

Focus Area: Information Technologies in Science and Society

Submitting Dean: Prof.dr G. van Koten (Faculty of Science).

Participating Research Foci

- Information Society (Science)
- Health and Life (Science)

Scientific Focus

Research Area

”... decades of stunningly rapid advances in processing speed, storage and networking, along with the development of increasingly clever software, have brought computing into science, business and culture in ways that were barely imagined years ago. The quantitative changes delivered through smart engineering opened the door to qualitative changes. Computing changes what can be seen, simulated and done.” (Stephen Lohr 2006)

The, unexpected, longevity of Moore’s Law for all hardware components of computers proves to be a double-edged sword both for science and society in general. On the one hand, the nearly limitless availability of computing power, storage space, and network capacity enable new, and better, ways to conduct almost any human activity. Progress in science increasingly depends on the computer models that informatics allows one to create, businesses depend crucially on the complex systems of modern IT. Locality is quickly becoming irrelevant for collaborations, and information is available everywhere and anytime.

On the other hand, almost paradoxically, exactly these boundless opportunities prove to be the biggest hurdle for their exploitation. For example, having all information at your finger tips does not make it easier to find the information that you need. The biggest challenge for the information society is to harness its complexity in such a way that it can deliver its full potential. Advanced information technologies are needed to fulfill the dreams of e-science.

The goal of this focus area is: pushing the frontiers of what is possible in science, business and culture by the deep challenges of suitable information technologies, while ensuring the usability. The main themes of research in the focus area are the following:

Game, Media and Agent Technology: The research of this theme centers on game technology, multimedia, intelligent systems technology and human-computer interaction. These technologies play a fundamental role in many domains, in particular those in which interactive multimedia environments must be modeled, simulated, and visualized. The goal is to create technology for highly effective simulation, learning and training experiences and, for example, provide high-level technologies for the appropriate segments of the creative industry.

Information and Systems Modeling: The research of this theme centers on the deep problems in the understanding of information-based processes in any context. It concerns advanced issues in information mining, decision networks, computational complexity, software system construction, embedding in communication and organizational structures, business-IT alignment, and the cross connections in science. The research is fundamental for the efficient design, concept-based construction, embedding and delivery of systems. At the same time it impacts on the informational modeling and simulation of processes as complex, adaptive information systems in the sciences.

The research of multimedia and agent technology and of novel information and systems models are the core of the modern IT-developments. Advances in these fields continuously lead to new visions on scientific methodology (computation labs and e-science), to new concepts for business and industry (complexity masters and integrated supply chain management), and to great innovations in the way we handle information (world wide web and search engines), in the service industry and health care (agent-based systems and electronic patient files), and in our working and living environment (wireless grids and ambient intelligence). These development greatly influence the way we will do science and business in the future and more generally, the way people act and interact in the future information society.

The scientific challenge for much of the research on ‘Information Technologies’ is the not well-understood information processing nature of complex processes. Both man-made and natural complex system exhibit this and both in science and in society it has wide applicability. The understanding of complex processes is crucial for many fields of human endeavour and the key to new scientific vistas. In science there is a strong link to e.g. the focus area ‘Molecular Life Sciences and Bioinformatics’, as large parts of molecular biology research is also targeted at this phenomenon; Genomics, Proteomics, and Systems Biology are prime examples of this. Moreover, as an application area, the life sciences suffer from the double-edged sword over the information society as well. The vast amounts of experimental data that is generated in high-throughput experiments potentially offer unprecedented insight in biological processes. Actually distilling this insight from this data however remains a serious challenge in information processing technologies in many instances.

In the research on information technologies, we take an integral view of the ‘science-technology-user’ spiral. Aside from the impact of IT on science, what is the impact on businesses, how do companies adapt and improve, and how do they modify their business models? What is the impact on society, how do users adapt and how does IT in general lead to an improvement in the qualities that we experience around us? Increasingly, systems and services are only available electronically. These systems and services will be far more flexible than most other services in society at present, they are always on and reachable anytime, from anywhere. These aspects relate to the focus area ‘Lifecourse Dynamics’. In the course of people’s lifetime, the IT systems in society will provide them with a range of opportunities not accessible in any other way. How is social inclusion maintained, what is the ideal balance between IT and its users, and to what research does it in turn lead in the development of the informational foundations of IT systems?

