The relation between ICT and space
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1. INTRODUCTION

The contemporary society is characterised by high dynamics and an expansion of economic, cultural and social activities to a global scale. One of the driving forces behind this globalisation is the current technological revolution, centred around ICT. ICT offers the infrastructure that is necessary to instantly exchange information on a long distance. Distance constraints can be overcome by minimising time constraints. (Graham & Marvin, 1996) Capitalism uses ICT to operate on a global scale, in real-time. Furthermore, the economy is focussed on information and information processing. Information is used to generate new information, knowledge becomes both a raw material as well as a product. Manuel Castells refers to this new economy as the informational economy. The notion *informational* refers to a specific social organisation in which information generation, processing and transmission become the fundamental sources of productivity and power. (Castells, 2001)

Both the concept space and time are subject to change, by the technological revolution. Alongside the historically rooted spatial organisation of the *space of places*, the *space of flows* has arisen, according to Castells. The *space of flows* refers to the technological and organisational possibility to orchestrate social practices simultaneously without physical proximity. The *space of flows* is described by three layers. The first layer consists of the circuit of electronic exchanges, the material support of time-sharing practices. The second layer is constituted by its nodes and hubs, which are situated in specific places linked up into the electronic network. The third layer refers to the spatial organisation of the dominant, managerial elites. Regarding time, ICT created a new kind of time, which is called *timeless time*. Timeless time tends to a complete negation of time. On the one hand this is expressed by the compression of time to nanoseconds. On the other hand the traditional sequence of time is disturbed: past, present and future appear in random order. The death of Lady Di can easily be revived, by viewing her funeral on tape. The mail-box gives the opportunity to check and receive e-mail, at a different point in time than when it was send. Timeless time belongs to the *space of flows*, while the *space of places* is still subject to the traditional biological and chronological time. (Castells, 2001)

Also the locational pattern of activities altered during the last decades, partly due to the technological progress. In the beginning physical proximity was necessary to overcome time with space. Cities have developed to make communication easier through concentrated physical development. Now an extensive network of roads brings every place within reach. Above that, telecommunications offers the possibility to have a real-time connection between distant locations. So space can be overcome with time. As a consequence the locational pattern of activities thus overcomes the restrictions of physical proximity. Both residential as economic activities diffuse. The city is not a well-defined entity anymore, consisting of a core and a hinterland, which can be seen as one, both in functioning as in morphology. A new, more diffuse urbanity has arisen.

This paper tries to reveal a part of the logic behind current spatial developments, by analysing the relation between ICT and space. Insight in this logic contributes to a better understanding of contemporary spatial developments and makes it possible for the urban planner to direct and possibly control future urban developments. An existing model by Graham and Marvin was used as a starting point. In the context of their findings, different theses are formulated, each of which illustrates one aspect of the interaction and the logic behind it. Some of these theses directly conflict with each other.

2. MODEL

In their book 'Telecommunications and the city', Stephen Graham and Simon Marvin try to capture the impact of telecommunications upon patterns of urban form. Graham & Marvin use the concepts *electronic spaces* and *urban places*, to describe the relation between ICT and space. Electronic spaces refer to spaces constructed 'inside' telematics networks using computer software. (Graham & Marvin, 1996) Electronic spaces are immaterial, invisible, intangible, virtual and abstract. Urban places refer to the built environment, the physical space. Graham & Marvin subscribe the thesis that ICT plays both a centralising and a decentralising role in the current spatial developments. However they state that this dichotomous model fails to grasp the complex and contradictory nature of the linkages. Their framework consists of four relations between *electronic spaces* and *urban places*: synergy, substitution, generation and enhancement.

Physical and developmental synergy means a co-evolution of *electronic spaces* and *urban places*. Substitution refers to the replacement of physical flows by electronic flows, and physical spaces by virtual electronic spaces. The relations wherein electronic flows generate physical flows, is captured by the relation generation. Enhancement effects express the potentiality of ICT to ameliorate the capability, efficiency and attractiveness of physical networks such as roads, railways and airline networks.

