

Measuring Productivity in Green Buildings

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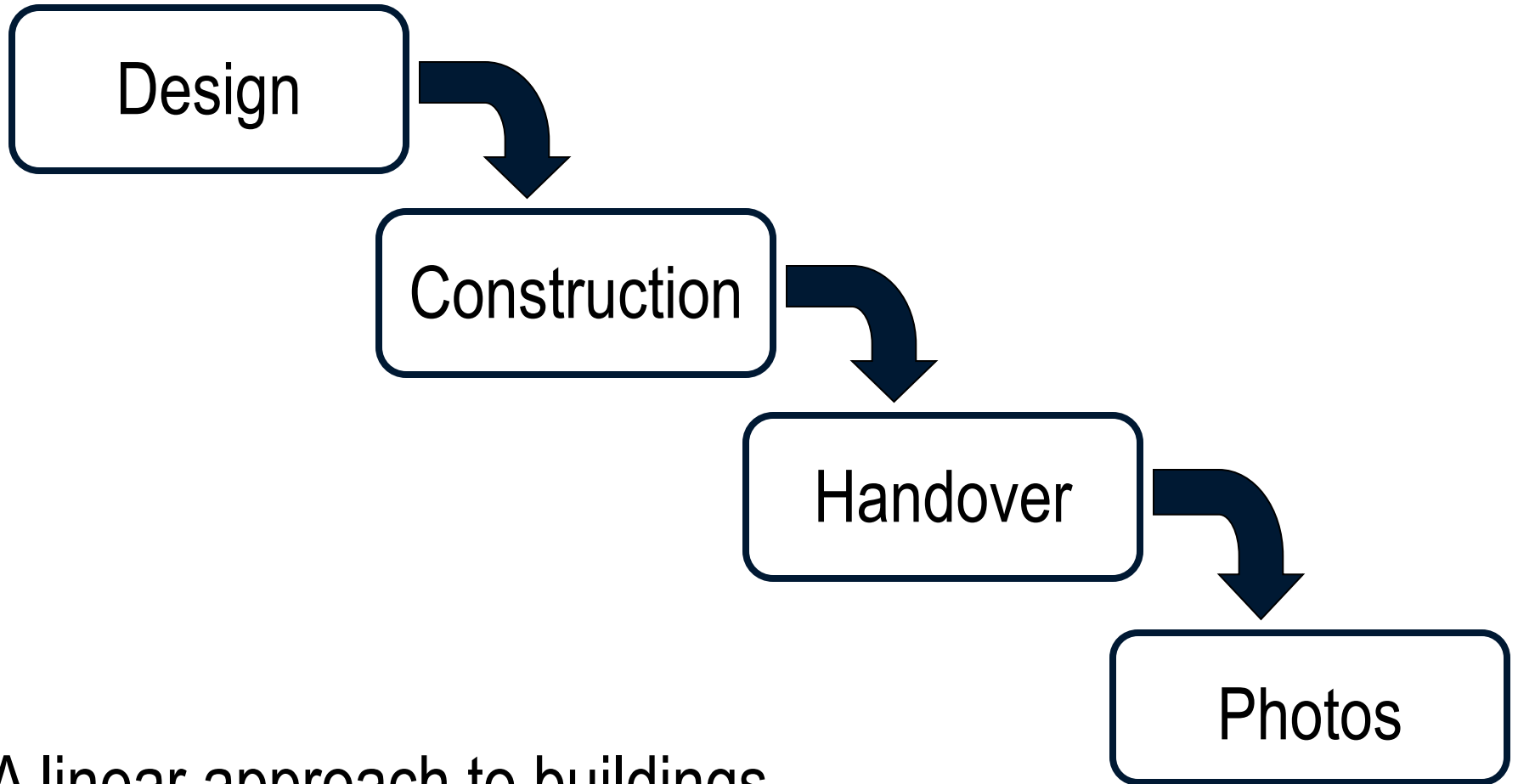




Its All About Us!

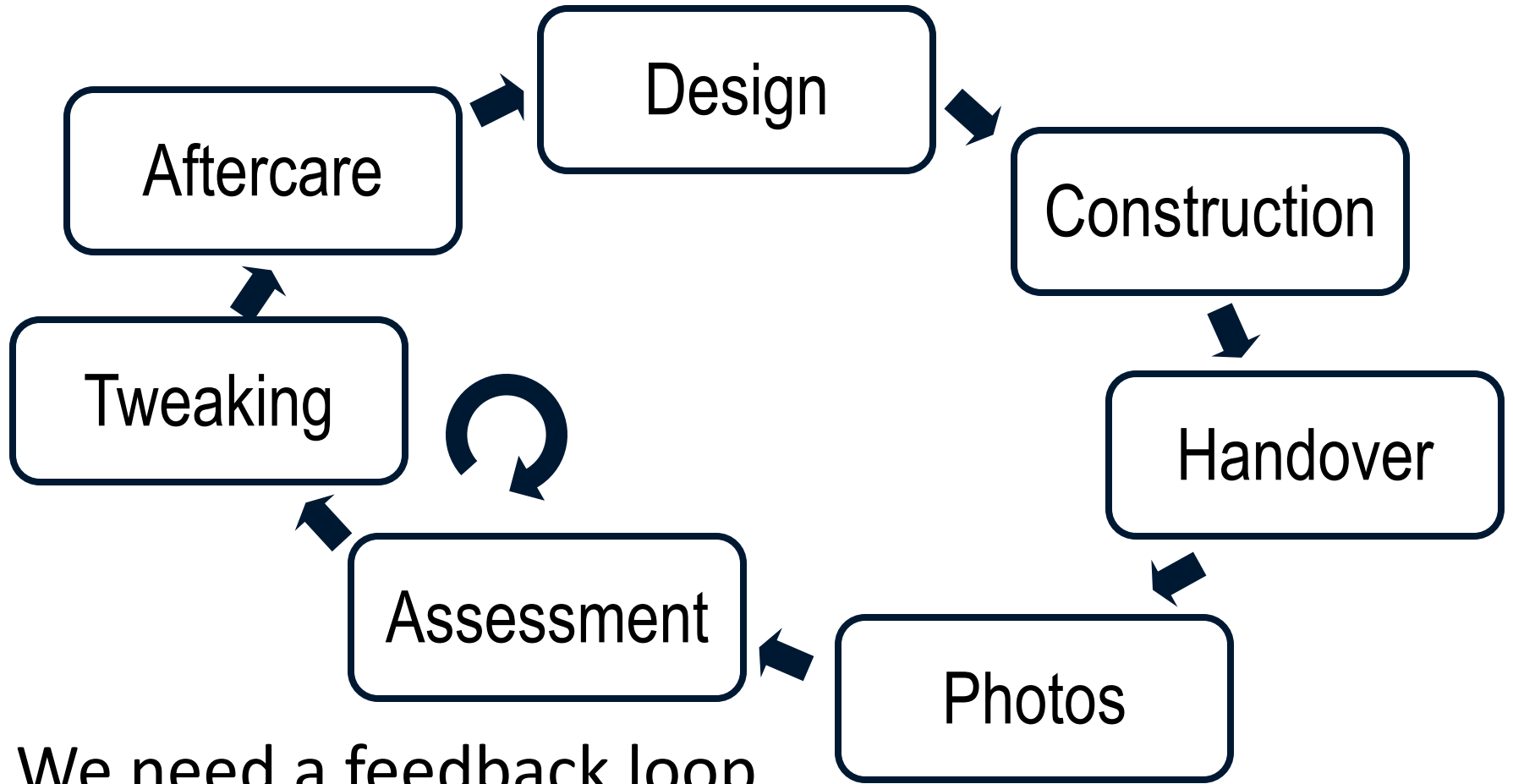
- This sort of “post occupancy evaluation” often ignores the occupants!
- This occurs across all fields
- Human factors need to be taken into account when assessing and rewarding design
- Current process sells the users (us) short