Activities

Together with TNO and the Utrecht School of the Arts (HKU) a research center on *Advanced Gaming and Simulation* (AGS, <http://www.gameresearch.nl/>) has been created. This research center will bring together about 45 fte researchers from the participating organizations. The center has been approved by the boards of the organizations and will start in the course of 2006. Together with the group ‘Nieuwe Media en Digitale Cultuur’ (Faculteit Geesteswetenschappen), HKU, and HU the *Utrecht Platform for Game Education and Research* (UPGEAR, <http://www.upgear.nl/>) has been created which establishes Utrecht as the focal point for game-related education in the Netherlands. The main research activity will center around the recently approved FES-project GATE. It is a 10 ME-research project of the mentioned partners, with co-involvement of TU Delft, UTwente, Waag Society, Thales, Nederland Breedbandland and many game-related companies in the Netherlands. It will be managed by the AGS center and establishes Utrecht as THE research center for gaming and simulation in the Netherlands. Along the same line there is an active involvement in the current round of the SmartMix program.

The Life Sciences are a good example of the data explosion seen in many contexts. High-throughput experiments in Genomics and Proteomics generate large amounts of data. Similarly, new microscopical imaging techniques yield large, detailed, images. All this data has to be stored, shared all over the world, integrated with related information available over the web, and above all, analysed. For the Life Sciences this is a very real application problem, while for Information and Systems Modelling, this is a treasure trove of research issues. One of the planned activities, therefore, is a collaboration between the focus areas ‘Information Technologies’ and ‘Molecular Life Sciences and Bioinformatics’. The goal is to found and establish a *Expertise Platform for Massive Data Research*, where the partners can share resources such as (storage) hardware, software as well as expertise in how to tackle these problems.

Outside the UU, within the Netherlands and internationally there are a large number of further research collaborations on all aspects of the focus area. This concerns participation in a number of BSIK projects: BRICKS (with the CWI and TU Delft), Multimedien (with UvA), and DECIS (with Thales). In the context of GATE there is a close research collaboration with e.g. CycloMedia and Noldus Information Technology. In a NWO-CATCH project there is collaboration with the Meertens Institute and the Theater Instituut Nederland, and in a NWO-Casimir project there is a collaboration with Elsevier. Other collaborations exist with AMC/UMCU, CIDC, CWI Amsterdam, FP5 NoE Epizone, NKI, NLR, Philips Research, Philips Medical, and companies like: Capgemini, Deloitte, Exact, Logica-CMG, NLR, ORTEC, Unit4Agresso, and the Platform Product Software. Moreover, there is extensive collaboration with universities abroad (see under Valorisation).

Accompanying Measures

Research on information technologies is a key issue across faculty boundaries and, also, across departmental boundaries in the Faculty of Science. The informational understanding and modeling of processes is of eminent importance in many contexts. Through this focus area the Faculty wants to contribute to IT research across boundaries, at the same time strengthening Utrecht University’s strong and leading position in this field. The connections with research

in artificial cognitive intelligence in the Department of Philosophy will be further developed.

The development of the focus area is accompanied by several measures. The outlined research themes of the focus area build on current strengths of various participating groups and of the Department of Information and Computing Sciences in particular. The research of the department is being aligned with the focus area, and the internetworking with the other themes is being facilitated. The growth potential is clear and all internally and externally funded research will be aimed to fit within the focus area. The further consequences will be formulated and developed in the forthcoming ‘hooglerarenplan’.

Positioning

IT-oriented research is high on the agenda of every University on the world and in many other research institutions. Europe’s Information Society portal (http://europa.eu.int/information_society/index_en.htm) shows an impressive range of relevant issues in IT. Utrecht has an excellent reputation in the field, both in the core science of IT and its application domains in e.g. bio-informatics, cognition, and scientific computing. The research directions which are brought together in the focus area at the University level form a unique and strong assembly, within the Netherlands and beyond. unique and strong assembly, within the Netherlands and beyond.

