SURF

Wetenschappelijk Technische Raad

WTR Trend Report 2004

Reaping the Rewards

Information and communication technology for higher education - trends and vision

Inhoudsopgave

1 Introduction

The Trend Report by the Scientific Technical Council (WTR) sets out the guiding principles for ICT policy in the Dutch higher education sector for the next four years. The WTR has taken upon itself the task of identifying relevant trends and assessing their importance for higher education in the Netherlands.

This is no simple task. Increasing numbers of people not only pick up new information but also new technologies that are not directly relevant to their everyday lives but which they find captivating. As a result, people come up with the wildest ideas for using ICT as well as practical ones, and this applies to the field of education as much as for work or hobbies. Inevitably, some of these applications fail and can generate scepticism about new ideas; by the same token, useful developments are adopted en masse.

This push–pull process ensures that new developments will continue to follow each other in rapid succession, albeit somewhat less dramatically than in recent years.

1.1 The Dutch higher education sector

Although Dutch higher education is not a trendsetter in all the fields of application of ICT, these technologies have found their way into all corners of the higher education system. We can no longer imagine functioning universities and universities of professional education without computers and computer networks. The field of academic and scientific research is the most advanced in this respect, particularly in the pure and applied sciences. The Netherlands is tenth in the list of countries making the most use of supercomputers, ahead of the Scandinavian countries, and is making particularly good progress in the use of networks.

The current ICT strategy for higher education is set down in the SURF Strategic Plan 2003–2006, *De kern van de zaak* [‘The heart of the matter’]. In part, this plan returns to the principles contained in the first Strategic Plan, *Samenwerking… Reken maar!* [‘Collaboration… Count on it!’]: putting the user first and collaborating within systems.[1] A big difference from the early years, though, is that ICT has penetrated into literally everything we do: research, teaching and administration. And because ICT influences everything, SURF does too. To underline this message SURF has subtitled the current Strategic Plan ‘Collaboration within systems, competition in teaching and research’.

At the same time, SURF stresses in its current Strategic Plan that we must not forget one important driving force behind innovation: research. For the first time, the research field has been given a specific place in the plan. In doing this, SURF follows the government’s own policy plans – or is it the other way round? – which identify research as a key motor for reviving the Dutch economy.

Looking back, we can say that SURF is both a trend-follower and a trend-setter in ICT and innovation. Over the next few years SURF will pursue the line that innovation and ICT are not goals in themselves, but facilitate users in the execution of their tasks. And facilities are not things you should have to think about: they are simply there, and they should work.

The WTR Trend Report, summarised in this publication, corroborates the choices made in the SURF Strategic Plan. It is time we joined forces again, not only at the national level, but also within individual institutions. Only by doing this can we reap the rewards of the investments made in the past.

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2 Current position and trends

2.1 ICT facilities in 2003 (Leo Plugge)

Each WTR Trend Report is preceded by a questionnaire survey designed to obtain a better grasp of the number of ICT facilities available in the Dutch higher education sector. In his chapter in Part 2 of the Trend Report Leo Plugge describes the outcome of this survey, which is summarised here.

2.1.1 Response

In a departure from previous surveys, a single questionnaire was used for all the institutions. It was sent to all the faculties and service departments of the universities and universities of professional education, including the computer centres. Compared with the 1999 questionnaire, the participation rate of the institutes of higher professional education rose from 60% to 72% and among the universities from 70% to 92%. However, the response rate from within the institutions was 31%, which is an average response for surveys.

2.1.2 Number of workstations reaches saturation point

In contrast to the previous Trend Report, there were no data on the cost of ICT facilities. The way individual institutions calculate their budgets and expenditure varies too much to allow any meaningful conclusions to be drawn on this topic.

A striking feature of the trend in the use of ICT facilities by personnel and students is that the number of personal computers (PCs) has apparently reached saturation point. Since the first Trend Report in 1999 the number of PCs for staff has risen sharply. In the higher professional education sector there were 43 PCs per 100 fte in 1991, rising to 76 in 1995 and 90 in 1999. By 2003 this had reached a ratio of 118 PCs per 100 fte.

The average number of pc's per 100 students has also risen rapidly in recent years. In the universities this has grown from 4 student PCs per 100 students in 1991 to 6.4 in 1995 and 12.5 in 1999. In 2003 the ratio had climbed to 23.6 per 100 students, or almost one PC for every four students. A similar rapid growth took place in the higher professional education sector, from 5 PCs per 100 students in 1991, via 6.8 in 1995 to 11.9 in 1999. In 2003 the ratio was 13.7 per 100 students, or one PC for every seven students. As a result, competition among students for the use of PCs has fallen sharply.

These statistics are averages; there are considerable differences in the ratios between study programmes. In the exact sciences the average is about 1 PC for every 2 students – at one institution it is even 1:1 (Eindhoven University of Technology). In the Language & Culture Studies, Education and Law study programmes the ratios are less favourable, varying from 3:100 to 6:100, levels comparable with the total averages in 1991 and 1995.

Besides using PCs on campus, increasing numbers of students have access to a computer and Internet at home. In 2002, 55% of all households and 64% of the total population in the Netherlands had a PC with an Internet connection. This leads us to conclude that virtually everyone taking part in higher education has access to a computer, either for personal or shared use.

2.1.3 Other trends

Most computers still are desktop computer, but notebooks are now the second most common form of computer and are a highly important tool in university education. Most of these computers run on a version of the Microsoft Windows operating system. Another noticeable trend is the emergence of thin clients, in which the main applications are run on a central server and the user interface is displayed on the user's machine. Many libraries provide this type of service, but thin clients are also becoming more popular for staff use.

The rise in the use of notebooks is accompanied by growth in the use of wireless connections. In view of this, it is reasonable to ask whether institutions should continue to invest in ICT workplaces for students. Although notebooks are much less common in higher professional education than in the universities, we can assume that it is simply a question of time before their use takes off here as well: the universities have always tended to lead the way in such developments.

An interesting trend is the use of IP telephony in the higher education sector. This technology has moved out of the experimental phase and will soon be adopted on a wider basis. This reflects developments in the market, which displays a clear trend towards the use of Voice over IP instead of existing PABXs. However, we should reserve judgement for the moment because we do not yet have a clear picture of the extent to which the current (experimental) services in the higher education sector are living up to expectations.

Finally, *application service provisioning* (ASP) and *educational service provisioning* (ESP) – the web-based delivery of (educational) applications on a pay-per-use basis – are quietly gaining ground in the institutions. ASP in particular, seems to be making a breakthrough after shaking off an association with the Internet hype and a pie-in-the-sky image. ESP will also profit from this breakthrough, although for the time being this will be limited to the distance provision of learning environments.