Current Practice



A linear approach to buildings...

Best Practice



We need a feedback loop...





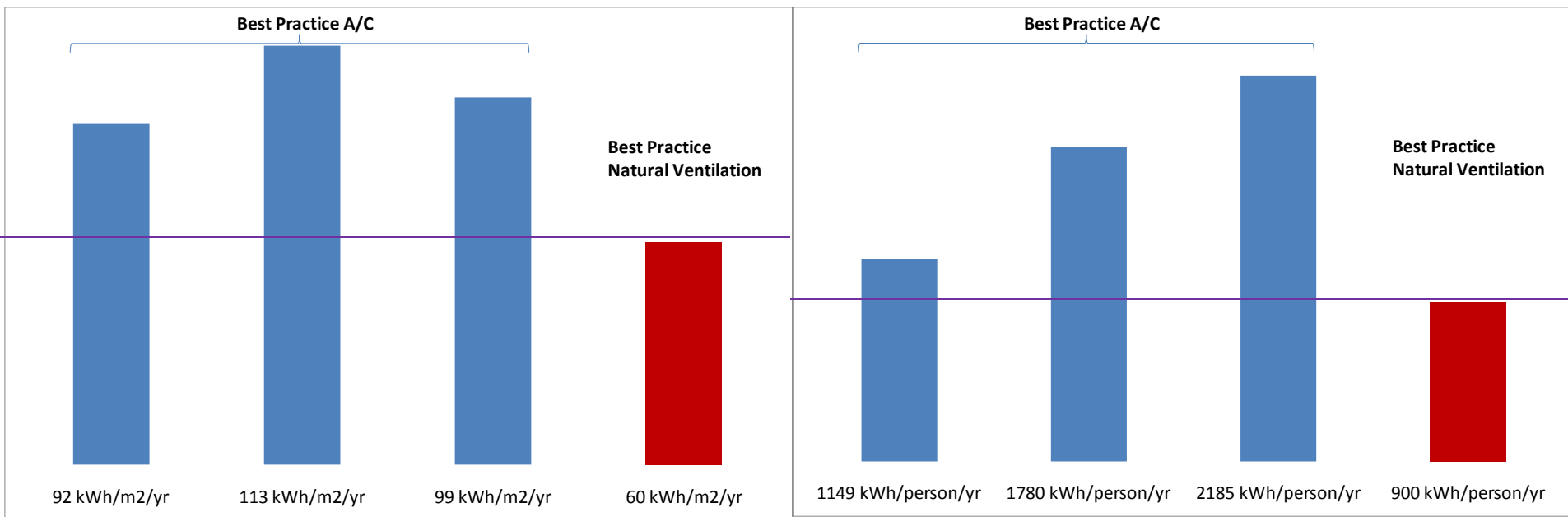
So in a low carbon future it's not just about the way a building looks its also about how it performs

Workplace Performance



From design potential to a performance culture

Green Buildings are about Workplace Efficiency and Energy Efficiency



From Traditional Real Estate to New Green and People Based Solutions



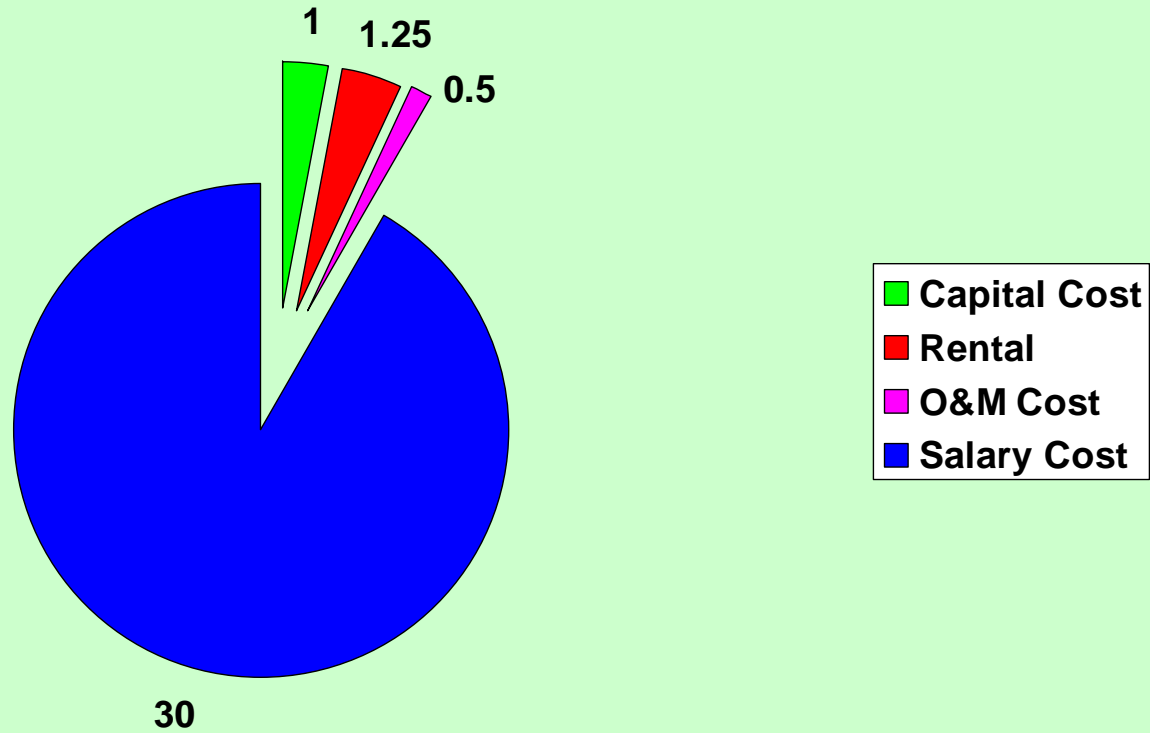
Do we need to reconsider our city demographic and real estate solutions?