Both *electronic spaces* and *urban places* are descriptive concepts, which means they describe a phenomenon. Therefore they can be replaced by other concepts, without altering the relevance of the model. I therefore use the concepts *space of flows* and *space of places*, by Castells. These concepts are better and clearer defined, so that they contribute to a better understanding of the model. The *space of flows* captures the layered structure of what Graham & Marvin call the *electronic spaces*. The *space of places* refers to 'locales whose form, function, and meaning are self-contained within the boundaries of physical contiguity'. (Castells, 2001; 453) If both notions are combined with the interactions of Graham & Marvin, the following model can be established. (Figure 1)
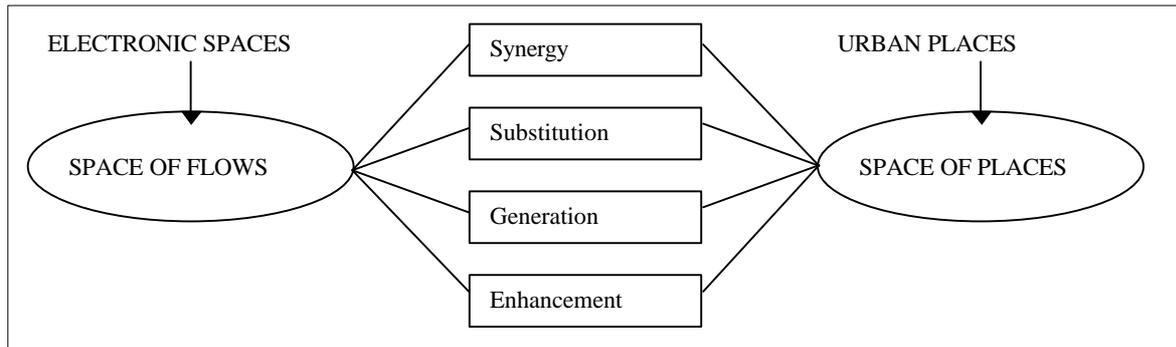
Figure 1: theoretical model that illustrates the relation between ICT and space

3. THESES

Within this framework different theses are formulated to capture the different mechanisms of concentration and deconcentration. Only when the logic behind those mechanisms is understood, urban planners can try to influence and direct the spatial developments.

3.1 Synergy

Telecommunications infrastructure is concentrated is cities

The current telecommunications scenery is characterised by two important evolutions. The first trend is the shift away from national monopolies towards the liberalisation and globalisation of telecommunications regimes. In the second place, the telecommunications market is characterised by a strong growth of the fiber optic networks, which are being considered as the fastest transmission medium. The construction of these networks is very expensive. Both tendencies inevitably lead to a concentration of telecommunications providers in the most profitable areas and markets. A preceding market research determines the routes along which the fiber optic is placed.

Figure 2 shows concentration of domain names in Europe. The highest number of domain names is found in big cities, such as Londen and Paris.
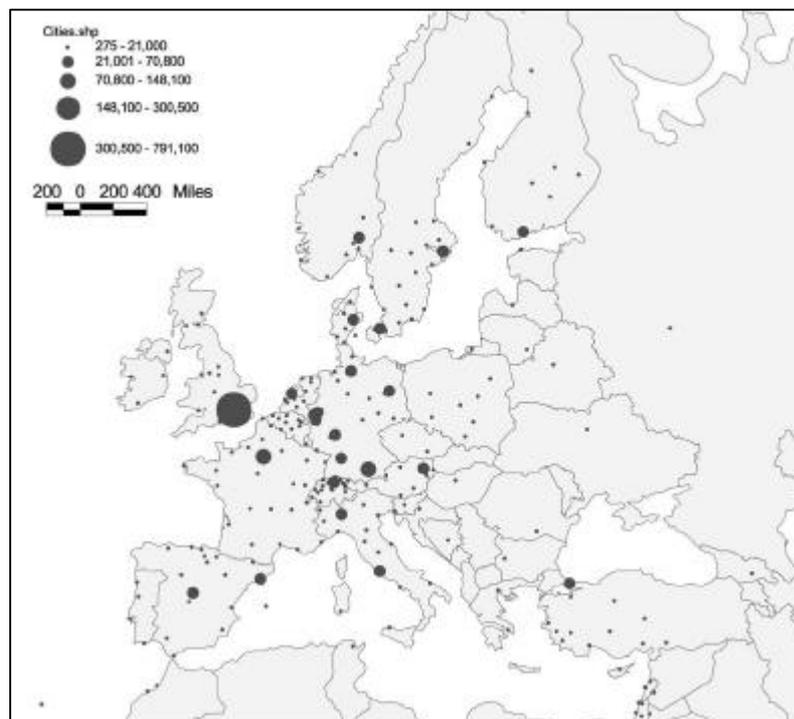

