INTRODUCTION

Our understanding of urban form depends on how we perceive the city. Much of the literature on urban form (1) has focused on the pre-industrial and industrial city, celebrating its compact form, contiguous functions and single dominant centre. More recently writings by Castels (2) and Soja (3) have described the dispersed, city of the post industrial era. This networked city triggered by the freedom afforded by the new technology (4) has exposed a new dimension to urban form. The model of the compact city advocated by those such as Lord Rogers Task Force for delivering the Urban Renaissance (5) is being questioned (6) and a new model of “high density nodes, in a high density landscape resulting in a low density city,” as in the Deltametropolis, described by Dirk Frieling (7).

Compactness, cramming more development into the city and making public spaces of a higher density and quality, Rogers and Burdett argue (8) will make “urban living attractive, ecologically sustainable, economically strong and socially inclusive.” The alternative argument is that the economic success of cities is reliant on the networking of resources across a metropolitan region. Echenique argues (9) that cities disperse in their search for mobility and space. “Mobility increases the efficiency of households and firms which in turn generates more income and profits. As income increases, so does the demand for space, residential and commercial alike.”

Sustainability has become the current banner of political correctness. Sustainability however is a slippery word. It is easy to focus on one aspect and lose the value of its holistic meaning. For many architects “green buildings” equals a sustainable future. However, clever design solutions single-mindedly pursued with little regard to the wider exploration of the potential environmental savings that may be achieved through organisational innovation are only half the answer. A holistic approach concerned with both building and organisational design and focused on ““lean thinking” (10) could make considerable inroads into reducing the ecological footprint.

The paper draws on DEGW’s experience of advising major corporations and cities on strategies for managing the process of intensification and change (11). It explores how major improvements might be gained in meeting our goals for the sustainable city through reconsidering the way we work and allocate space. The underlying proposition is that technology has offered us new opportunities which have changed our paradigm of living and working. This in turn has provided us with a new perception of the city, as a distributed series of high density centres connected by good public and private transport, within a low density landscape. The paper argues that considerable improvements in workplace sustainability can be achieved by applying a holistic approach. These may include a combination of strategies, from rethinking the organisation of work processes and the locations and time work is undertaken, to reducing the need for resources by a more intensive use of land and floor space. Disjointed, dispersed “urban sprawl” can be wasteful. The alternative emerging urban form is a planned, dispersed, “networked” city with well integrated public and private transport yields greater choice of location and lifestyles so supporting, social, economic and environmental sustainability.

KEYWORDS

Au: Please supply a few key words from the paper.

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CHANGING CONTEXT

Information and communications technology over the last twenty five years has transformed the way we undertake and accommodate business. Whilst the change has been incremental the effect over the period is that we are faced with a new paradigm of work. Work can now be undertaken, both face to face in physical locations and virtually, where ever may be most convenient. Organisations are networked across sites and political boundaries to harness ideas and intellectual talent. Technology has offered us choice and diversity in living and work style. The boundaries between what is work and what is pleasure have blurred. Innovation is fostered by “serious play” (12) and leisure as we sweat it out on the treadmill at the local fitness centre has become hard work. The new technology has the ability to both shrink physical space, with a simulator reproducing in 10 sqm, what could have taken a hectare of site in the past, and expand the experience in real time across continents. The football world cup was a passionate experience for vast audiences around the world as they donned their tribal paint to watch their team on the big screen in their local pub. Kevin Kelly, founding editor of Wired magazine, in his book Ten Rules for the New Economy describes a world in a networked economy where value is created by abundance not scarcity, you give to get, collaborate to compete, change is the norm and process dominates the product (13). The challenge of the twenty first century is to embrace paradox. Complex problems in the past were invariably resolved through a binary approach of simplifying the solution to one approach or the other. Today most solutions are seen to embrace and reconcile often conflicting desires. Our workplaces need to accommodate both privacy and communality and our cities are both concentrated and dispersed. It might be argued that in the past environmental sustainability has taken the stance of being binary in its approach, with a single minded concern for the mechanics of energy conservation at the expense of a more holistic approach.

Andy van den Dobbelsteen a lecturer at the Technical University Delft, in his Doctoral dissertation (14) argues that the reasons for the poor current performance of the building industry in meeting the challenge of major improvements in energy usage is that the industry has focussed on small scale, ineffective technical solutions. He argues that major improvements in sustainability will be achieved by more than just technology. To achieve a factor 20 improvement will require a paradigm shift that in addition to the green building technologies already being pursued is prepared to explore; new typologies for communities and buildings; prolonging the life span of buildings; optimising the use of space and embracing new ways of living and working. Van den Dobbelsteen began his dissertation on The Sustainable Office by being firmly focussed on “green architecture” but by the end had realised that a more holistic approach starting from a reassessment of the way work is organised was more likely to lead to a step change improvement in office sustainability.