97.2% (463,278) of enterprises in New Zealand employ 19 or fewer people.

Relative Costs

Relative Costs Over A 10 Year Period



Work-style principles

Business Strategies that Impact on Working Environments

Support future growth strategy



Workstyle Principles

Provide a flexible working environment to accommodate future changes in staff numbers
Project space to allow project teams to get out of business as usual

Achieve competitive advantage by doing more with people



Productive work point
More informal meeting rooms and collaboration spaces
More quiet spaces to work and think
Appropriate technology

Recruiting and retaining the best people



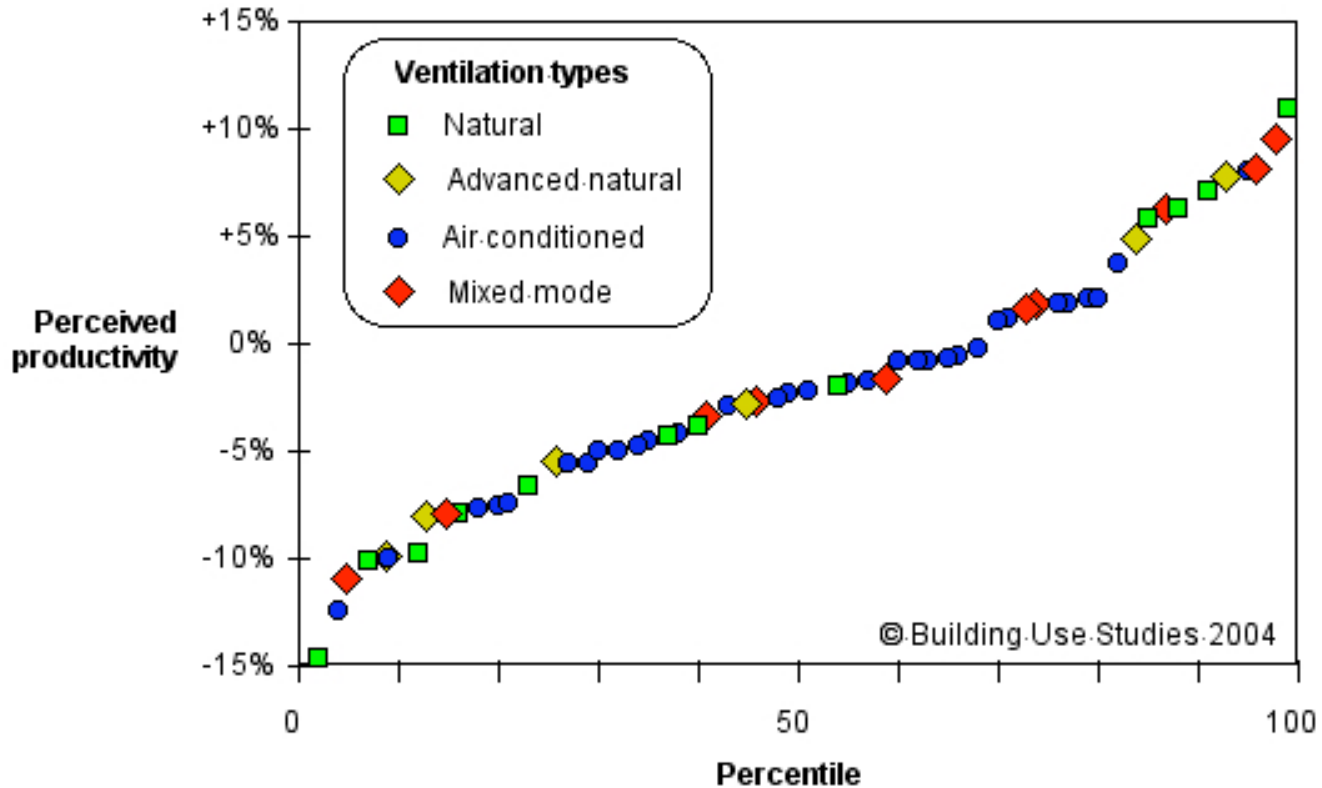
Provide a working environment with a point of difference
Support staff work/life balance
Appropriate facilities to encourage family participation

Enhance culture



Encourage communication with open, flexible working environment
Create a family friendly working environment
Places for staff to unwind

Perceived Productivity



Source: Building Use Studies

Basic Productivity Statistics

Basic productivity statistics

Building Use Studies International

Dataset; n=192

Range: minus 15% to plus 15%

Perceived productivity gains are only made in about 30% of new buildings

All buildings

Perceived productivity mean
minus 1.9%

Air conditioned

Perceived productivity mean
minus 2.35%

Non-Air conditioned (bottom) (i.e.NV, ANV, MM)