In the course of 2006, the Computer and Information Sciences departments of UU, UvA, and VU, together with the national Centre for Mathematics and Computer Science (CWI), are expected to agree on a far-reaching strategic cooperation in research. This will lead to one of the strongest centers for ICT research in the Netherlands, joining and respecting the unique strengths of the departments in the ICT research field. The UU focus area ‘Information Society’ is complementary to the fields of the other partners.

The combination of research groups as found under the research themes of the focus area is unique in the Netherlands. Healthy competition is combined with fruitful collaboration. The first theme combines research areas, ranging from the informational and technical aspects to the cognition and communication aspects, is only found here, with the expert cooperation with TNO and the HKU as further unique feature. With the University of Amsterdam there is a close collaboration on ‘creative content technologies’. The second theme covers the full development chain of information and systems modeling, which is also unique in the Netherlands. The research on dependable and embedded systems as found e.g. at Technical Universities is characterised by a more technological emphasis. Complementing 3TU-themes, the research on information technologies emphasizes the entire chain from the advanced analysis to the formal and operational aspects of the development and deployment of innovative information-based systems and services.

Internationally the positioning is very much the same. The individual groups are well-positioned players in their key areas, while the combined focus is a strong formula only found at the best Universities, including Utrecht.

Valorisation

Consortia

Together with TNO and the Utrecht School of the Arts (HKU) a research center on *Advanced Gaming and Simulation* (AGS) has been created. The consortium is nationally recognized as one of the leading centers for research in serious gaming and simulation technology. The recently approved FES-project GATE, in which also the group ‘Nieuwe Media en Digitale Cultuur’ (Faculteit Geesteswetenschappen) participates, is a leading project with a substantial valorisation component. The university increasingly calls on the research theme as an example of how fundamental and applied research and valorisation can go hand in hand.

Utrecht is also a leading member of the ‘Platform Productsoftware’ in the Netherlands, an organization of software vendors and research groups for the exchange of knowledge and experience on the novel issues and challenges in the design of scalable information and software systems. The consortium closely links to the new European Software Association. At UU, valorisation also takes place through its unique ICT-incubator construction *Netherware*, especially aimed to help students bridge the gap to entrepreneurship in IT. It is a unique activity which has already attracted much interest and attention.

The consortium that is being formed by the Computer and Information Sciences departments of UU, UvA, and VU, together with CWI will be one of the strongest Centers for ICT research in the Netherlands. The consortium has as one of its aims to further the technology transfer and valorisation of IT research to industry and society.

Furthermore, the UU is a key member in several large BSIK project consortia, viz., BRICKS, Decis, and Multimedien. The valorisation of this research in these projects is directed in a broader context under the auspices of a special ‘Outreach Office’. Moreover, the research groups of the ‘Information Technologies’ focus area participate in many smaller collaborative projects funded by NWO, STW, and/or IOP.

Internationally, the ‘Information Technologies’ groups have been and are active in a large collection of EU projects. Moreover, there is formal and informal collaboration with leading European universities such as BRICS Aarhus, CTI Patras, Free University of Berlin, LAAS-CNRS, Max Planck Institut für Informatik, Rome La Sapienza, UPC Barcelona, and many more. In the US there are active collaborations with research groups in e.g. Berkeley, Princeton, UC Santa Barbara, Stanford, University of Illinois at Urbana-Champaign, and MIT.

Societal Valorisation

Interactive multimedia environments play an increasingly important role in many applications. Computer simulations and games are for example used in many learning and training situations and offer an important added-value to traditional learning. The market for such ‘serious gaming’ applications in the Netherlands alone is estimated to be currently about 375 MEuro per year and is expected to increase rapidly. Beside the economic impact there is also an important societal impact as such applications will enhance learning, improve the

quality of life and lead to better safety training. Other important application domains include the creation of virtual museums, better communication applications, and improved user interfaces.

