



## Annual Report 2008

**European Institute for Statistics, Probability,  
Stochastic Operations Research  
and their Applications**

The core business of EURANDOM is fundamental research in the stochastic sciences and their applications in an international environment



### **Alumni meeting**

During our 10th Anniversary, we also scheduled an Alumni-meeting. We had an interesting discussion with 20 alumni about the future of mathematics, and a lively dinner.

# 1. Introduction

EURANDOM was founded as an international institute on June 30, 1997 by the Netherlands Organisation for Scientific Research (NWO) and Eindhoven University of Technology (TU/e), with a large grant from the Ministry of Education and Science, and has been operational since the summer of 1998. Basic funding came from NWO and TU/e, until January 1, 2008.

January 1, 2008 the position of EURANDOM in the TU/e has been changed. The institute became organisationally embedded in the Department of Mathematics & Computer Science. Our location (Laplace building) will not change until the Department of Mathematics & Computer Science will move into a new building in 2011. Funding from the foundation EURANDOM is presently supplemented with money from grant applications. In addition, part of former costs is now covered by (in kind) contributions by the general board of TU/e and the Department of Mathematics & Computer Science, TU/e.

In 2008 we celebrated the 10th anniversary of the institute, with a conference in August and a "Public Evening" in October. *Statistica Neerlandica* dedicated its August issue to the institute. It contained an introduction by 3 former directors and contributions from speakers during the festive conference.



# 2. Mission Statement

The mission of EURANDOM is to foster research in the stochastic sciences and their applications. It achieves this mission:

- by recruiting and training talented young researchers and helping them to find their way to tenured positions in academia and industry;
- by carrying out and facilitating research through postdoctoral and graduate appointments, visitor exchange and workshops;
- by taking initiatives for collaborative research at the European level.



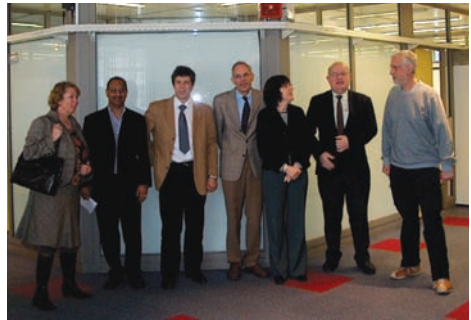
Research at EURANDOM covers *stochastics and its applications*, as well as its interfaces with other disciplines. The core business of EURANDOM is *fundamental research in an international environment*, carried out by a select and non-tenured staff of senior and junior researchers, supplemented with an extensive program of seminars, workshops and visitors. In spite of its modest size, EURANDOM is engaged in many activities on a local, national and international scale, making it into an important research facility in Europe.

### 3. The Role of Stochastics

Stochastics, consisting of statistics, probability theory and stochastic operations research, is a mathematical discipline that plays an important role in our technological society. We are more and more faced with organisations, systems and processes so complex that a description and analysis in terms of random elements is more appropriate and effective than a fully deterministic approach. Accordingly, stochastics is becoming increasingly important in other disciplines, like physics, chemistry, biology, economics and telecommunication.

Stochastics is internationally flourishing. Consequently, there is a great need to train a new generation of mathematicians with a strong knowledge of the foundations of stochastics, a good insight into the applicability of stochastics in diverse areas, and an open attitude toward newly developing theories and applications.

EURANDOM is officially recognised by the CNRS (Centre National de Recherche Scientifique) in France as UMI (Unité Mixte Internationale). This is an international joint unit through which CNRS is consolidating its international position in the field of mathematics, facilitating researcher mobility and creating a vast network of growing partnerships.



*CNRS delegation at EURANDOM*

### 4. Research at EURANDOM

One of the key instruments of EURANDOM in realising its mission is its workshop and visitor program. This program offers young scientists a well developed training opportunity. Workshops gather top researchers in the field to exchange the latest developments and ideas; sometimes concentrated mini-courses are given, in some cases junior researchers play a special role in a workshop.

Senior and junior researchers frequently develop a close cooperation with the visitors.

The scientific activities of EURANDOM are organised in three research programs, which are all central in the area of stochastics. Programs have two to four themes. In addition to the three programs, other projects may be running. In 2006 a project as a follow-up of the Battery Management program started: Integrated Batteries (i-Bat). It is performed in collaboration with the TU/e Department of Chemical Engineering and Philips Research.