Perceived productivity mean
minus 1.57%

Maslow's Hierarchy of Needs

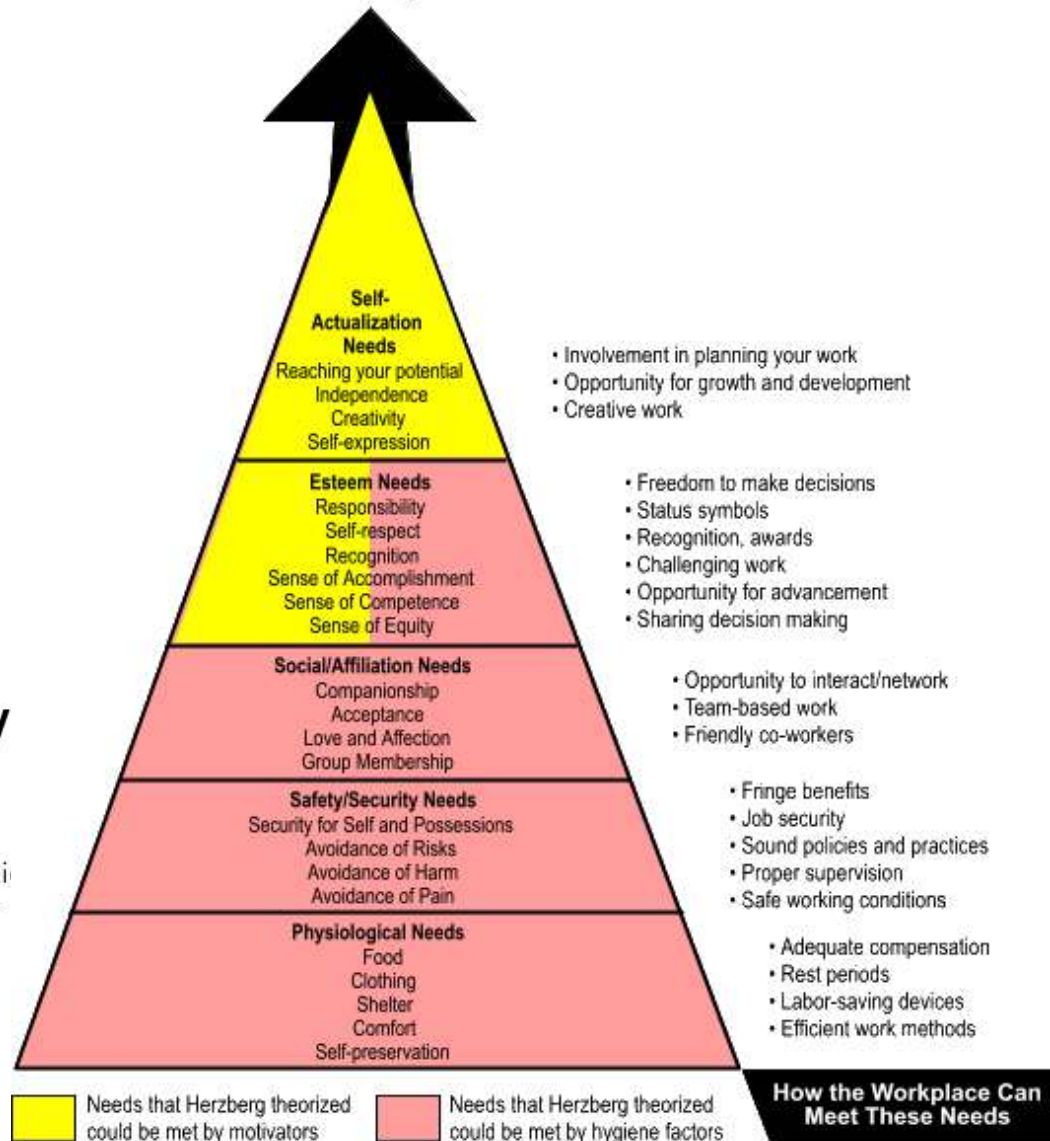


Abraham Maslow

1908-1970

The father of humanistic psychology and creator of Maslow's Hierarchy of Needs.

Self-actualization is not an endpoint, but a self-renewing need/drive



From Verma, V. K., Human Resource Skills for the Project Manager: The Human Aspects of Project Management, Volume Two, Project Management Institute, 1995, p81.

Comfort, Health and Productivity Drivers

Physiological

Physical

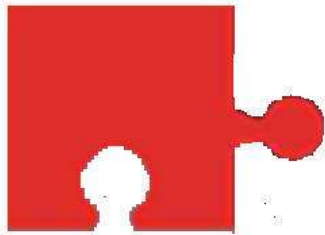
Cognitive

Motivational



Physiological and Cognitive

Physiological



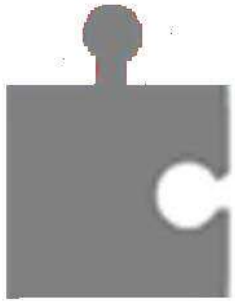
- Thermal Comfort
- Visual Comfort
- Acoustics
- Indoor Air Quality
- Personalization
- Facilities Management

Short Term Instantaneous Experiences.