2.1.4 Conclusion

The main conclusion that Plugge draws from his comparison with the earlier Trend Reports is that ICT is now a standard part of the higher education landscape; almost everyone has access to it and makes use of it, and no-one asks whether a computer can cope with multimedia applications or which applications are available for use. Thanks to SURF, just about everyone in HE has access to the applications they need and everyone who wants to can gain access to a multimedia computer with an Internet connection.

ICT has become a commodity: a computer with an Internet connection is practically as common as a television or a telephone.

For this reason, claims Plugge, future reviews of the current situation regarding ICT will have to be conducted at a higher level of abstraction. Instead of asking 'What ICT technology and services do we have?' we will have to ask 'What are we *doing* with ICT?' The chapter by Steyeart and de Haan, 'Social aspects of ICT in higher education' provides a springboard for answering this question.

2.2 Social aspects of ICT in higher education (Jan Steyaert & Jos de Haan)

According to Steyaert and de Haan the digitisation of the social environment in the last ten years has had an enormous effect on the flow of information between academics and between faculty and students.

2.2.1 Knowledge as an open source

Since the publication of the previous Trend Report, say Steyaert and de Haan, three trends can be identified in the academic world: the digitisation of libraries, self-publication of knowledge products and the emergence of digital 'information theme parks', by which the authors mean digital assembly points, usually built around a website, where scholarly and practical information on a specific theme can be clustered. Digital theme parks area a new illustration of Woolgar's third law of virtuality: virtual technology supplements rather than replaces existing activities.

But this leaves us with one fundamental problem: Internet gives us easy access to such a huge volume of academic information that we simply cannot digest it all.

2.2.2 Social inequality and access

To take part in the process of digitising academic information services described above it is essential to have a PC with an Internet connection. Following a slow start in the 1980s, PC ownership among the Dutch population grew rapidly in the 1990s, rising from 9% in 1985 to 76% in 2002. The percentage of Dutch citizens with access to the Internet at home rose from 21% in 1998 to 64% in 2002.

Young people have led the way in the spread of new ICT facilities and only a small proportion of students have no computer (14%) or their own Internet connection (26%). Inequalities in the possession of ICT products will in time erode and may even disappear altogether, as is now largely the case for telephones and televisions. In a knowledge society, social differences will not be a reflection of the possession of complex technologies, but in their use and the value this has for the user. Students start their journey through the higher education system with a considerable stack of hardware and considerable experience of using computers, and this will probably increase over the years. A growing number of secondary school pupils are teaching themselves how to use a computer and the availability of a computer at home is more important than having access to one at school.

2.2.3 Diffusion patterns

The authors describe the distribution of PCs and Internet connections in households as a process of diffusion that follows an S-shaped curve: a relatively slow start, followed by a rapid growth that only slows down again as the market becomes saturated.

The position adopted by individuals in this diffusion process creates new inequalities. Those that purchase a computer during the initial phase seem to benefit more from the opportunities presented by the digitisation of information, and this may influence their later participation in various fields of social activity. The early adopters acquire an advantageous position and possibly a permanent head start in the information society.

The diffusion of innovations also takes place through educational institutions along the same S-shaped curve, with a group of early, experimental users followed by another group that follows at varying rates. The innovations now taking place in higher education can set the tone for what will happen in a few years time in other parts of the educational infrastructure.

2.2.4 Use of time

A detailed comparison of schoolchildren who use the Internet and those who do not shows that the Internet users have more or less the same amount of free time, but that they use that time differently. Internet users spend less time on electronic media (television, radio and stereo systems) and more time reading printed publications; they seem to read more books, although there is no discernible difference between the groups in the time spent reading newspapers, magazines and local newspapers.

2.2.5 Accessibility of electronic learning environments

Before embarking on their studies, students in the Dutch higher education system already enjoy a robust socio-economic position and for this group the digital divide is an almost irrelevant concept. The current generation of schoolchildren – certainly those that go into higher education – belong to the Internet generation; they enjoy easy access to new media and have extensive experience with using it.

For students with one or more functional disabilities – either physical or psychological, such as dyslexia – the digitisation of higher education can throw up new barriers. An estimated 70,000 students (10–15%) are affected each year. Access to digital education for this group is just as important as access to non-digital education. However, accessibility is to a considerable degree something we determine ourselves, and so this is a task for the content providers.

2.2.6 The Google citation index

The key development in ICT and higher education is undoubtedly the increased level of access to academic information and the creation of new knowledge products, such as the web essay and the information theme park. Now the Government is emphasising the exchange of information between higher education and the workplace, via the innovation platform and more generally, the way the quality of academic research is measured can change: it is time to supplement the Science Citation Index with the 'Google Citation Index'.

3 Infrastructure and service delivery

3.1 Technical infrastructure (Chris Hendriks)

The technical facilities needed to work in the digital world are increasingly taking on the character of *infrastructure*. As dependency on the technical platform grows, so does the required level of availability of the technical platform. This is driven in part by new technologies. What is often more important, though, is how people react to and work with existing technologies.

In this chapter, Chris Hendriks reviews technological trends in a number of areas, revealing that innovation is geared particularly to strengthening the infrastructural nature of the relevant services. Aspects deserving particular attention include fixed and wireless networks, data storage, data processing and security.

3.1.1 Fixed and wireless networks

The fixed network is approaching maturity. Fixed network architecture has the following characteristics: a layered star-shaped structure; one or more central nodes where the servers are concentrated; and a dimensioning based on excess bandwidth, processing capacity, etc. Nevertheless, network managers will be confronted with a number of additional needs in the years to come: authentication of users of the network; upgrading bandwidth to workstations; integration of telephony in the data network; access security; and introduction of the new IPv6 network protocol.

3.1.2 Data storage

There is a rapid and continuous growth in the demand for storage capacity and a growing need for widely distributed storage capacity in comparison with processing capacity, but the precise requirements are hard to predict. The obvious solution is to provide for flexible growth in storage capacity separate from processing capacity, coupled with the ability to provide central back-up facilities. In other words: decoupling storage from processing capacity. A large number of universities and universities of professional education are already using (one or more) storage area networks (SAN).

3.1.3 Servers and server-based computing

The advantages of the flexible assignment of storage space that SAN provides also apply to processing capacity. It is no surprise, then, that developments in server infrastructure are moving primarily in this direction. Two different approaches lead to the flexible use of processing capacity: the farm and grid concepts. The difference between the two mainly has to do with the nature of the applications the system is designed to run. The farm concept is most suited to users of transaction-oriented applications; the grid concept for calculation-intensive applications that can be run in parallel

Once an institution-wide infrastructure is in place, it makes sense to replace the classic PC with server-based computing (SBC): a server on which a number of PCs are emulated so that all application software runs on the server; the client machine is used solely for communication with the user. Sever-based computing can also be used to meet the need for flexibility because the PC is freed up for installing the user's own applications.