DISTRIBUTED LIFESTYLES IN A NETWORKED CITY

Technology has changed the way we live, work and use space (15). New “flexible” ways of working have emerged which are:

- Open, flexible and collaborative
- Non hierarchical with a largely autonomous, professional workforce
- Cross disciplinary in response to traditional silo thinking

Successful firms today are focussed on managing both space and time to allow for parallel working often across time zones. Functions are overlapping with a shared use of space in a wide variety of settings. The outcome is not only to reduce overheads through the use of less resources but improved organisational productivity through increased collaboration, resulting in greater innovation and a rise in staff satisfaction. Organisations are becoming networks of direct and indirect relationships. Cisco describes itself as a value network that includes “competitors, strategic partners and standards groups, all with whom the company never exchanges money or tangible goods. Cisco estimates that its intangible exchanges outnumber tangible exchanges by two to one.” Cities like the organisations they host are also changing from single centres to a series of centres in networked conurbations.
Our perception of cities takes a variety of parallel forms:

- The *city of our imagination*, is a virtual collection of experiences; Venice for pleasure, Boston for learning and Tokyo for intensity.
- The *city of convenience*, where we are prepared to travel anywhere within the dispersed conurbation that will provide the best value, service and convenience.
- The *city of place* a high density, easily accessible, distinctive place of character, within which we can walk between a diversity of functions. This fragment of a city is for many of us how we perceive the city. New York is far larger than Midtown Manhattan and Greater London more than Regent Street.

Cities are becoming “splintered” (16) across a network of centres. Copenhagen a city of half a million is now part of the Oresund a far more powerful economic conurbation of 3.5 million inhabitants straddling two nations, whilst the Helsinki conurbation is a network of 1.2 million population with a number if distinctive centres. The discourse on urban form is frequently framed as centre versus periphery rather than recognising that it can be both central and dispersed, each defining their appropriate strengths linked within a networked conurbation.

Virtual and physical spaces are becoming complimentary. Bill Mitchell puts the paradox succinctly, in *City of Bits* (17) when he says of future work styles “We will gravitate to settings that offer particular cultural, scenic and climatic attractions. . . . Sometimes we will network to avoid going places. But sometimes still, we will go places to network.” Location takes on a new significance in the dispersed city. Significant places in the wider conurbation are growing up at locations that are, simultaneously:

- **Hubs:** Interchanges with different modes and levels (local, regional, International) of transport
- **Nodes:** Mix of functions—with overlapping functions over at least sixteen hours.
- **Places:** A memorable gateway—accommodating a distinctive range of symbiotic functions.

In many organisations the place of work for many of their staff may be spread across a variety of locations, in different settings. Work might be undertaken at home, in the train, at a hotel, in the client’s office, at a company satellite office, in addition to at the office that might be “home base.”

**THE ARGUMENT FOR SPATIAL DISPERAL**

In 2003 DEGW Asia Pacific undertook a study for ANZ bank on the opportunities for distributed working. In the study a workplace survey of management and knowledge workers showed that more than half the respondents would like to work from half a day to two or more days per week at home. From these findings DEGW assessed alternative options for distributed work that allowed: A choice of diverse work settings both within and outside the office; the use of technology to support the way people wished to work, and a respect for the individual. The conclusion was a distributed virtual campus that was located in the CBD with suburban offices and touch down spaces at retail branches. Additional time would be spent working in transit, from home and at hotels. Compared with the portfolio of buildings they currently held or a strategy of one single campus the virtual campus was perceived to be low risk and more flexible.

Space is an increasingly valuable resource which is dramatically underutilised. On average our office buildings are only used for 10% of all the hours available in the year. And within these “office hours” studies show that on average an individual’s desk is occupied of less than 50% of the time available. This underutilisation is compounded by the least used desks being those of the most senior members of staff who have the highest space allocation per person (Figure 1). With the take up of new ways of working, organisations are exploring alternative means of allocating space, with less space to the individual and more to shared settings, dispersed across a variety of locations. In the Netherlands 21% of the working population work at least one day a week from home, the comparable figure for the national financial services company found that of those surveyed 70% chose to be “mobile.” The momentum for remote working building rapidly. The Office of National Statistics latest figures show that 3.2 million of the working population work all or part of the time from and that number is increasing by quarter of a million
each year. CBI figures show that 14% of its industry members (250,000) now offer employees the option to telework. The impact of the home as a focus for work is even more sharply indentified with the fact that today over half new start companies are founded from home. Cheap computing and ease of connectivity has dramatically reduced the cost of starting in business. Geographical centrality is no longer an essential. Work can now be located where ever it is most convenient, amendable and cost effective.