The information society leads to (i) ever more data being produced and stored, (ii) growing needs for ever more decisions based on it, (iii) which have to be processed and shared by ever more applications, (iv) by individuals as well as companies that wish to form and cooperate in flexible network organizations, (v) to provide the virtual worlds and services limited only by imagination. Data become ever more complex and so do the IT-systems on which society needs to depend. Classical design methods seem to have reached their limit and new inventions are needed for software and system generation. Research on novel concepts for information and software systems addresses the key issues, focusing on knowledge-intensive domains to address these challenges.

Research on Information Technologies impacts on many themes: education and training, the e-Economy, culture and society, and the general quality of life ‘through making health promotion, health care and environmental protection more efficient, and by giving people the information they need to make informed decisions about their lives’¹. The focus area can make unique contributions here, with its crosslinks to the focus area ‘Lifecourse Dynamics’.

The modern information technologies affect many parts of people’s lives and challenge all notions we have of an inclusive society. Individuals as well as companies wish to form and cooperate in flexible network organizations. Large amounts of data are being produced and stored, and the information systems on which society increasingly depends become ever more complex. The participating research groups in Information and Computing Sciences (‘Informatics’) heavily contribute to the scientific and technical developments, but also study the ways the new technologies have to be made available, how they might be most useful for people, and what factors determine their success or failure. For example, in very successful research jointly with Deloitte, instruments are developed for the problem of business-IT alignment. In other projects, issues of usability and ‘cooperative ict’ are tackled, and also e.g. the impact of large-scale national and international information exchange. Through many contacts with companies and organizations (e.g. Ministry of Justice), there is excellent potential for future valorisations of the research.

Position and Opportunities for Graduate Education

The focus area is very active in engaging students in its research themes, and the training programs score consistently high in the national assessments. More than 250 masterstudents currently study in the corresponding masterprogrammes and prepare for a career in scientific research, industry, business or other sectors of society. High Tech starters are accommodated in *Netherware*, the ICT Incubator for Students, through the masterprogramme MBI.

¹Quoted from the European IS portal.

Acquired funding in the past five years

Utrecht is the leading site of the recently approved FES-project *Game Research for Training and Entertainment* (GATE). From its leading position in this field, the focus area is involved in various other Dutch initiatives in game research, education, and business development. A next proposal, in the domain of information and software systems and their application ('Software as Service'), is under development for the upcoming funding rounds. The rapidly growing position in terms of external funding is listed under the 'Key Figures'.

Future Opportunities

The 'Information Technologies' focus has a long history in successfully attracting both national and international funding for its research. The opportunities to remain doing so in the future are excellent as can be seen from the following list.

NWO/EW: The research in the Information Technologies focus fits in the current NWO-theme *Digitalisering en informatisering*, the NWO/STW themes *Digitale Beleving*. It also matches the themes *Intelligente Systemen*, *De Computer van de Toekomst*, *De Data-Explosie* and *Methoden voor Ontwerpen en Bouwen* of the *NOAG-ict 2005-2010*, the areas *Ambient Intelligence* and *Creative Industry* of the *Strategic Plan ICTRegie 2005-2010*, and the 'key area' *Creatieve Industrie* of the Innovation Platform.

NWO: In the recently announced 'NWO-strategie 2007-2010', the research themes in the Information Technologies focus directly match with the themes *Creatieve Industrie* and *Kennisbasis voor ICT-toepassingen*. They also link closely to several of the other thematic programmes such as *Nieuwe instrumenten voor de gezondheidszorg* and *Systeembiologie*.

ICTRegie: The Information Technologies focus fits very well in various strategies and initiatives that are being developed by the *Netherlands ICT Research and Innovation Authority* (ICTRegie). In particular, several of the anticipated 'ICT Innovation Platforms' that are to be created in the Netherlands directly connect to the themes of the focus area.

EU: EU-level research is concerned with the Information Technologies focus already for several years and continues to target it in a major way. The research fits in the EU FP-7 theme (2007-2013): *Information and Communication Technologies*, especially the ICT Technology Pillars: *Simulation, Visualization, Interaction and Mixed Reality, Software, Grids, Security and Dependability* and *New Perspectives in ICT drawing on other Sciences and Technical Disciplines*, and Application Research in *ICT Supporting Business and Industry*.