Figure 2: The number of domain names

Source: http://ist-socrates.berkeley.edu/~zook/domain_names/

Figure 3 shows the European network of Colt Telecom. Again the big cities are shown on this map and connected to each other with an international internet backbone.
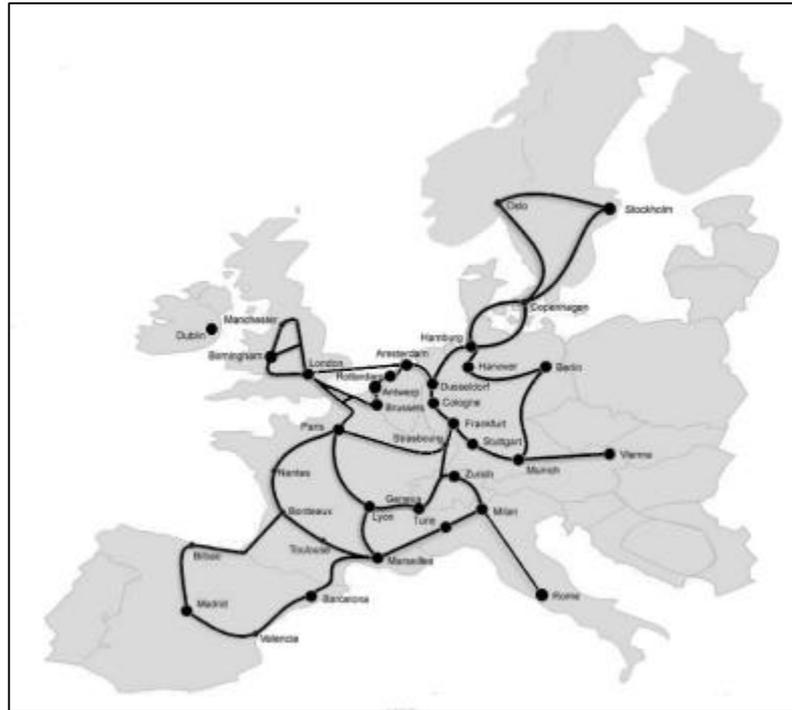

Figure 3: European network Colt Telecom

ICT-infrastructure follows at present the current urban pattern. The nodes of the network are situated where there are concentrations of economic activities with high telecommunications spending expenditure. Most telecommunications traffic is concentrated in the cities and attracts telecommunications networks. Although further geographical sprawl has been made possible by new communicationtechnologies, there is a clear preference in location by the hardware of telecommunications for urban regions, which have a large amount of information-exchange through telecommunications. In other words, the *space of flows* clings to existing nodes in the *space of places*.

Nodes of telecommunications networks have a centralising effect

Also the reverse is true. Telecommunications nodes attract information-intensive business. This is a result of the structure of the World Wide Web. The closer one is situated nearby the so-called Internet backbone, the faster information or data can be transmitted. The Internet has a hierarchical structure where the Internet backbone has the highest bandwidth. It connects the Internet exchange points, situated in strategic places, where data is exchanged between different networks. A location near an Internet exchange point offers the highest transmission-speed and quality.
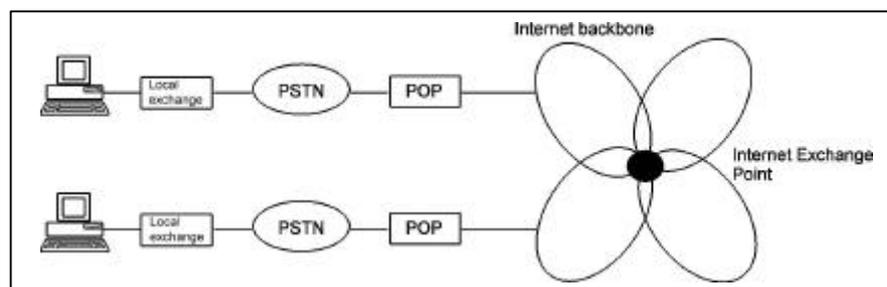