The base level of Maslow's Hierarchy of Needs

Physiological and Cognitive

Physiological



- Experience
- Interaction
- Likes and Dislikes
- Well-being
- Mood

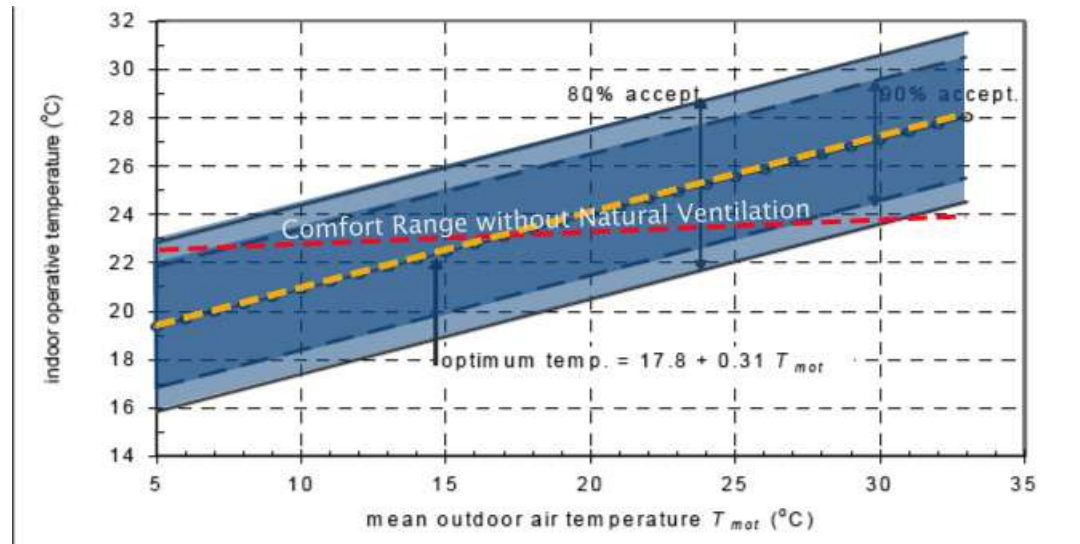
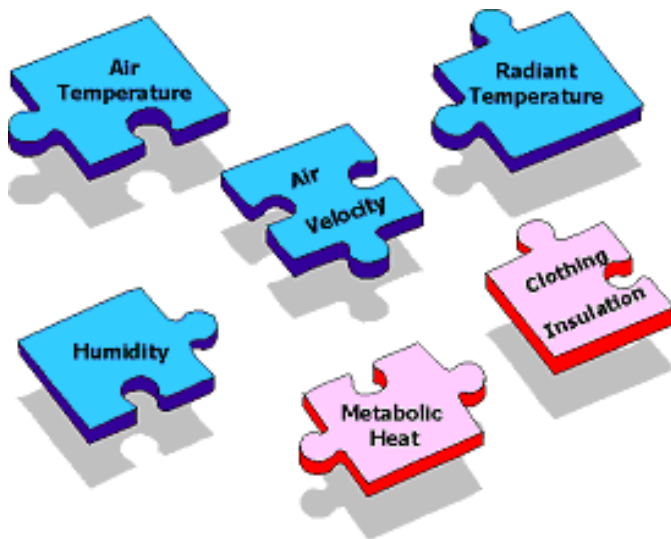
Generally Develop Over First Year based on the Memory of Previous Experiences

A group of Attributes and Characteristics that users like or dislike The mid levels of Maslow's Hierarchy of Needs.

Thermal Comfort K.P.I.s

- Mode of control - Air conditioning / mixed mode / natural ventilation. Current and proposed.
- Air temperature
- Mean radiant temperatures / radiation asymmetry / shading
- Resultant temperatures
- Air delivery method - air movement/velocity/temperature/draughts
- Clothing
- Metabolic rate
- PPD
- PMV
- Overheating hours for naturally ventilated spaces
- Controllability

Perceptions of Comfort are extended for naturally ventilated buildings



Indoor Air Quality K.P.I.s

- Natural / Mechanical / Mixed Mode Strategy
- Outdoor air inlet location
- Outdoor air quality
- Outdoor air quantities
- Ventilation Effectiveness
- Air quality monitoring / control
- Filtration Standard
- Localized extract
- Finishes Chemical Loading

Visual Quality K.P.I.s

- Distance from Windows / depth of space / distribution / space to height ratio
- View / ownership of glass line
- Daylight factor and uniformity distribution
- Daylight hours p.a.
- Blinds / shading / lightshelf / glare control – luminance ratios.
- Artificial lighting type / level / distribution /glare index
- Floor ceiling and wall reflectances
- Task /ambient
- Vertical plane illuminance
- Lamp type
- Balance with natural light
- VDU Type
- Controllability

Acoustic K.P.I.s

- Space planning principle – open plan / cellular
- Space and volume per person
- Volume per person
- Natural / Mechanical / Mixed mode ventilation strategies
- Acoustic Design / Background Noise Criteria
- Ceiling acoustic properties
- Screen properties / height
- Wall / window sound reduction properties
- Sound masking
- Office protocols

Personalization K.P.I.s

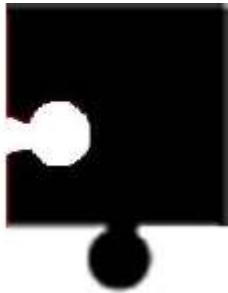
- Space per person
- Space type - cellular or open plan(present/previous)
- Lighting Control
- Temperature Control
- Ventilation Control
- Blind / Shading Control
- Environmentally responsive workstation
- Furniture – New /Old
- Workstation adjustment / design
- VDU, mouse and keyboard type
- Storage space
- Personal storage space, Drawers / Clothing
- Pin-up space
- IT/ Power provisions
- Service Centre Provisions
- Time-out Facilities

Facilities Management K.P.I.s

- Building commissioning and handover procedures
- Building user guide
- System complexity
- Staff training
- Fine Tune / Continuous Commissioning
- Post-occupancy evaluation
- Operating regime
- Maintenance regime
- Complaints procedures and response times

Physical

Building, Facilities and Services



- Location of Space
- Quantity of Space
- Efficiency of Space
- Physical Quality of Space
- Connectivity of Space
- Flexibility and Adaptability of Space
- Layout and Organization of Space
- Servicing of Space

Motivational

- Recognition
- Job Satisfaction
- Responsibility Level Trust
- Work Interest / Opportunities
- Relationships
- Working Conditions
- Work / Life Balance
- Career / Skills Development
- Culture of Organization
- Personal Life
- Job Security
- Remuneration