Key Figures

Participating research groups

- *Games and Virtual Worlds* (M.H. Overmars),
- *Multimedia and Geometry* (R.C. Veltkamp),
- *Intelligent Systems* (J.-J.Ch. Meyer),
- *Cognition and Communication* (H. van Oostendorp),
- *Content Engineering* (J. van den Berg),
- *Algorithmic Systems* (J. van Leeuwen),
- *Decision Support Systems* (L.C. van der Gaag),
- *Large Distributed Databases* (A. Siebes),
- *Organization & Information* (S. Brinkkemper),
- *Software Technology* (S.D. Swierstra).

Cooperation with:

- Molecular Life Sciences and Bioinformatics
- Lifecourse Dynamics, Economic Flexibility and Social Cohesion.

Results of most recent research quality assessment

The figures below are averages of the SEP-scores attributed to the programmes related to the focus area (in 'Information Society'), with their standard deviation. Overall comparative score: very good to excellent (VSNU).

Quality	Productivity	Relevance	Viability
4 (0,61)	3 (0,52)	3 (0,41)	4 (0,55)

Number of Professorships

Currently: 8 full professors, 6 extraordinary/parttime professors.

Research size in FTE

The figures below do not include supporting staff.

	2001	2002	2003	2004	2005
1e geldstroom	70.4	60.4	79	82.3	66.4
2e geldstroom	14	20.4	21.8	23.4	19.8
3e geldstroom	5.4	9	10.8	20.6	18.3
Total	89.8	89.8	111.6	126.3	104.5

Research funding in KE

The figures below do not include the costs for housing and services.

	2001	2002	2003	2004
1e geldstroom	4.194	3.943	4.942	5.551
2e geldstroom	521	801	827	731
3e geldstroom	199	323	394	882
Total	4.914	5.067	6.613	7.164

Acquired ‘persoonsgerichte’ NWO/KNAW support

Selection:

- CASIMIR grant (drs A. de Waard, Elsevier), 2006.
- GADGET-project (dr M. van Kreveld), NWO FOCUS project comparable to Vidi, 2006.
- NWO PIONIER project (prof.dr.ir L.C. van der Gaag), 2002-2007.
- VENI project (dr V. Dignum), 2006

Relation to Graduate Education

Research master programmes, all part of the *Graduate School of Natural Sciences*:

- *Agent Technology*
- *Content and Knowledge Engineering*
- *Game and Media Technology*
- *Applied Computing Science*
- *Business Informatics*
- *Software Technology.*

Further Indicators of Research Quality

Selection:

- Prof.dr. J. Jeuring: OU professorship.
- Prof.dr. J-J.Ch Meyer: ECCAI Fellow.
- Prof.dr. M.H. Overmars: member ‘Koninklijke Hollandse Maatschappij der Wetenschappen’, scientific director UU-TNO Kenniscentrum AGS.
- Prof.dr. A. Siebes: scientific advisor Centre for Mathematics and Computer Science (CWI, Amsterdam).
- Prof.dr. S.D. Swierstra: scientific advisor Philips Research.
- Prof.dr. J. van Leeuwen: member European Academy of Sciences (Academia Europaea), member ‘Koninklijke Hollandse Maatschappij der Wetenschappen’, vice-president Informatics Europe, member ‘Nationaal Regieorgaan voor ICT-onderzoek en -innovatie’ (ICTRegie).

- Members of the research groups are frequently asked to serve on PhD committees elsewhere, both within the Netherlands and in other European countries, for their unique expertise.
- Members of the research groups frequently act as program committee chair or serve as program committee member for international conferences, symposia and workshops, evidencing their international research leadership.

Some Important Research Partners

Small selection (in the Netherlands):

- Centre for Mathematics and Computer Science (CWI)
- HKU
- Noldus Information Technology
- Philips Research Laboratories
- TNO
- Unit4Agresso