Figure 4: The hierarchical structure of the internet

A good example of such a synergy between information-intensive activity and the Internet exchange points is Zaventem. Zaventem houses the Belgian National Internet eXchange and also possesses a high concentration of ICT-industry. (IDEA Consult, 2001) The same trend occurs in Amsterdam, near the Internet exchange point. Recently the American E-commerce company Cisco Systems has located her new European headquarters in Amsterdam. (VROM-raaad, 2001)

The concentration of information-intensive companies attracts investments in telecommunications infrastructure that on its part attracts new companies and strengthens the concentration of information-intensive activities.

Telecommunications infrastructure adheres to existing infrastructures

Another form of synergy between ICT and space is the parallel layout of telecommunications infrastructure and other existing infrastructures, such as pipes, highways and roads, metrolines, ... The most illustrative example in Belgium of such a synergy is the fiber optic network of the national railroad company along its railways (Figure 5). Recently this network has been opened up for external users.
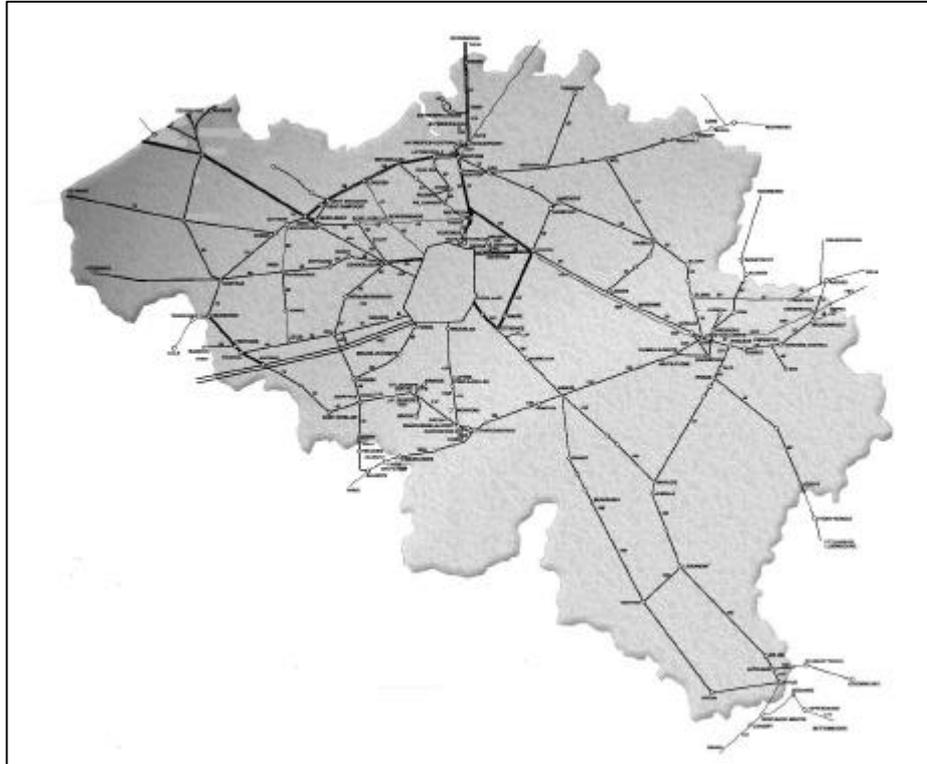

Figure 5: Optical fiber network, national railway operator Belgium

In the UK, Mercury, the second largest telecommunications company, laid their city of London network within an old network of hydraulic ducts that underlies the main financial district. (Graham & Marvin, 1996)

Cities are the command centres of the new economy

Despite of the possibilities of ICT to spatially spread functions, cities still fulfil an important role in the location of companies and other economic activities. Moreover, cities become the command centres from which the dispersed networks are being co-ordinated and controlled.