Short, Medium and Long Term HR Strategies

The highest level of Maslow's Hierarchy of Needs

Design Stage Productivity Analysis Tool

Physiological



Cognitive

Physical



Simulation Slice

Internal Zone



Perimeter Zone



External Environment



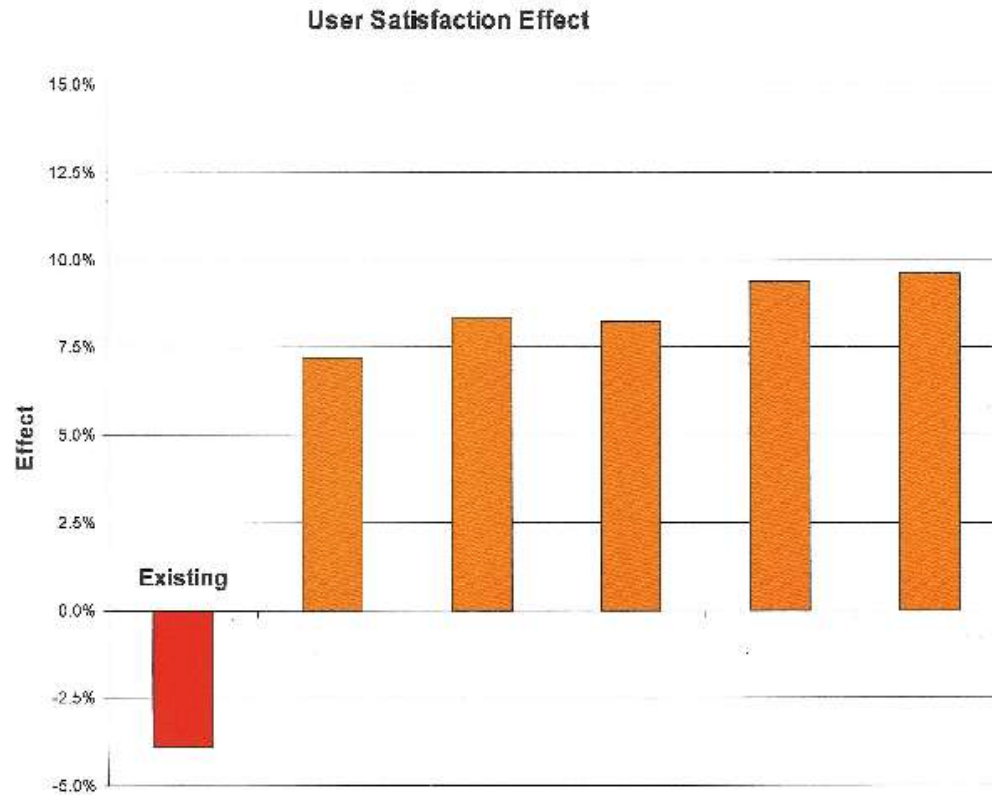
Façade

Attributes Analysis Ranking and Weighting Spreadsheet

Score your building by marking

	Really good example	As per standards	Poor	Weighting	2	1	0	-1	-2	Score	Weighted score
Visual Quality											
What percentage of working area can use full daylight?	100%	80%	60%	5	x					1.6	8
	50%	30%	0%								
What percentage of the working year can the building rely on daylight?	85% and over		Never		80%						
Quality of light	Diffuse southern sky and northern façade		Unshaded eastern and western façades	2		x				1	2
Glare issues	DGIs < 18; GIs < 13	DGIs < 22; GIs < 19	Pass the sunglasses (DGIs & GIs >= 28)	4			x			0	0
Light shelves and shading	Designed to maximise daylight	Shading for mechaical heat load reasons only	Nothing	1		x				1	1
Awareness of outside	All occupants have a view	50% of occupants have a view	Windows are for light only and are too poorly placed to see out of.	3		x				1	3

Use as a comparison tool for choosing new office accommodation



Case Study – Meridian Building

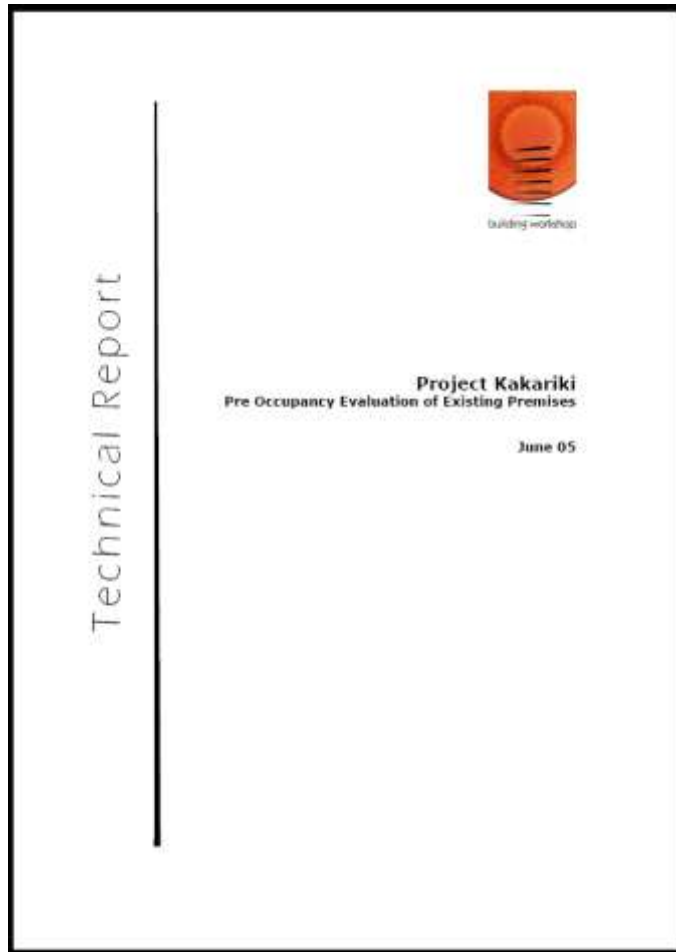


•Meridian's Strategic Framework

- Building had to be a physical embodiment of Meridian's business and outlook

Vision	Cost effectiveness	User experience	ESD
Goals	Demonstrate the value of ESD in a commercial context	Create a healthy safe and exemplar office building as a point of difference	Leverage our building to align with our brand and Renewables Strategies
Objectives	Total occupation cost neutral or better compared to a conventional (non ESD) commercial office development over a 20 year period	Office environment that improves user satisfaction to at least +5% A “wowness” factor	Energy usage of 80kwh/m ² /pa – 31kgCO ₂ /m ² /pa Water usage of 0.16m ³ /m ² /pa 4 ½ + Green Star
Defining Aspects	Cost Programme Commercial terms	Working Environment Indoor Environment Quality Aesthetics Amenities	Energy Efficiency Water Conservation Materials Management & Operations Star Rating

• 'Pre-Occupancy' Evaluation



- Created benchmark
- Internationally recognised
- Attempts to measure:
 - Working Environment
 - Staff Satisfaction
 - Productivity
- 63 seven-point questions, in 12 areas of building performance