3.1.4 Access security

'Security' is one of the most all-embracing concepts within ICT. Hendriks draws a distinction between security within the network and the protection of what is connected to the network. Authentication is of prime importance; in other words, determining whether someone is who they say they are. Besides the usual security measures it is essential to be able to detect attempts to gain unauthorised access to servers (hackers) immediately and to trace those responsible after the attempt.

3.1.5 Availability

Computer infrastructure must be available for use. It is no longer acceptable for normal ICT facilities to be unavailable for long periods. Whereas an availability of 99% used to be considered more than acceptable, today's requirements are more like 99.9% or even 99.99%. A key factor in the ability to add an extra 9 to the availability percentage is redundancy. Clearly, availability is a policy issue that each institution has to decide for itself.

3.1.6 Scale and decreasing differentiation

As we have seen in the development of the electricity network and drinking water supply, the development of an infrastructure leads to increases in scale and changes in the relationship between the supplier and the consumer, driven by the desire to optimise costs. The same will be true for ICT infrastructure. Infrastructures will increase in scale and the differentiation in service provision will decrease. In the research environment, the latter trend will increase the need for support in areas not covered by the infrastructure. Summing up, Hendriks concludes that a shift in maintenance responsibilities can be expected, but also that the expected trends will require a policy vision and the operationalisation of that vision.

3.2 Trends in wireless and mobile communication (Ignas Niemegeers)

In this chapter Ignas Niemegeers draws attention to the emergence of *ubiquitous computing and communication*, in which practically every appliance can be fitted with processing and communication capacity at a very low cost: a few euros per chip.

The communication infrastructures we are familiar with, such as Internet, mobile and wireless cellular networks, LANs and wireless LANs, will evolve and gradually converge to form an all-pervasive integrated infrastructure. This will consist of three levels: the core network level, the access network level (e.g. fibre-to-home and UMTS) and the periphery, consisting of end systems (hosts) or end networks.

In addition, a new class of ad hoc networks will arise which operate independently from the infrastructure, but which make use of the available infrastructure networks where the opportunity arises and where the applications demand it. Examples are *personal area networks* (PANs) and *personal networks* (PNs): these create personal distributed environments in which the elements do not have to be physically near the user.

Wireless networks can be divided into four categories:

1) *Wide area* networks, especially cellular networks such as GSM, GPRS and UMTS.

2) Wireless LANs (IEEE 802.11): these have a range of about 100 m, but in the near future will be linked together to form 'hot spot' infrastructures that can cover areas the size of a university campus.

3) Radio networks for short distances (IEEE 802.15), the main example at the moment being Bluetooth, with a range of about 10 m.

4) *Broadcast* networks: the rapidly emerging terrestrial broadcast networks, used for example for digital audio and video broadcasting (DAB and DVB), can play a major role in providing high-bandwidth downlinks to supplement cellular networks.

Besides these networks, there are other types of wireless networks: the *satellite broadcast* networks, *in-house cordless* systems such as DECT, and the *fixed access* wireless networks (IEEE 802.16).

3.2.1 Integration

The various radio technologies and wireless networks now in use and under development are optimised for different scenarios and applications, which has led to a situation in which we have a number of largely complementary networks. Each of the technologies and wireless networks designed to work with them are being further developed. This is not expected to lead to the formation of a single technology suitable for all situations and all applications.

What is now happening is the integration of the various wireless networks into an infrastructure that the user experiences as a seamless whole as far as services, authentication and security is concerned. This is generally referred to as 4G (fourth generation wireless networks). The first types of integration that are emerging are IP-based integration of GPRS and UTMS networks with WLAN hotspots. These integrated networks, however, cannot yet be called ‘seamless’.

3.2.2 Security

Wireless networks are inherently insecure because physical ports are not needed to make a connection. Each device within the range of a WLAN access point can, in principle, send and receive signals – and can also listen in. Authentication is required to ensure that only authorised parties can communicate with each other.

The increasing use of WLANs in particular is creating dangerous situations. Improving security and authentication in these WLANs is the objective of IEEE 802.11i. Ad hoc networks pose particularly difficult problems because they cannot be based on an infrastructure for key distribution. All sorts of devices detected in the neighbourhood of these networks can, in principle, be assimilated into the network. So-called ‘light-weight’ solutions are needed for the many battery-driven devices in ad hoc networks. Future 4G networks will be able to make use of the available infrastructure for authentication, such as SIM cards and subscriber databases in existing cellular networks.

3.2.3 Future developments

The future, according to Niemegeers, belongs to powerful optical core and access networks. End users will have access to these mainly through wireless connections. Wireless access networks with a much higher capacity than current cellular networks (UMTS) will be needed to satisfy the demand for mobile communication while supporting existing applications without restriction. Research and standardisation activities are already underway within the framework of IEEE 802.20.

The main limitation of wireless networks is and will remain the radio channel. In the long term, a breakthrough in the use of the available frequency spectrum will be needed to meet the demand for bandwidth. Answers are being sought in new and improved radio techniques, such as smart antennas, Ultra Wide Band, OFDM and MIMO, and in adaptive radio systems that can detect which spectrum is available and in use and take advantage of this in real time. This will require further development of software radio, but the complexity of the required signal processing presents considerable difficulties.

This problem has not yet been solved for the many mobile low-energy devices that, because of the costs involved, will have to handle a high degree of complexity. Mobility only increases this problem. This technology, therefore, is something for the more distant future. A positive sign is the growing pressure around the world for a review of the frequency spectrum in the light of new technologies, future applications and changing economic interests.

4 Research

4.1 Grid computing and e-science (Nikolai Petkov)

Grids are dynamic distributed ICT environments that allow software applications to integrate ICT resources, such as processing and storage facilities, databases, displays and instruments, via a computer network. This integration can take place within a department, institute or organisation or across a number of organisations or network domains. For the user, the grid looks like an integrated computer system with all the necessary facilities; users do not know whether these facilities are in the adjacent room or in another continent.

In his chapter in the Trend Report, Nikolai Petkov argues that grids can be used to bring numerous goals within reach: more efficient use of the existing ICT infrastructure, reduction of direct investment in ICT and maintenance costs, access to high computer capacity, integrated distributed databases and applications, and long-distance interactive collaboration and experimentation with devices

4.1.1 Local grids

Universities have sufficient knowledge of ICT in house to create grids themselves or contract the work out to a company. This can be done using their existing ICT infrastructure available within a department, institute, faculty or institution, with the help of special (often free) middleware. But this requires a commitment by management to introduce grid technology into the organisation because it requires, among other things, a closer integration of ICT facilities.

Over the next five years, Petkov sees the best opportunities for introducing grid technology for higher education and research in the bundling of processing and storage facilities within an organisation’s intranet. This would allow, for example, pools of PCs to be used at night for parallel distributed processing. Such grids can be built using existing mature technology without many technological or security risks, which can deliver significant savings in direct hardware and maintenance costs. Organisations that ignore these opportunities, warns Petkov, will pay too much for their ICT infrastructure and get too little out of it.

