² surface area

Milk Demand 429 litres per day
160,000 litres/year
9.2 hectares
Invisible terrace: autonomous living machine

Professor Greg Keeffe
Nutritionally Complete:

Biospheric
Urban Carpet

Citylab 2001
Energy
Food production
Transport
Leisure space
Connection
The Biospheric Project

Aquaponic food system

- Large-scale building system
- Closed cycle
- Biodiverse
- Permaculture
- Organic

- ‘The future will be born not made’
  Kevin Kelly
Closed cycle urbanism

Professor Greg Keeffe
Extra structural support!!

Agreement on these 16 15x10cm pieces of steel took 6 months!

[they took a morning to fit!]

Professor Greg Keeffe
Biospheric Aquaponic System

Fish

Worms

Nutrient Film System

Window Systems

Professor Greg Keeffe
Fish!
Three pumps needed.

Total power needed 960Watts
£3.60 per day
UV filtration x 3
To prevent Legionella build up
Miineralisation and filtration

84 containers
100Kg worms

Professor Greg Keeffe
Worm mineralisation detail.
Window systems

Professor Greg Keeffe
Polytunnel
NFT systems

Professor Greg Keeffe
Prototype food producing façade: Building becomes cyborg

Hardware = technology
Software = biotic components
Interface = food management
Green genius façade with BDP, Siemens, QUB and Biospheric Foundation
Synergetic City: Bio-port free energy city Liverpool

Self assembly urbanism

Final form 10 glass factories Producing 250,000 tonnes pa

Stage 1: Glass Factory
Stage 2: Algae Array
Stage 3: Energy Production
Stage 4: More Glass

Professor Greg Keeffe
Bio Port: Carbon neutral, self-assembly city

FREE ENERGY CITY

Professor Greg Keeffe

Citylab
with Kees Christiaanse
and
MacCreanor Lavington, Rotterdam

A productive vision for Salford - Shortlisted

(we were told we were ‘trying to run the place down’)

Professor Greg Keeffe
Food and the city

[the best way to predict the future is to design it!]

Thanks to

QUB Design team: Andy Jenkins
Tilly Hall

QUB Build team: Morgan Grennan
Josh Greenfield
and the students of Queens University Belfast.
School of Architecture.

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Queens University Belfast

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