The Randstad a conglomeration of fiercely independent cities at the heart of the Netherlands is a “low density city in a high density landscape” (Freiling 18). The metropolitan conurbation is a community of 6.5 million including the major cities of Amsterdam, Utrecht, Rotterdam and the Hague and one “inner city” international airport, Schiphol. It is spread over a land area similar to greater London and yet is only 45mins within central London. The Randstad exemplifies the polycentric city, combining both compactness and diversity and integrated by a network of overlapping communications systems (Figure 2).

Space has shrunk in terms of time. Average travel times to work vary little for the suburban or central city household (19). With improved virtual and physical communications we no longer need to be in physical proximity “to gain access to information, culture, recreation or work.” The dream of living,
and working in the same geographical neighbourhood has been discredited as we recognise that we change jobs on average every 5 years and that family households may have three working members each generating a work trip at a different time to a different destination. Global city comparisons show that the lowest density cities have the highest GDP per capita. A well serviced dispersed polycentric city region allows functions to locate in the most costs effective locations, a wider range of choice for the consumer and greater buying power. There is a direct relationship between mobility and wealth (20).

THE EFFECTIVENESS OF DISTRIBUTED WORKING

The triple bottom line benefits of distributed working are recognised to be at the:

- Level of the Individual; the opportunity to blend living, working and movement, so optimising the use of time, enhancing the experience and increasing choice
- Level of the Organisation; freeing up assets and by so doing liberating capital to be invested into new ways of interacting and support innovation.
- Level of the City; increasing choice, supporting triple bottom line sustainability and re-envisioning the paradigm of the city

A recent survey by DEGW for a financial services company which measured the impact of new ways of working showed (Figure 3):

- Greater individual productivity through; a combination of less individual downtime and increased focused concentration
- More productive group collaboration through; fewer formal meetings, more spontaneous interaction, more cross group interaction and less group downtime
- Better staff retention through; increased staff satisfaction with the perception of a better work-life balance
- Real Estate savings through; a reduced floor space demand

FIGURE 3.
Companies are recognising the business benefits and sustainability gains of using space more intensely over longer periods of time by; overlapping uses, sharing facilities, and allowing for flexible working. Companies are achieving major savings in the use of resources by reconfiguring their real estate portfolios to provide a combination of tenure and accommodation types as:

- **Core space:** owned or on very long leases, that reflects the values of the organisation or accommodates specialist functions, typically this might only be 20–30% of the total portfolio
- **Flexi space:** generic space on short term leases suitable to accommodate projects which grow, change or are terminated, say 40% of the portfolio
- **On-demand space:** Facilities shared by others in the neighbourhood. Contracted out functions or facilities on short term hire.

**MEETING THE SUSTAINABILITY AGENDA**

The protagonists against the networked city perceive it as an endless, low density, placeless, sprawl, which “devours the countryside” requires expensive infrastructure and increases the number and length of journeys. The advocates for dispersal recognise that the increase in mobility for people and goods may increase infrastructure costs but also improves efficiency and thus income. (Echenique). Solutions the recently completed EPSRC funded research project led by the University of Cambridge, Martin Centre (21) point out that whilst 80% of the UK population live in cities and towns of over 10,000, these only cover 7% of the land.

With greater mobility allowing the freedom to choose when, where and how we work, the flexible use of resources can intensify space utilization and drive down per capita energy related emissions. A recent study undertaken by DEGW in North America (22) compared a traditional workplace solution for 640 staff each with their own workstation with a flexible approach for 400 assigned desks and 220 touch down spaces. The flexible approach accommodated 210 additional people, and showed a saving of 2,000MT of CO₂ per annum, the equivalent of 3.9 metric tons of CO₂ per annum. Conclusions from this study have shown that in a comparison of conventional open plan and remote working combined with flexible workplaces; Flexible working scores highest in cost savings, increased productivity, satisfaction and greenhouse gas reductions. (Figure 4)

Sustainable design has inevitably been viewed by the architectural profession as new and innovative design. It has been less well understood as being about increasing the effectiveness of existing resources. Womack and Joneses book on Lean thinking is sobering reading on how much waste is built into most systems and the opportunities that exist to increase capacity by the more intensive use of what we have already. Significant improvements in utilisation can be made by the more effective use of space, time and technology through the overlap of use and integrated thinking to establish synergies with the application of appropriate hybrid solutions that address the combined issues of economic, social and environmental sustainability. From my personal experience of advising both cities and organisations, four major opportunities for improvement are apparent.