4.1.2 Large-scale applications

The number of partner grids in which two or more organisations share their ICT resources – usually for joint projects or study programmes – will increase, but for the time being a worldwide service grid will remain something for the future.

But one form of large-scale grid technology is feasible: research projects in which thousands of people make some of the processing capacity of their home computers available to researchers. Such projects attract widespread interest outside the academic world. They are certainly conceivable in the Netherlands if they are clearly relevant to society at large (e.g. projects in the field of health care, the environment, public safety and water management) and can count on broad public support. Relatively small incentive programmes by the Ministry of Education, Culture and Science, SURF or the universities themselves would generate considerable returns.

4.2 Web services (Jörgen van den Berg)

Web services, says Jörgen van den Berg, do not just make it possible to share applications via the Internet, they also – more impressively – make the functionality of applications available, irrespective of the specific characteristics of the technical environment: the hardware, operating system and programme environment are no longer relevant. To make this possible, web services rely on a number of widely accepted standards, such as XML, SOAP, WSDL and UDDI. This standardised form of communication is their main advantage.

4.2.1 Integration of applications

The integration of existing applications is an important application area for web services. All higher education institutions have essential applications, which are in fact digital islands, or 'data silos': they are not able to exchange data with other important applications in an elegant way. Web services offer many opportunities for integrating these islands without harming the autonomy and integrity of the various elements.

The exchange of data and complete databases between parties in the higher education sector (institutions, the Association of Universities in the Netherlands (VSNU), the Association of Universities of Professional Education (HBO raad), the Information Management Group (IBG) and others) can be made redundant through the introduction of web services into information systems, providing direct access to relevant and up-to-date information without the need for human intervention.

4.2.2 Greater choice for institutions

The dominant position enjoyed by software suppliers will slowly be eroded, expects van den Berg, because of the greater choice offered by the concept of standardised web services. This will apply to both the educational applications (e.g. suppliers of electronic learning environments) and administrative applications. The research domain will see the emergence of all sorts of smart web services that support some research functions. These are frequently made available free of charge by the researchers themselves.

4.3 Standardisation of technical information (Erik Duval)

In recent years there has been considerable interest in setting standards for learning technologies to ensure interoperability. The aim is to allow independently developed software components to be used in combination.

4.3.1 Specifications and standards

The standardisation of learning technologies is driven by specifications developed by various consortia, such as AICC, IMS and ARIADNE. Such organisations focus on the needs of their own communities. Accredited organisations like IEEE LTSC, CEN/ISSS and ISO/IEC JTC1 SC36 are obliged to take the needs of the whole education sector into account: they guarantee an open and fair process in which all interested parties can make their wishes and requirements known. This is of prime importance in the education world because it is both determined by culture and plays itself a role in shaping cultures. The intention is to have real users test and validate the specifications developed by the consortia before they are formalised as standards.

4.3.2 Content standards

The core concept in the field of content standards is the learning object. Standards for the content of learning objects are nowadays usually based on an XML language. In the field of educational applications, the IMS consortium has developed a specification for multiple-choice questions: *Question and Test Interoperability* (GTI), based on XML as the underlying standard.

4.3.3 Metadata

In recent years much progress has been made with developing standardised *descriptions* of learning objects in the form of *Learning Object Metadata* (LOM), for which an *XML binding* is under development. Moreover, the World Wide Web Consortium has built a framework for metadata applications: the *Resource Description Framework* (RDF). Besides LOM there is the more general, and somewhat more limited, *Dublin Core Standard*.

The IEEE LTSC is developing a specific standard for handling digital copyrights, in the form of a *Digital Rights Expression language* (DREL). Under the *Creative Commons* initiative a number of variants of frequently requested licences are being developed, with special attention to educational applications.

Finally, with regard to metadata, Duval mentions that work is in progress on standardising student information: the IMS *Learning Information Package* (LIP) specification and the *Reusable Competency Definitions* in the IEEE LTSC, based on earlier work in IMS.

4.3.4 Structure standards

In the general hypertext world, *Synchronised Multimedia Integration Language* (SMIL) is an example of a specific standard for the structure of multimedia presentations. The IMS *Simple Sequencing* specification was developed for the sequencing of learning objects and is based on rules that describe the branching or flow of instruction through content according to the outcomes of a learner's previous interactions with earlier content.

Geared more to the modelling of the pedagogical approach are the educational modelling languages, of which there are many in circulation. Based on earlier work of the Dutch Open University, IMS developed the Learning Design Specification. However, support for this specification in commercial or open source products remains very limited.

4.3.5 Subsystems

Of course, technical support for educational and study programme initiatives is often provided in interaction between various subsystems. Specifications and standards are also being developed for this form of interoperability, including the IEEE's *Computer Managed Instruction* standard. In essence, this standard covers the interaction between learning objects and a *learning management system* (LMS)

4.3.6 From standards to conventions

It must be stressed that while standards ensure a certain level of interoperability, the conventions often have to be developed by communities of users to create a meaningful use of technical standards in a specific context. This is clearly an area in which communities can increase the value of a standard.

5 Education

5.1 The long road to collaborative learning with ICT (Martin Valcke)

Within the subject of technical developments for education, Valcke focuses on a new generation of groupware environments. The classic forms of communication such as mail, shared white-board and chat rooms have now been integrated into what could be called a 'virtual office' or 'virtual company'. User support consists of file management (including version management), calendars, diary systems, sources, news, integrated mail, etc.

A number of groupware environments are geared specifically to collaborative learning and now also incorporate *knowledge building tools* or *knowledge representation tools*. Initial experiences and research results confirm the potential of this new generation of ICT tools.

A separate technical trend is a consequence of developments in hardware. With the aid of wire-less networks and devices, such as integrated personal digital assistants, collaborative environ-ments are developed for educational purposes to provide students with synchronous and asyn-chronous support for classical education, study assignments, field work and work placements.

5.1.1 Success factors

The use of ICT to support collaborative learning has clearly become a mature research field. Both positive and negative experiences have been reported, and the resulting controversy has forced the supporters of *computer supported collaborative learning* to go back to the basics and start from the lessons learned from collaborative learning outside the ICT environment.

This has proved to be a fruitful endeavour. The results of meta-research by Slavin and Johnson & Johnson have reaffirmed the importance of critical success factors for effective and efficient use of ICT in collaborative learning. A striking application of this is the incorporation of a form of steering, sometimes referred to as *scripting*.

Valcke describes various forms of steering: communication steering (e.g. using roles) and content scripting that provides groups of students with learning task support (e.g. a step-by-step plan, partial procedures, etc.). Research shows that such scripts do indeed help to optimise participa-tion, the transfer of knowledge and collaboration.