Post-Occupancy Evaluation



eCubed Building Workshop Ltd

The Meridian Building, Wellington
Post Occupancy Evaluation

27 November 2018

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website
www.ecubed.co.nz

email
enquiries@ecubed.co.nz

- Completed after the first summer and winter seasons
- Used the same methodology as the earlier 'pre-occupancy' study

Post Occupancy Evaluation

- A survey of occupants views or experience of the building they use
- Can be either qualitative or quantitative depending on the type of survey
- We use a licensed, standardised survey from Building Use Studies (UK)
- Essential from a design point of view for 'closing the loop'

2yrs of Aftercare

- Continuous commissioning process with quarterly reviews
- Compared performance with targets
- Post occupancy evaluation completed after a full years occupancy
- Performance based lease discussed but not taken up

•Continuous Commissioning

Report

Site 7 Kumutoto ESD Outcomes
Quarterly Reporting April 2009

Prepared for Mallard Cooke Ltd (Client)

By Beca Carter Hollings & Ferner Ltd (Beca)

28 April 2009

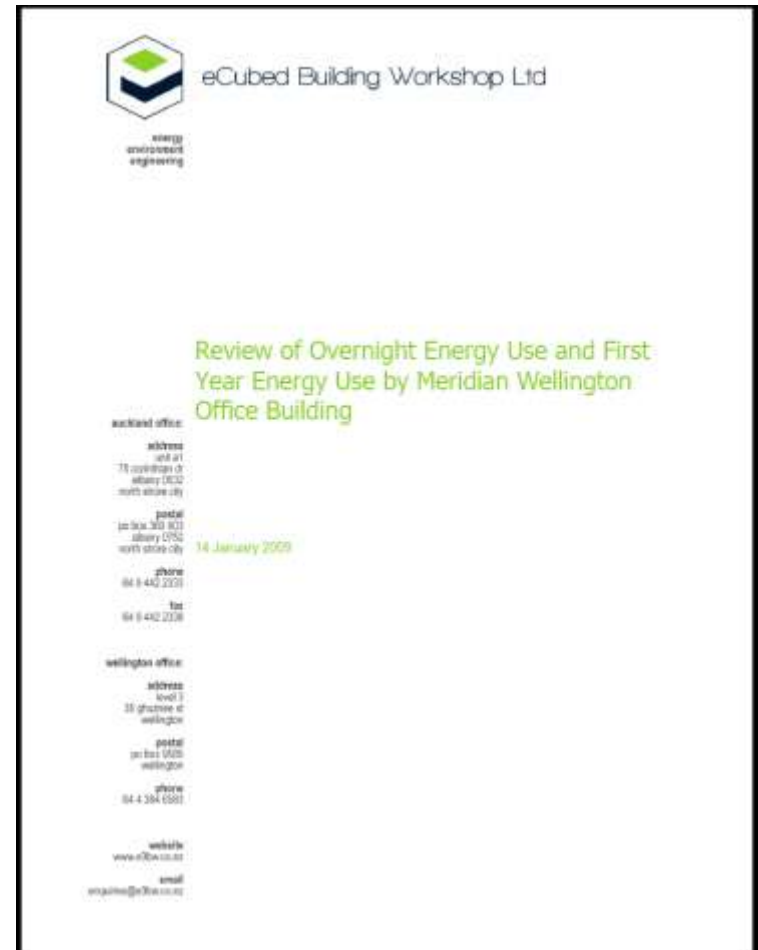
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- Quarterly Reporting since occupation
- Energy
- Water
- Base Building
- Tenant
- Compared against targets

•Continuous Tweaking

- Occasional issues arose
- Building usage and conditions were constantly changing
- Changes needed to be incorporated into the building systems



Before and After

Figure 9 - Building Comparison

<i>Variable Name</i>	Old Buildings	New Building	New Zealand Benchmarks (Copyright Building Use Studies 2007)	International Benchmarks (Copyright Building Use Studies 2008)
Temperature in Winter Overall	4.54	5.00	4.21	4.72
Temperature in Summer Overall	3.84	4.92	4.03	4.29
Noise Overall	3.72	5.11	4.24	4.62
Lighting Overall	4.70	5.10	5.10	5.02
Comfort Overall	4.32	5.67	5.67	5.67
Health	3.69	5.03	3.55	3.97
Forgiveness (-1 to +1 Scale)	1.04	1.12	-	-
Overall Rating (Selected Variable Method)	66/100	100/100	-	-
Perceived Productivity (-40% to +40% Scale)	-6.37	8.96	-2.69	3.45