There are a few different reasons for the concentration of strategic parts of the economy in big cities: the still remaining need for face-to-face contact and thus physical proximity when strategic decisions have to be made; the spread of the production process world-wide which generates a demand for centralised control; and the supply of centralised high-quality services and financial centres through which the global flows of capital can occur and be co-ordinated. (Graham & Marvin, 1996) The traditional benefits of an urban region still remain valuable. However a new dimension has been added, namely the presence of a high-quality telecommunications networks. Not all cities benefit from this trend of concentration. Only those cities who offer a concentration of specialised information and where the exchange of this information can both occur electronically as face-to-face, can strengthen their position in the new global economy. Communicative multimodality becomes one of the powers of conurbation.

This multimodality is well illustrated by the developments in the Tribeca district in New York. A concentration of small companies in digital design, multimedia, computing, communications, etc. is established in old, relatively cheap, warehouses. The need for on-going face-to-face contact, to sustain continuous innovation and reflexivity, is closely combined with exceptionally high use of advanced telecommunications. (Graham, 1999)
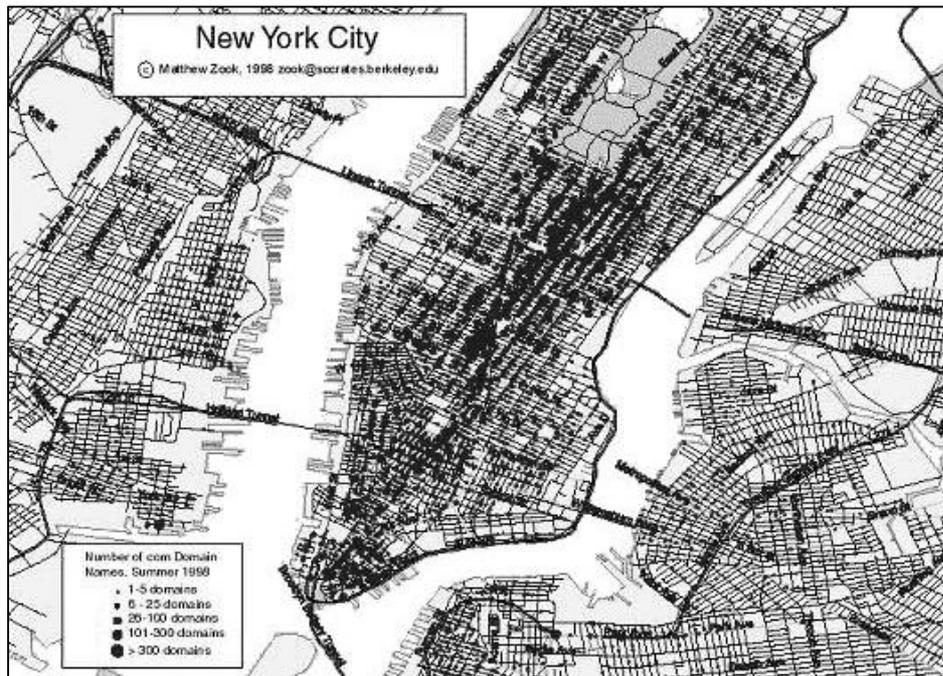

Figure 6: Number of .com Domain Names, New York, summer 1998

Source: http://ist-socrates.berkeley.edu/~zook/domain_names/

ICT strengthens the existing polarisation

The freedom in location that ICT offers, by reducing distance and time is not omnipresent. Telecommunications networks are characterised by a geographical inequality. Telecommunications is not a universal service anymore, as was the case with the national public telecommunications monopoly. Polarisation and fragmentation replace standardisation and equalisation. Some places have a high-quality network, others do not. This strengthens the present polarisation between regions and cities.

3.2   Substitution

ICT leads to a dispersal of economic activities

ICT is capable of compressing time and space. The physical proximity of two segments of an integrated production process is not a necessity anymore. This has an influence on the locational pattern of companies. In some cases this leads to a growing sprawl of economic activities, depending on the activity. There is a distinction between back office functions and front office functions, where the contact with the customer is most important. Back offices both contain management functions as routine tasks. It is mainly these last ones that relocate to cheaper places or closer to (cheap) labor. The relocation of the 'call centre' activities of British Airways, where millions of calls from customers and travel agents about flight availability and reservations are handled, illustrates this. In stead of locating these activities in expensive offices next to Heathrow airport in London, they were moved to five sites. In spite of their dispersed location across the peripheral cities of the UK, they operate as 'one virtual single office', by means of ICT. (Graham & Marvin, 1996)