A second category of research studies the relation between the type of collaboration and the re-sults achieved. In a discussion on this topic, Valcke examines linear versus synergetic group func-tioning.

A third category of research examines group characteristics that influence collaborative activities in an ICT environment. In this context, Valcke discusses the relation between optimal group size and task focus. Using the research data and results from the meta-research mentioned above, he identifies eleven design guidelines for collaborative learning using ICT.

5.1.2 Implications at the institutional level

The last part of Valcke's contribution emphasises the impact on the institutions of microlevel decisions on collaborative learning using ICT: these affect a whole range of core variables and processes. The limited available research data on the Dutch situation suggest that the implications at the level of the whole institution are largely absent in the many reports. The consequences of using ICT for collaborative learning at the institutional level are only genuinely taken into ac-count when collaborative learning is part of an educational vision (e.g. problem-based teaching). The development of an educational vision remains an important task for the future.

5.2 ICT in education moves into phase three? (Robert-Jan Simons)

ICT in higher education is somewhere between the second and third phase of the ‘hype cycle’, which moves from initial over-enthusiasm into a dip phase and then into a stabilisation phase. The lowest point of the dip may well be behind us and the first signs of stabilisation are noticeable. This last phase is characterised by interest in new ideas to do with integration and implementation.

5.2.1 Digital teaching methods

First of all, Simons concludes that there is growing interest in self-guided study and in greater opportunities for implicit learning from students’ own experiences. In addition, increasing attention is given to *blended learning*, a more dynamic vision of knowledge, competence-based learning and academic curricula. This finds expression in new orientations, such as student activation, problem-based, project-based and competence-based learning.

Digital didactic (teaching methods) make use of ICT to facilitate learning, in part for acquiring general knowledge and skills relevant to all subjects (general digital didactics) and in part for acquiring principles specific to certain subjects (subject-based digital didactics).

Simons describes seven pillars for the further development of digital teaching methods which can add value to the ICT in use:

1) focus on competences
2) increase flexibilities
3) develop relations with other students, faculty and other actors within and outside the institution
4) creative learning: by solving problems, taking decisions, forming opinions, designing something or constructing deeper meanings
5) give students a broader and more authentic public for the results of their learning
6) make learning, thinking and collaborating more visible and transparent
7) contribute to learning how to learn

However, it is also very important for faculty to develop their expertise in day-to-day work. Integration in the curriculum requires a new division of tasks between people and computers to exploit the strong points of both and compensate for the weaker aspects. This also means greater emphasis on teaching methods and continuous learning paths for cross-curricular competences.

The costs and benefits of using ICT in educational institutions cannot easily be measured, for one reason because many costs are hidden and the benefits are almost impossible to express in terms of time and money. Neither is it easy to charge costs to investors or turn the benefits into revenue. However, because the use of ICT in education is virtually unstoppable, the best option is to try and keep the costs as low as possible and the benefits as great as possible. Simons uses examples to demonstrate how this can be done.

5.2.2 Knowledge communities

In his section on the professionalisation of the use of ICT by faculty, Simons identifies six ways to support and facilitate learning:

1) reorganising the work to enable learning by doing
2) helping faculty with independent and focused learning activities
3) providing guidance on learning and professionalisation (training, courses, mentoring)
4) introducing review points to make the results of learning visible (teaching materials, websites, tests, outlines, publications and such like)
5) supporting the sharing of individual learning processes and results
6) incorporating faculty training into organisational change.

Simons argues for establishing and supporting knowledge communities in which faculty, supervisors, researchers and developers work together to design new teaching methods, whether digital or not, through experimentation and research. After all, each organisation should gain knowledge of the workings and innovation of its primary processes. Simons describes how such knowledge communities could be structured and facilitated.

Finally, Simons provides a summary of how the various trends and developments can be used in education policy. Policy makers and managers can use the information in his chapter to obtain a picture of how their own institution has developed so far and to prepare for the next steps.

6 Organisation

6.1 Information planning and architecture (Alexander Udink ten Cate)

In his contribution to the Trend Report Udink ten Cate stresses the importance of information planning in providing a sound basis for improving the information services in the organisation and management of institutions of higher education. Information planning makes use of various architectures that provide guiding principles for achieving the desired situation.

Information planning leads to the compilation of an information policy plan, in which the architectures are described as a coherent whole. The plan should contain a description of the current and desired situations and the relation between the two, and contain a project calendar describing how the desired situation will be achieved within the period covered by the plan (usually four years) and within the available budgets.

As the architectures are constructed according to fixed rules, together they describe the full complexity of the challenge posed by ICT in the institution and present an objective picture of the existing situation. This results in a more manageable change process, which in turn creates better opportunities for the innovative use of ICT.

6.1.1 Architectures

The *information architecture* describes developments within the various information domains. These domains are coherent clusters of activities and information exchange, an example being student administration. Most information domains are much the same in all institutions of higher education and are therefore suitable for benchmarking.

The *system architecture* describes the desired information systems that serve each of the information domains.

The *system architecture* describes the hardware, networks and associated system software.

The *organisation architecture* describes the organisation of automation services (and regulates, for example, the division between the central service department and the faculties).

When programming the process of changing from the existing situation to the desired situation, the responsible line managers set priorities by weighing up the costs and benefits, degree of urgency and anticipated difficulties inherent in the project proposals. This results in a set of realistic, manageable and practicable plans. This is not an unnecessary luxury given the realities of everyday life within institutions of higher education, in which many different goals have to be achieved at the same time. A good information plan also unites both management and users on the one hand and the ICT professionals on the other hand behind a single purpose.

6.1.2 Trends

The trends in ICT and organisation are best explained in terms of their consequences for the various architectures.

1) We can expect that ICT within institutions will receive more attention from administrators, if only because of the increasing importance of sound economic management.
2) The use of information policy plans will ensure that innovative ICT projects are better incorporated into the existing organisational structure.
3) The availability of Internet technology will allow a variety of processes within institutions to be redesigned to make the organisation more responsive to the needs of the student.

4) The development of technical infrastructure is moving towards central facilities of a general nature.
5) Institutional standards (including reference models for information services) are becoming more important.

6.1.3 ICT Management Review

For many years the Scientific Technical Council (WTR) has advised the higher education sector on the use of ICT in the organisation and administration of institutions. Given the nature of the institutions of higher education, the challenge facing management lies mainly within the sphere of implementation, primarily relating to issues of managing the changes needed to achieve the objectives. This prompted the WTR to prepare an *ICT Management Review* for universities and universities of higher education. The underlying methodology resembles the approach taken in quality management in education and research through the use of improvement plans.