Meridian POE Results

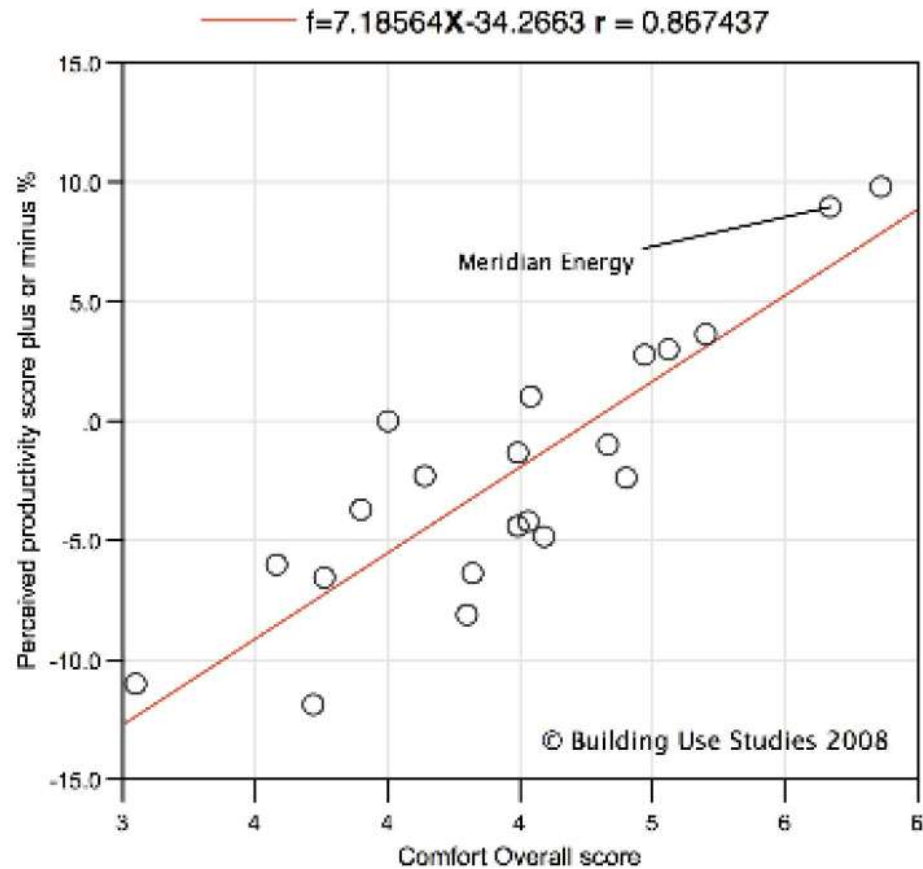


Figure 1 - Comfort Vs Productivity using New Zealand Benchmarks

Meridian POE Results

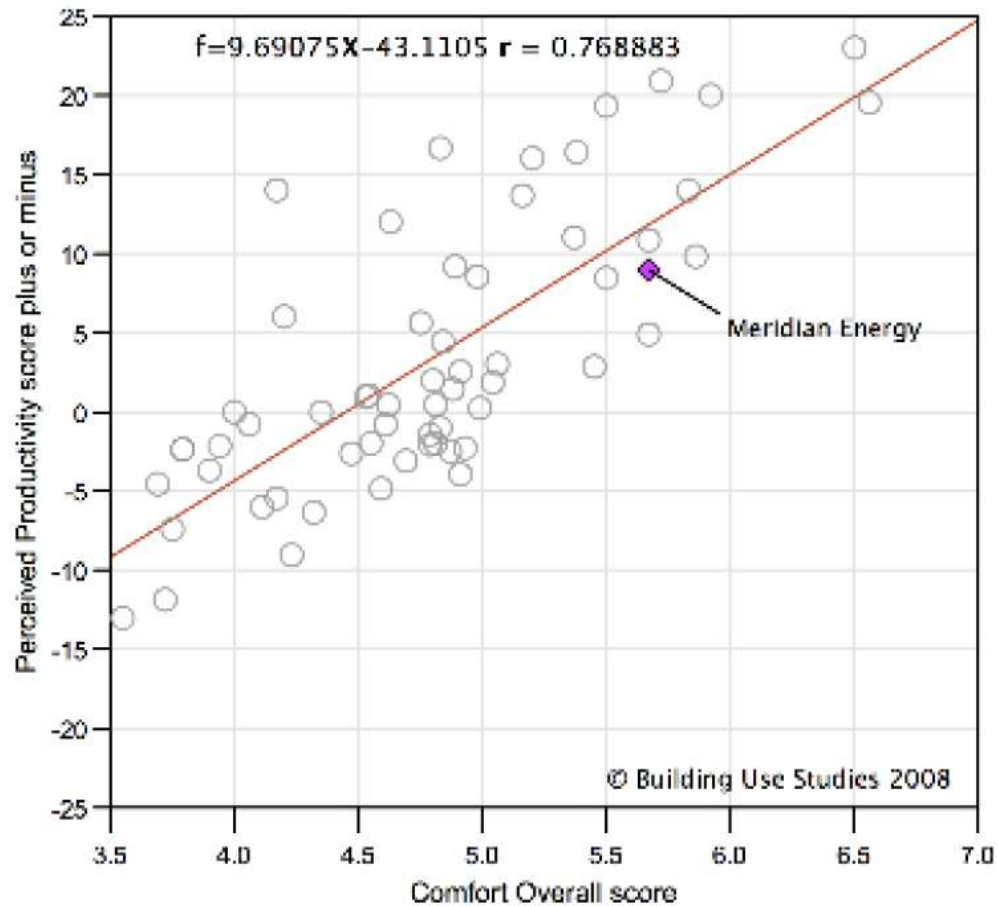


Figure 2 - Comfort Vs Productivity using International Benchmarks

Some Conclusions

What makes an productive building

- Pleasant internal environments
- Reasonable outside awareness(interior views to atria and streets can sometimes count)
- Not too hot in summer(but not within tight band if occupiers have some autonomy)
- Not overcrowded, not too noisy or too quiet
- Some personal control (or good facilities management)
- Responsive cooling and ventilation systems
- Effective and unresponsive facilities management
- Openable windows (Usually).

What makes an unproductive building

- Poor internal environments
- Poor outside awareness(remote from windows)
- Hot in summer(and sometimes winter too)
- Overcrowded (and often noisy)
- Little personal control (in where to sit too)
- Unresponsive cooling and ventilation systems
- Poor and unresponsive facilities management
- Natural ventilation systems, both old and new.

What does a 10% productivity gain really mean

- 10% less staff?

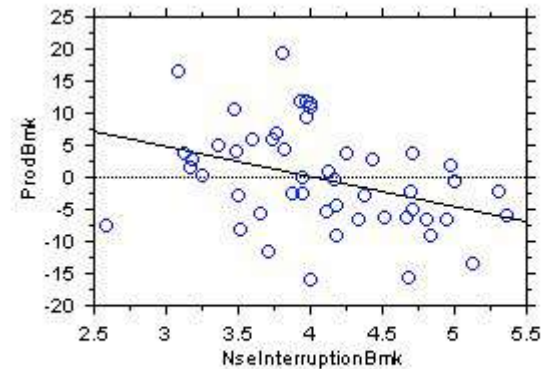
Or

- 10% less non productive time?

And of course, we now also live in a real and virtual world



- Interruptions lower productivity



$ProdBmk = 18.839 - 4.663 * NseInterruptionBmk$; $R^2 = .137$; ; $p=0.0082$

If we get things right then the economics of green buildings are quite compelling

An integrated workplace solution offers:

Workplace Location, Accessibility and Identity	No direct cost benefit
Workplace Efficiency	\$25-60/m ²
Workplace Environment	\$40-50/m ²
Workplace Sustainability/Affordability	\$10-15/m ²
Total Benefit	\$75-115/m²

The above benefit has the potential to add in the order of 6-9% to an organisation's profitability.

‘There are only green buildings,
damned green buildings and
statistics’

Adapted from Mark Twain