ICT offers virtual substitutes, the space of flows replaces the space of places

But also front offices can disappear and become virtual, when the interaction with the customer can take place via telephone and Internet. Such is the case with telebanking. The First Direct phonebanking operation of the Midland Bank UK, illustrates this. All financial transactions are made by telephone. This lead to the shutting down of 750 branches of the Midland Bank and the erection of one central office in Leeds. (Graham & Marvin, 1996) In spite of the fact that this telephone-service could take place anywhere, Leeds was chosen because of its location at the geographic centre of the UK and its local accent that showed to be the most understood and acceptable throughout the UK, because of its classlessness. This shows that specific local features still play an important role as locational factor. (Castells, 2000)

Such tele-activities, like telebanking, could reduce the demand for space and contribute to a reduction of displacements, although these effects are not unambiguous.

ICT changes the way we work and use space

Seeing that by means of ICT it is much easier to stay in contact with the office, many administrative tasks can be handled at home or somewhere else outside the office. This place and time independent working by means of ICT, is called teleworking. Teleworking can help reduce the commuter traffic and can result in a lower need of office space. But both these arguments can easily be refuted. Teleworking works best when it is limited to 2 or 3 days a week, since ICT can not fully replace face-to-face contact. Teleworking could stimulate people to move further away from their work, so that the total amount of kilometres per week remains the same.

Besides new office concepts seem to organise this recovered space as conference rooms and meeting places, so no reduction in office space is obtained.

Teleworking is not restricted to working at home. Telecentres are offices where employees of different companies can come to work. Every employee chooses the telecentre that is closest to home and best fitted to his needs. In Belgium there is a network of telecentres, named 'Televillage'. These offices are mostly situated in small cities or on the edge of big cities, nearby important infrastructures or railway stations and bus stops.

3.3   Generation effects

ICT generates flows of data

First these flows of data, although they are invisible, rise to the surface form time to time. Many satellite ground stations or telecommunications towers illustrate this. Sometimes those constructions are designed as an urban landmark, as opposed to the common infrastructural invisibility.

Second these flows of data demand a high power supply. Especially the so-called colocation centres, where data and hardware of different companies is stored. A power failure must be avoided at all times. The demand for such colocation centres, and thus energy supply, is high at the moment. In Silicon Valley this has lead to a waiting list for the building of a colocation centre. But also in Amsterdam the electricity grid threatens to be overloaded. (Infodrome, 2001)

ICT generates flows of traffic

There are many different causes for the generation of traffic by ICT. Virtual contact generates physical contact. Through email and Internet the network of contacts expands, even world wide, but the need to meet someone in person stays. So the distances that are being covered enlarge. With e-commerce goods are being delivered at home and traffic from producer to retailer is cut short. This leads to more displacements by lesser amounts. A recent Dutch research concluded that e-commerce will lead to a growing number of displacements: as far as business-to-business traffic is concerned a growth of 8% is expected, business-to-customer 4%. (Van kasteren, 2000) As already described also teleworking can generate traffic. And to conclude, a striking quote by Graham Bell, directed to his assistant the first time he spoke through the telephone 'Watson, come here'.

3.4   Enhancement effects

ICT optimises the efficiency of transportsystems

ICT is often used to solve problems, like congestion and traffic jams. ICT is then used to manage traffic in a way that more cars can use the same infrastructure. But ICT is also used to ameliorate the capacity of vehicles, for example car-sharing.

4.   THE SPATIAL LOGIC OF ICT

Considering all different theses, the relation between ICT and space, or between the *space of flows* and the *space of places*, proves to be very complex. Space and ICT interact in different ways and the results are not always unambiguous. The most important aspects of the spatial logic of ICT are summarised here.

The internal logic of the hardware of ICT leads to a geographical inequality. Telecommunications infrastructure arises where there are big spenders in telecommunications present. The Internet backbone connects existing concentrations of economic activities. The transmission speed of data depends on the route that has to be followed to the Internet exchange point. The route that has the least hops to the Internet exchange points and has the highest bandwidth, offers the highest transmission rate. Activities, which depend on such high speed and thus the availability of high-quality telecommunications infrastructure, establish themselves in the direct vicinity of an exchange point or Internet backbone.