6.2 Information transparency (Robert Blom)

The trend in ICT service provision over the last few years will certainly continue, according to Robert Blom in his contribution to the Trend Report. We can expect that system integration will accelerate. As soon as computers were linked in networks, an *information infrastructure* was created in which increasing amounts of information are made available for operational management. This information is used both for running processes and for administration.

Each organisation obtains considerable benefits from this information infrastructure – provided the necessary information can be obtained; it can make organisations ‘smarter’. Administrators who can see through all layers of the organisation are able to take decisions that are easier to carry out, because, in principle, everyone can obtain the same information during all stages of the process, from the making of strategic policy to ex post accountability.

6.2.1 System innovation in the knowledge infrastructure

Blom also believes that in the years to come this type of system innovation will be required in the two core fields of education and research. With the recent introduction of the innovation platform, the link between the knowledge infrastructure and employment levels in the Netherlands has received attention at the highest political levels: the knowledge economy must be given a boost, particularly by translating research results into information for practical use by the business community. This sets a clear course for the creation of a ‘smarter system’ for scientific research, a process that will need better communication between actors and clearer guidance.

The newly established accreditation body NVAO, which will assess the quality of every existing and new funded study programme in the Dutch higher education sector, will shape system innovation in the other core field, higher education.

But the process of change will not stop there. Major steps can be taken in other policy fields, from the promotion of research and educational institutions to the professionalisation of planning and control. And then there are the European agreements on standardisation and mutual recognition of study programmes (Bachelors/Masters). The question, though, is whether this strategic step by the ministers will meet the wishes of the clients (the students) and the suppliers of products (the research and educational institutions). Can measurable performance indicators adequately describe the implementation of policy and ex post accountability?

6.2.2 Information transparency

According to Blom the knowledge infrastructure in the Netherlands suffers from too little information transparency. Information is used mainly in the policy preparation phase, with too little attention given to planning and control of implementation. The information infrastructure can be of help in this complex process by making the information required to support the management process available to all those involved, whenever they need it. Information transparency contributes to system innovation in the management cycle, both in the research and educational institutions themselves and in the total knowledge infrastructure.

Four development phases can be identified in the ICT service industry:

1) components
2) integrated system
3) business intelligence
4) business process management through ‘management by surfing around’.

The international business community is in a period of transition between phases three and four. Most of the research and educational institutions, however, are busy with the transition from phase two to phase three. They can make up lost ground if the knowledge infrastructure is tailored to serve a more fact-oriented and uniform information infrastructure. This information transparency will provide the basis for a more commercial application of information in the management cycle in government and the research and educational institutions. Building on this, measurable objectives and results such as performance indicators can be set.

Robert Blom’s conclusion is that administration and control, both in the field of quality and in the financial arena, can be enhanced over the next four years. The information infrastructure is capable of facilitating this.

6.3 Growth model or goal model (Ysbrand van der Veen)

The information services in institutions of higher education have evolved in a rather ad hoc way over the years. There is little evidence of a coordinated information infrastructure, says Ysbrand van der Veen in his contribution to the Trend Report.

The ICT landscape is fragmented, the level of compatibility between applications is low, and the whole system contains inconsistencies and overlaps. Moreover, the complexity resulting from the spontaneous growth of these information services has led to high maintenance costs, especially those relating to interfacing. The growth in the number of systems and the need for greater communication between systems has made it impossible to maintain direct links between them.

To achieve objectives such as economically sound management (see 6.1), a high degree of information transparency (see 6.2), integration (see 4.2) and rapid and flexible response to change, van der Veen expects that the management of ICT will be as high on the administrative agenda as financial control. Proper control over the development and use of ICT will require a coherent administrative framework in which the main criteria are the strategic, tactical and operational goals of the organisation, rather than the technical possibilities.

6.3.1 Spatial planning: administrative framework

To gain control over the random growth in the information landscape it will be useful to impose some spatial planning in the virtual world. Just as in the physical world, we can work with a *spatial planning policy* at the highest level. This will provide the framework within which increasingly detailed regional, structure and zoning plans can be prepared. Formal responsibility will lie with the owners of the zoning plans. This will provide a firm basis on all administrative levels for guiding the development of the information landscape in the desired direction in terms that are understandable to everyone, and for clearly assigning responsibilities without the constraints of a centralised regime.

The plans could contain sections on the following:

1. zoning (residential, industry, recreation, retail)
2. functions appropriate for each zone

3. transport
4. traffic flows (one-way, priority roads)
5. public services (health care, sewerage, fire services)
6. administrative evaluation frameworks
7. urban and regional development.

For each zone the responsibilities of the institutions will be clearly stated to prevent inconsistencies arising, preferably with a single database for each domain. In other words, the processing function (ELO, LCMS, digital portfolio system, etc.) would be detached from the storage function (see 3.1).

The above suggests that van der Veen does not think that information technology itself is part of the competitive edge of an institution, as is often thought. After all, the required technology is available to everyone. This does not apply to the use of ICT facilities to bring the strategic, tactical and operational goals of the organisation within reach (*business ICT alignment*).

6.3.2 Enterprise application integration (EAI): technical framework

Once the spatial planning procedures have been adopted, a technical architecture must be chosen within which the spatial planning agreements can be implemented. This technical architecture is referred to as *enterprise application integration* (EAI). EAI is a continuous process of creating an information infrastructure in such a way that a logical environment is created in which it is easier to introduce new ICT-based operational processes, or to adapt existing operational processes, and to connect or disconnect applications as required. This makes EAI an excellent basis for replacing legacy systems when the time is ripe.

EAI cannot be bought: it is not a product, but an activity geared to raising the added value of ICT for the organisation. The results of EAI are characterised by a high degree of abstraction, far-reaching forms of automation, increased organisational flexibility and reduced response times. It is not geared to solving specific problems, such as linking the student administration to the electronic learning environment (ELE) or the learning content management system (LCMS). EAI is by definition a strategic activity designed for finding generic solutions.

The core of an information infrastructure based on modern principles of technical architecture is a separation of process logic and applications (*service-oriented architecture*, SOA). This requires separating the data access components and the business and process logic (the ‘what’) from the applications that contain the functionality and process data (the ‘how’). A central service backbone, also called an XML bus (based on http and web services, see 4.2), provides the functionality needed to make this division between the ‘how’ and the ‘what’.

This can be clarified by the use of an example: in the existing situation the student administration system, via direct links, will have to be aware of the ‘what’ when dealing with requests for student information from the ELE or the portal. In the traditional situation, if one of the applications connected to the student administration is changed, the student administration (and usually other functions too) will have to be adjusted as well. In a service-oriented architecture, the student administration system no longer has to know which application or process is asking for the information; it simply provides what it is there for: student information.

6.3.3 Enterprise information integration (EII): semantic framework

Spatial planning and EAI create frameworks for turning the ‘application spaghetti’ into an efficient and flexible information infrastructure. The third challenge is to provide integrated searching of the broad range of data sources: email, graphics, relational data, web content and Word documents. This is the domain of *enterprise information integration* (EII), in which information standardisation (see 3.3) and standards such as *XQuery* will pay an important role.