**Intensification of use:**

Our desire to measure success through economic growth fuels a desire for new construction whilst at the same time with careful husbandry we have huge spare capacity in the buildings and infrastructure we already have. For an architect or engineer it is far more challenging to build afresh and answer the most complex of needs than to husband what already exists and search out the low key, simple solution. New building places a significant impact on resources, not just on the building site but in transportation, sourcing the materials, manufacturing...
Components and waste disposal. Dobbelsteen argues that by designing for long-lasting, multi-functional buildings the environmental load of building materials could be reduced by a factor of 30.

In 1998 DEGW Twynstra were asked by Shell international to provide a new learning centre for the training of senior managers from Shell worldwide (23). The Brief was to provide a residential venue for three-day courses within forty-five minutes of Schiphol Airport to be available Monday to Thursday evening, and not for 8 weeks in the summer when most managers would be on vacation. The solution was a deal with Holiday Inn whose peak times of use were the weekends and the summer holidays. It was a perfect fit and maximized the use of the facilities. When Shell were in residence the space was personalized by the use of projected logos, hinge down room names with Shell branding and a new built small auditorium which was used at the weekend as a cabaret theatre. Both parties gained, space use was intensified, and five years later Shell have been able to move out as planned to a long term facility, with the minimum of wastage. It was not iconic design but a model of sustainable thinking.

In 1992 DEGW was commissioned to advise BAA at Heathrow airport on the brief for a new flight connection centre to serve the central terminal area. Passenger numbers per annum at Heathrow had grown dramatically since the airport was founded in the early 1950’s. By 1992 the number of passengers had risen to 45 million of which only 9% were transfer. The airport had reached capacity for landing and take off slots and the capacity to allow for vehicles to enter and leave through the only tunnel available to the central terminals areas was saturated. As an alternative, building additional runway capacity was ruled out. The alternate was to “increase yield.” Many of the flights at off peak periods were below capacity, but by airlines selling cheap interconnecting tickets for off peak usage, plane capacity was increased with no extra demand for runway space, the transfer passengers who stayed airside put no extra burden on the road access tunnel addition and disruptive construction work was minimised and the overall capacity of the

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<th>FIGURE 4.</th>
<th><img src="image1.png" alt="Functional optimization" /></th>
<th><img src="image2.png" alt="Open plan" /></th>
<th><img src="image3.png" alt="Remote work" /></th>
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<tr>
<td><strong>Changes to work</strong></td>
<td>Greater access to support spaces</td>
<td>Greater accessibility, natural light and energy</td>
<td>Option to work remotely part time</td>
<td>Work anywhere in or out of the office</td>
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<tr>
<td><strong>Changes to space</strong></td>
<td>More needed spaces, less waste</td>
<td>Lower partitions, more variety, team-based neighborhoods</td>
<td>Remote workers use unassigned space when in the office</td>
<td>Maximum variety with more informal settings &amp; specialized team spaces</td>
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<td><strong>Increased Satisfaction</strong></td>
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<td><strong>GHG reductions</strong></td>
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Source: DEGW
airport was increased. Between 1992 and 2004 passengers per annum increased from 45 million to 67 million, with transfer passengers increasing from 4 to 23 million per annum an increase of 86%, whilst transit passengers increased by a mere 14%.

Rethinking the way we act:
The story of Heathrow’s expansion shows clearly how capacity can be dramatically increased if a company is prepared to think creatively outside the confines of the expected construction solution. The success of the budget airlines has been through their willingness to reconsider the perceived demands of the passenger and by so doing strip out potential wastage, allowing the passenger to add back additional functions by paying for each service on an on demand basis. South West Airlines were the first airline starting in America to rethink the offer with a dramatic effect on profitability which has subsequently reinvented the airline industry. Such shifts in thinking are going to be required in construction if major advances are to be achieved in reducing the negative impact society has on our environment by 2040 (24).

Applying appropriate solutions:
Design may be defined as the appropriate, meaningful and elegant allocation of resources. In this context the term elegant being used in the way one defines an elegant mathematical solution.