The omnipresence of telecommunications infrastructure seems to be a myth. Telecommunications infrastructures spread out over the *space of places* and connect certain cities, regions, countries to the *space of flows*, while others are neglected. ICT strengthens the polarisation and fragmentation of space.

ICT both leads to deconcentration as concentration. ICT is capable of connecting different segments of companies, located in different places, in the same process. This allows activities to spread out. This increasing sprawl for its part generates the need for central control points. From central places, the whole networked global economy is directed and co-ordinated. These places are the big cities, like New York and London. Whether an activity tends to concentration or deconcentration, depends on the hierarchical position in the organisational network. The highest ranks, like decision-making and innovation, tend to concentrate. When face-to-face contact can be replaced by ICT, for example routine administration tasks; activities can easily be dispersed.

Face-to-face contact still remains an important aspect of communication. Therefore, the need for physical proximity does not disappear entirely. ICT does not lead to dissolution of cities. Only in some cases, depending on the kind of information that has to be exchanged, can ICT (partly) replace face-to-face contact. Communication is multimodal and functions best when physical and tele-communications complement each other. So there is both a need of spaces where meetings can take place (squares, cafés, conference rooms, ...) as spaces with a good telecommunications infrastructure.

When mobility and need of space are concerned, there are no net results yet. ICT both leads to a reduction as well as a generation of traffic. Teleworking could lead to a smaller need of office space, but then again it can lead to more conference rooms or bigger houses, each with a small office in it. In spite of the lack of net results, it is still useful to know the logic behind a possible reduction or increase of traffic or space requirements.

Finally, it can be stated that ICT both confirms the existing spatial patterns as disturbs it. Cities still fulfil an important role in the new economy. Their role as control centre and innovation milieu is strengthened by ICT. Telecommunications infrastructure connects existing concentrations of economic activities. Etceteras. On the other hand activities become more and more footloose.

Banks and shops move to cyberspace through e-banking and e-commerce. New nodes in telecommunications can arise and attract activities.

5. RECOMMENDATIONS FOR THE URBAN PLANNER

5.1 Spatial impact of ICT

A first recommendation states that ICT has a spatial impact. Not only has ICT a spatial component in the contemporary urban landscape, by means of technical infrastructure like telecommunications towers and colocation centres. But also ICT structures economic activities in their organisation and locational pattern. Economic activities and telecommunications infrastructure co-evolve: concentrations of information-intensive companies attract telecommunications investments and vice versa. The central role of cities is strengthened. New innovation milieus arise. Back office activities spread out. Teleworking may lead to a spreading of residential locations. The urban planner has to be aware of the impact of ICT on the locational pattern of activities.

However, ICT does not necessarily lead to a radical change in locational pattern. The traditional factors like accessibility, presence of labour, services, market, continue to play a decisive role in choice of location. These demands are still well satisfied in the city. Furthermore ICT has added a new dimension to these location factors, namely the presence of a high-quality telecommunications infrastructure.

5.2 Complex relation and case-specific approach

The relation between ICT and space is rather complex, which calls for a different, case by case approach. ICT may cause decentralisation as well as centralisation of activities. ICT substitutes physical traffic but also generates traffic. Depending on which activity is focussed on, there will be a different outcome, for example the difference between front office and back office activities. The model by Graham & Marvin tries to capture this complexity and can be used as theoretical frame within which further specific research can be done.

5.3 Integration of ICT-infrastructure

Cities and regions should pay attention to ICT, since ICT-infrastructure offers the base for an excellent position in the new economy. When a city fails to connect to the international networks of information flows, and therefore fails to connect to the global cities from which the world economy is directed, it will be left behind. So attention should be given to the construction of a good telecommunications infrastructure and the adoption of its use by its inhabitants. As every operator creates its own network, it is difficult for the city council to obtain a clear overview. The new concept where one firm constructs the network and sells it to different operators facilitates the co-operation between the city and this firm, instead of with many operators. Furthermore the city council should be informed about the spatial logic of telecommunications infrastructure: the creation of nodes, geographical inequalities, places with multimodal communication skills. The urban planner should assist in this process and try to direct the location of the infrastructure. Striving for synergy has to be an important aim. The location of the infrastructure should contribute to the desired spatial structure. Telecommunications infrastructure is only capable of strengthening the position of a city when it is supplemented with a network of meetingplaces where face-to-face contacts can take place. Places where both forms of communication can occur, have the ability to attract information-intensive economic activities. Telecommunications infrastructure should be implemented at those particulare places where these developments are desirable. In Belgium all big cities are already provided with numerous telecommunications networks. However there is yet an opportunity to navigate these evolutions in smaller cities, where there is a lack of network.