6.3.4 Growth model or goal model

Radical innovations such as EAI and EII require a paradigm shift and so can only be successful if the users – the reason for change in the first place – can grasp the potential they offer. The best chance of ensuring this seems to be through an evocative form of communication based on the principles of story-telling. The goal is to move away from a *growth model*, with yet more and more applications, to a *goal model*.

7 And now?

Identifying trends and assessing their significance is important, but in accordance with the remit of the WTR we decided to provide some advice for the various interested groups. This advice is structured according to a matrix with the target groups on the Y axis and the action domains on the X axis (see Table 1).

The SURF Foundation is not listed separately in the matrix because it operates in all the domains. For each target group and domain we indicate the role SURF plays or can play.

Domain Target group	Organisation	Research and information	Education	Infrastructure and services
Institutions				
Researchers				
Faculty				
Students				
Government				

Table 1 Target groups and action domains

7.1 Institutions

It is dangerous to lump all institutions together under one heading. While there are many similarities between educational institutions, SURF makes a point of respecting and promoting the individual character of each institution. All universities and universities of professional education strive to deliver quality, but how they set out to do so is up to them. ICT plays a supporting and not a leading role in that aim, but (new) ICT facilities do have consequences for the choices the institutions are free to make in their pursuit of quality, efficiency and effectiveness.

7.1.1 Organisation

Administration is often still based on a hierarchical structure with an associated ‘island’ system of automation. The growth of computer networks may have broken down this isolation, but data often still has to be converted by hand into a suitable form for use by the receiving party. Solving this problem requires action in three fields.

• *Middleware*: Developments in this field, particularly web services, allow data used for various purposes within and across organisations to be linked together, while respecting privacy rules. A good example is the Virtual Clearinghouse for the exchange of distributed student data. This principle can also be applied within institutions.

• *Information policy plans*: Each institution has to draw up an information policy plan that describes a system, a technical and an organisational architecture. A sound and secure information management depends on having a clear picture of the information needed, the information flows and the systems that support these.

• *Standardisation*: Joint action via the SURF Foundation avoids having to deal with problems of compatibility at a later stage. Moreover, cooperation in this field allows the higher education sector to put pressure on suppliers to take account of these standards.

7.1.2 Research and information

• *Grids*: These are already possible at the level of the institution (organisation grids) by using the existing machine park. Student and staff PCs are especially interesting for processing tasks because they are not used at night. Such local processing grids can deliver considerable savings in the purchase and maintenance of hardware in future. SURF’s ICT and Research Platform is the appropriate arena for experimentation and exchanging information in this area.

• *Information services*: New technology enables the institutions to become publishers of their own academic results, with the libraries playing an important facilitating role. Interconnected institutional repositories of publications are an important means of gaining access to Dutch academic output.

• *Copyright*: Maximum access to academic information for research and teaching will depend on a more balanced policy and practice. This is a task for the all the institutions via SURF's ICT and Research Platform.

7.1.3 Education

There are two conditions for the fundamental renewal of education through the use of ICT.

• *Digital didactics (teaching methods)*: Various disciplines, such as educationalists and educational psychologists, will have to conduct research into types of teaching methods that make the best use of new ICT tools. Developing an educational vision and an associated pallet of teaching methods is a job for the institutions, as employers and providers of high quality tuition.

• *Training the teaching staff*: This is a question of lifelong learning as part of the institutions' HRM policies; we cannot wait for the next generation of faculty. The SURF strategic plan mentions the sabbatical as one opportunity, but others are possible, such as knowledge networks, refresher courses, one-day seminars and hands-on training. The SURF Foundation can provide help in organising these learning activities, for example via ICT and Education tenders in which institutions can try out new techniques in a new pedagogical design before applying them on a larger scale.

7.1.4 Infrastructure and services

Centralisation engenders resistance to relinquishing ownership because of an understandable fear of losing control over information. It is appropriate for those facilities that are used in the same way by large groups of people. These include infrastructural facilities like email, file servers and office applications. Specific facilities for small groups of individuals can also be provided locally (per faculty).

• *Decentralised ICT services* will no longer be owned, which will probably lead to a change in the way they are structured.

• *Service level agreements*, laid down in contracts, must be a key element in the new relation between ICT services and their clients. 'Best effort' contracts will only be adequate in special cases, for example for supporting research.

• *Server-based computing* (SBC) will, in a few years time, be able to accelerate the process of centralisation through the possibilities for reducing the costs of maintaining ICT workstations. Institutions should encourage their ICT service departments to start pilot projects in this area.

• *Storage area networks (SAN)* are transparent clusters of storage media and are now available for operational use. In time, grid technology can also be used to present various geographically distributed storage media as if they were one system.

7.2 Researchers

Researchers often find their own way through the maze of new developments in their own academic field. However, in the humanities and social sciences they run the risk of failing to keep up with technical developments.

7.2.1 Organisation

• *E-science*: For almost every activity it is possible to find a suitable method for long-distance collaboration, such as email, instant messaging, peer-to-peer Internet telephony, data grids and access grids. The associated working methods have been developed, particularly in the science subjects, and are collectively known as e-science. Together with other organisations, such as NWO/NCF, SURF can play an important role in raising awareness of the available possibilities.

7.2.2 Research and information

• *Open archive*: Researchers must become aware of their key role as producers of information. Offering access to their own research data also means obtaining access to the research data of others. Copyright must not be transferred to publishers as a matter of course.

7.2.3 Education

• *Digital research tools*: Initiatives like the National Education Web for Knowledge Technology (*Landelijk Onderwijsweb Kennistechnologie*) show that an extensive collection of subject-specific assignments can be constructed using relatively simple tools, while at the same time bringing faculty and developers of assignments together.

7.2.4 Infrastructure and services

• *Academic applications*: Many academics have to install special software on their workstations which cannot be supported centrally. This does not apply to applications like email, or to software that can be made available from a server, such as office applications and groupware solutions. It is advisable, therefore, to work with standard SLAs for these standard applications and separate contracts or 'plus services' (support provided specially for an individual or small group) for special applications.

7.3 Faculty

Everyone recognises the advantages of educational innovation, including faculty, but at the same time everyone (including faculty) thinks that faculty are the least inclined to help to make it a success. In the years to come they will have to improve their own image.

7.3.1 Research and information

• *Information broker*: The continuing process of digitisation is creating almost unlimited access to all sorts of information. Now that the services of the UKB licensing office are also available for use by the Samenwerkingsverband Hogeschoolbibliotheken ['Partnership of University of Professional Education Libraries'][2] both the quality and number of information sources available to faculty and students are rising. It is up the faculty staff to incorporate use of this information in their teaching activities by adopting the role of information broker.