Much of today’s design adds in features which have no real value but may just possibly be useful in the future whilst supposedly adding to the perception of value. In 1992 DEGW in association with Teknibank (Milan) published a multi client study on the Intelligent Building in Europe (25). The intelligent building movement, started in North America, grew out of the integration of building automation and integrated communications systems which were rapidly merging and becoming an independent revenue stream from the traditional sources of commercial office building income. The North American “intelligent” or “smart building” was rated according to the number of features it possessed. The more features the smarter the building. The Intelligent building in Europe redefined Building intelligence (Figure 5) as any building which “…provides a responsive, effective and supportive intelligent environment within which the organisation can achieve its business objectives.” Successful intelligent buildings it was argued rely on the provision of three layers of inter-related solutions:

1. Common sense; the provision of an effectively designed shell which has the flexibility to absorb information technology and adapt to growth and change.
2. The appropriate I.Q; sufficient IT applications to meet the needs of the immediate target market so as to reduce costs and improve performance in building, space and business management. An over provision of features for the context it was recognised could be counter productive, resulting in a “dumb” building.
3. Integrating technologies and services; which allow disparate organisations, systems, data and personnel to focus on the common goal of increased business effectiveness.

![Figure 5.](image-url)
In retrospect the definition of intelligence would have equally fitted that of a sustainable workplace environment. The definition encompassed, capacity to meet future needs, included appropriate attributes sufficient to meet current requirements, and provided a holistic integrating supporting structure.

**Changing perceptions:**

Yet another paradox of our lives is the way that change is both incremental and seismic. Imperceptibly a myriad number of small seemingly unconnected changes are daily occurring, which gradually are changing the expectations, mood and behaviour of a community. It takes a major event, such as Woodstock or the American eastern seaboard power cuts to trigger a paradigm shift. With events such as the Boxing Day Tsunami and Hurricane Katrina, global warming has risen in the public’s interest. Achieving our sustainability goals, I believe, will be as much about changing perceptions and so behaviour, as it is about technological prowess. The awakening is happening rapidly through an ever wider group of the population being exposed to alternative practice and seeing it can work. The growing recognition that “seeing and feeling is believing” has shifted the emphasis on publicising rather than hiding good practice. The reality of the relevance of alternative energy sources only fully came home to me when I flew over the wind farm near the Oresund Bridge and read that over 20% of Copenhagen’s power demands are now provided by alternative energy sources.

John Thackara in *In the Bubble; Designing in a Complex World* (26) suggests that in our infinitely complex world, designers have a role to play, by reducing complexity and making environments and products more understandable. He argues that “Things may seem out of control—but they are not out of our hands. Many of the troubling situations in our world are the result of design decisions.” These however he argues are often bad design decisions, and could be overcome. What an opportunity when you realise that 80% of the environmental impact of the products, services and infrastructure around us was determined at the design stage.

Van den Dobbelsteen in his study of sustainable offices shows how big gains could be achieved by a combination of factors (Figure 6) that encompass:

- Rethinking organisational structures
- Use of space at both the urban and building scales
- Building design in the choice of depth, configuration and height.
- Technical considerations, such as energy usage and service support.
- These in turn should each be addressed through time and designed for life

However, he recognised these could only be achieved with a parallel programme to change expectations, perceptions and behaviour.

![FIGURE 6.](source: The Sustainable Office; Andy van den Dobbelsteen)
CONCLUSIONS
The perception of the compact, dense and diverse uni-centric city as the model we might follow for a sustainable future is perhaps over simplified. I have argued that the sustainable urban form of the future will be both concentrated and dispersed. Compact nodes in a sub-urbanised landscape, connected by a network of interconnected public and private transport, and telecommunications. The essential features of the future sustainable city logically from what has been argued previously might be:

• More mobility, allowing for a flexibility and diversity of accommodation and greater choice of work style and location.
• Simpler buildings, which are flexible, more easily re-configured and adaptable to changing uses. Environmental systems will be less precisely designed more reliant on natural elements and “responsive” to personal demands and local conditions.
• More complex cities, which are difficult to comprehend as single entities, but act as highly serviced managed environments. The integrator will be multi-modal access across a rich diversity of amenities.

The challenge is to be prepared to rethink our approach to sustainable buildings by questioning the need for new construction and seeing it as the choice of last resort. The skill will be to search out redundancy by applying “lean thinking” through intensifying the use of space and time and recognising that changing the way we operate may have as great an impact as the innovative design solution. The answer may not be one action but a combination of actions applied responsibly.

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