5.4 Layered structures and the space of flows

ICT transformed the fundamental dimensions of human life, namely space and time. Alongside the historically rooted *space of places*, the *space of flows* has developed, consisting of multiple layers. Alongside the chronological time, the timeless time arose. The urban planner has to consider this complex and multilayered reality. Attention has to be drawn to the visualisation of the *space of flows*. The *space of flows* attaches itself to specific places, which can be visualised. For instance the location of telecommunications networks and Internet exchange points. But also the flows of data, which circulate through these networks, can be visualised. 'Invisible' relations between places become visible this way. Every place is part of a bigger network that exceeds the scale of that place. The urban planner has to try to discover the position of a place in the network. The visualisation of these networks, or the *space of flows*, can be a valuable aid.

By considering the layered structure of space and time, and the visualisation of the *space of flows*, the switches between the different layers are discovered. The interaction between the *space of places* and the *space of flows* takes place in these switches. So the interaction between the *space of places* and the *space of flows* can be influenced in these switches. This interaction is the result of the lasting need for face-to-face contact in the *space of places*, alongside telecommunications. The communication process benefits from a multimodal communication. This is a task for the urban planner: discover what these switches could be and how they can be directed.

The Internet exchange point can be considered as such a switch. The ICT-industry is concentrated in the vicinity of this point, situated in Zaventem, Brussels. All the important telecommunications networks are present there, the airport is an important node in the international air traffic and there is a good accessibility by car and train. The synergy that is already present, could be strengthened. This place is connected to the national and international economy, to the local and the global.

Also railway stations can play a part as switch on a smaller scale. All stations are connected to the fiber optics network of the NMBS, the national railroad company and are accessible by public transport and car. The neighbourhood around the station of a small city, offers an ideal location for back office activities, satellite offices and telecentres. Meanwhile the local people can use the

telecommunications infrastructure like in internetcafés and electronic kiosks. When all this is combined with a high-quality public space and the presence of hotels, cafés and services, this neighbourhood can revitalise and develop into a true multimodal node in the city.

5.5   Use of concentrating and deconcentrating tendencies to ameliorate spatial structures

The appearance of both concentration and deconcentration is a given fact. Insight in which activity is subject to which process, makes it possible to capture these trends and navigate them. Activities which tend to decentralise can be attracted at certain places by offering a good telecommunications infrastructure among other things like flexible office space, services, accessibility and so on. These activities should be drawn towards those places where they can create a surplus value, for instance the location of back office activities in the vicinity of railway stations in smaller cities. When activities tend to concentrate, the presence of multimodal communication-possibilities is essential. For example the creation of an innovation cluster. Physical proximity is essential to innovate. Nowadays every abandoned site or brownfield is destined to become an innovative business park. But specific requirements have to be met, in order to succeed: access to the sources of innovative information (university), presence of a high-educated labour market, close interaction with applying industries, accessibility and good telecommunications infrastructure.

With the two opposite trends of concentration and deconcentration as context, the significance of smaller cities increases. They are less subject to congestion, expensive real estate, pollution, crime, ... than big cities, but offer analogue benefits on a smaller scale. Teleworkcentra in Belgium are located in small cities, nearby a highway or station. Computer sciences are more and more arising in small cities, alongside the big cities but in less quantity. When telecommunications networks are constructed in these smaller cities, their position could be strengthened. They can be an ideal location for back office activities. The location of these offices in certain parts of the city could lead to a synergetic development, like in the vicinity of a railway station.

5.6   ICT as powerful aid

Finally ICT can be used to solve problems like congestion. These solutions should always be integrated in a bigger picture, in the obtaining of a desired spatial structure.

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