• *Meta-information*: Faculty is also a producer of information because they prepare teaching materials. The exchange and reuse of this material will depend on standardisation of the meta-information. Standardisation, however, requires an intuitive interface so that the faculty staff can concentrate on the content.

7.3.2 Education

• *Own initiative*: Faculty are generally satisfied with the level of technical support and training they receive in the use of ICT in their work. However, only 28% think that support for teaching

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[2] The Samenwerkingsverband Hogeschoolbibliotheken (SHB) was established and is run by eight

methods is adequate. ICT is used mainly in the logistics and organisation of tuition, such as registering for interim examinations. Instead of waiting for this support to materialise, faculty would be better advised to take the initiative and start exchanging teaching tools and experiences among themselves. By doing so, they would be making an important contribution to innovation.

• *Communication:* Communication with students, among students and among faculty is a key requirement. Collaborative learning requires the development of new types of tasks and the provision of adequate resources. Although the institution can adopt a facilitating role and come up with new forms of education, it is the faculty staff that will have to take the necessary steps.

7.3.3 Infrastructure and services

• Via the *ICT and Education tenders* SURF offers a good platform for trying out various facilities and educational methods and establishing the types of support they require.

• *Coordination at the level of the institution* is necessary to ensure that new methods are compatible with the educational vision of the institution and that the facilities used eventually become a structural part of the services provided. The ICT services will also have to be included in the design of educational innovation projects.

7.4 Students

Students easily pick up new technologies, and with the introduction of the Bachelors/Masters system they will soon be able to 'vote with their feet' on the quality of the courses. It is advisable, therefore, to engage them in a proper discussion about the courses, including the structure, implementation and evaluation of projects.

7.4.1 Organisation

• *Switchers*: We do not yet know how many students will move between institutions during their studies, but administrative systems will have to be organised so that they at least do not form an obstacle to mobility.

An important first step in this direction is the Virtual Clearing House, which enables the transfer of administrative data. Another development is the digital portfolio, in which students can save their study information, results and products and use them elsewhere. These developments are still in their infancy, but are being moved forward in various SURF-projects.

7.4.2 Research and information

• *Learning to use digital information*: For students, faculty will become a prime source of expertise on information sources: their reliability, the linkages between them, their usability, etc. Students will have to learn that this is the essential difference between experts and laymen, and that access to an unlimited amount of information is a necessary but not a sufficient condition for acquiring competences.

• *Security* is an increasingly urgent issue. Sometimes access to information is only granted if users are on the institutions own network. In future students will be less willing to accept this limitation and will demand that their institution provides user-friendly access to information, wherever they may be.

7.4.3 Teaching

• *Collaborative learning* is clearly gaining ground, albeit somewhat hesitantly due to the lack of adequate experience among both faculty and students. Students have to learn to plan and allocate tasks, complete some tasks on their own, and report on these to the other members in their team and to the faculty staff. Communicative skills and the effective use of communication techniques will be increasingly important in future.

• *Contributing ideas* on the structure and implementation of a course or new method should be encouraged in students. The SURF Foundation can further this by demanding that students (or their representatives) actively participate in the management of educational innovation projects.

7.4.4 Infrastructure and services

• *Wireless mobile devices* will soon be a more common feature of student infrastructure and the distinction between the mobile telephone and the computer will become blurred. The rise of the ad hoc network based on short-range radio technology (up to 10 metres or more) fits perfectly in the trend towards more collaborative learning. This requires a seamless integration of various communication techniques, and students will expect these to be available on campus. This will also require a user-friendly form of security.

7.5 Government

Higher education relies to a large extent on the facilitating frameworks and finance provided by government. This means that government plans for higher education established in national and European objectives have a crucial influence.

7.5.1 Organisation

• The *Bachelors/Masters (BaMa) system* requires a rapid exchange of study data and an administrative system to support this, while respecting the rules governing data protection and privacy. In anticipation of this, the various actors have proposed the introduction of a Virtual Clearing House. It is crucial that government does not only support initiatives like this but that the necessary financial and legislative arrangements are put in place. Before it encourages new activities, government should consult with the education sector to determine whether they meet the needs and wishes of the higher education sector.

7.5.2 Research and information

• Without *high-quality research* of its own, the Netherlands will have to rely on foreign expertise and skills, and students will be more inclined to choose to study elsewhere in Europe. The recently established Innovation Platform can provide an important impetus for teaching and research.

• In particular, the existing *knowledge infrastructure* must be promoted as a key motor for new developments in higher education. Core concepts are e-science, grid technology and wireless. An example of a concrete and powerful incentive by government is the NAP subsidy for the 2003–2006 period for the Digital Academic Repositories initiative.

7.5.3 Teaching

• *Professionalisation of faculty* is a priority goal. Faculty tends to teach in the same way that they themselves were once taught, and too often they lack the ICT skills their students have. This gap can only be bridged if faculty are given the opportunity to undertake continuous professional development, and are actually required to do so. The prime responsibility for this lies with the institutions as employers, but the government also plays an important role in helping the institutions to design the HRM policies needed to achieve this.

7.5.4 Infrastructure and services

At the moment, the higher education infrastructure in the Netherlands is among the best in the world, but its position is highly vulnerable. Taking a complacent attitude now will mean we will have to invest heavily in catching up again in five years' time. Issues concerning the educational infrastructure that will require action in the near future, including action by government, comprise *fibre to the home, mobile* and *wireless communication* and *grid technology* for e-science. *Authentication* and *identification* must be improved, standardised and made user-friendlier if the services available via this infrastructure are to be transparent for all parties. A good example of this is the *Burgerpin*[3] initiative taken by various government agencies. The same parties, however, justifiably note that while they can do a lot on their own, 'extra benefits can be obtained if the Government would quickly resolve a few crucial issues', especially in the filed of electronic identification, the reuse of data and a generic infrastructure for accessing data.[4]

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[3] www.burgerpin.nl

[4]

8 In conclusion

An important conclusion that can be made on the basis of the Trend Report is that Dutch higher education is on the right course and is every bit as good as in other countries. The reported trends have not changed in any fundamental way since the Scientific Technical Council (WTR) published its advice for the SURF Strategic Plan 2003–2006 (*De kern van de zaak*) at the end of 2001.

One exception to this is the rapid growth of wireless mobile telecommunications with increasingly fast and better quality connections. These improvements are of special benefit to the more mobile users, such as students, because it frees them of the need to find computer facilities to use.

In future, people will genuinely be connected to the rest of the world independently of time and place. The key issue will not be the technology itself, but using it efficiently and to best effect.

More information

You can find more information about the WTR, including a list of completed projects, on our website:
http://www.surf.nl/wtr

If you are interested in obtaining advice from the WTR for your organisation, please contact the secretary.

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