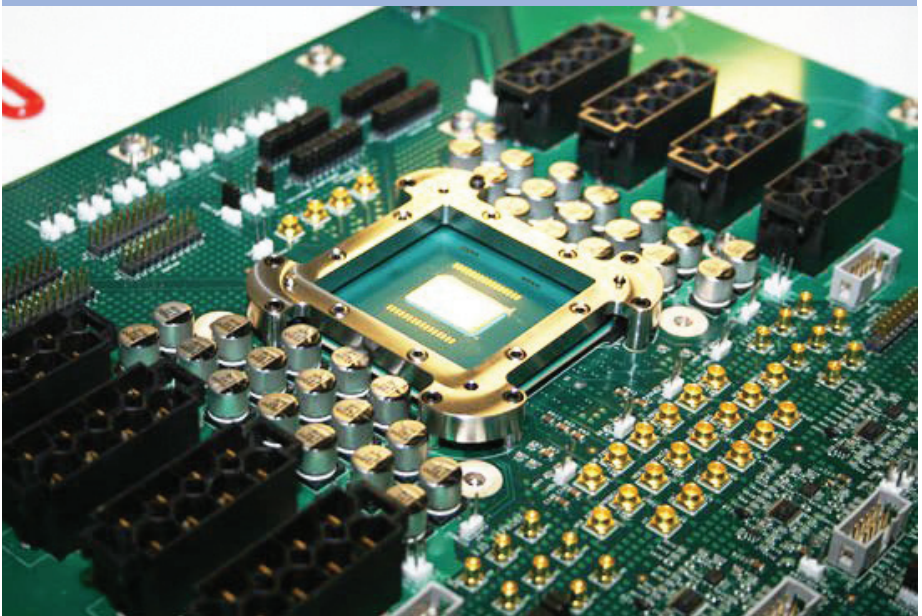
## **An example of research in QPA**

Paul Beekhuizen

Modules on a chip, such as processors and memories, are traditionally connected via single wires (buses). As chips become more and more complex, and the number of modules on a chip increases, communication difficulties arise because these buses cannot be used by multiple modules simultaneously. Networks on chips are an emerging paradigm for the connection of on-chip modules.

In networks on chips, routers are used to transmit data, so that multiple buses can be used at the same time and communication becomes more efficient. These routers have buffers, which leads to many performance-analytic questions that are interesting from both a theoretical and practical point of view.

For example, one is typically interested in how much data can be transmitted by the network (throughput), how long it takes data to be transmitted (delay), how large buffers have to be to deliver a certain quality of service, and so on. Due to the complex and unpredictable nature of data traffic, stochastic modeling and queueing theory play a key role in answering questions of this sort. EURANDOM participates in a project funded by and in close cooperation with Philips Research, where mathematical models are developed and analysed in order to answer such questions and predict the performance of networks on chips.



## **Queueing and Performance Analysis (QPA)**

The goal of QPA is to give a strong impetus to the analysis of queueing systems and their applicability to the performance analysis of computer, communication and production networks, and to the analysis of multivariate risk models. The program consists of four themes:

- Queueing Theory
- Performance Analysis of Production Systems
- Performance Analysis of Communication Systems
- Multivariate Risk Modelling

The latter topic lies at the interface of economics, finance and insurance. In the framework of a dynamic financial analysis, there is a strong need to investigate financial and economic issues that are relevant with respect to risk modelling. In 2009 Multivariate Risk Modelling will become the 4th research program of EURANDOM.

## **Random Spatial Structures (RSS)**

The RSS-program moves at the interface between probability theory and statistical physics. It focusses on the study of systems consisting of a large number of interacting random components. These components interact with each other and with their environment. Even when the interaction is local, such systems typically exhibit a complex global behaviour, with a long-range dependence resulting in anomalous fluctuations and phase transitions.

Themes:

- Critical phenomena
- Disordered media
- Combinatorial probability
- Applications in biology

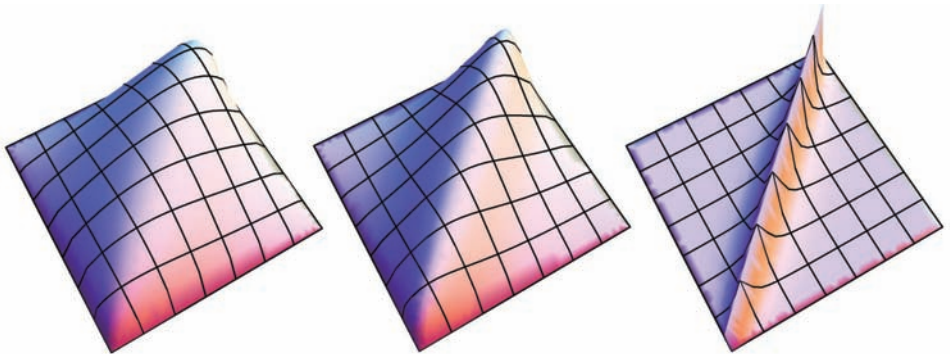
In the fall of 2008 EURANDOM became a member of the COST Action MP0801 "Physics of Competition and Conflicts". This Action promotes discussion and research across the physical and sociological disciplinary boundaries by providing a platform from which the participating researchers can develop important, new and substantial research initiatives aimed at tackling key trans-disciplinary issues. Overall the Action will provide a unique forum for physicists and mathematical scientists to share leading-edge knowledge, experience and to build up a common language with economists, social scientists, industry and government.

## An example of research in RSS

Dimitris Cheliotis

Several geometric properties of a finite graph are captured by the eigenvalues of its adjacency matrix or of the transition probability matrix of the simple random walk on the graph. A probability measure that encodes the set of the eigenvalues of either matrix is the one that assigns equal mass to each eigenvalue, taking also into account multiplicities. This is called the empirical spectral distribution of the corresponding matrix, and for the case of the transition matrix mentioned above, it has been computed for finite graphs with special properties, like the complete graph and certain trees. An issue of interest is the sensitivity of this distribution to small perturbations in the transition probabilities. That is, after altering the probabilities by a small random noise, independently at each site, how large and of what form is the induced noise in the empirical spectral distribution?

In a joint paper with Balint Virag, we study this question for sequences of vertex transitive graphs that converge locally to an infinite graph. We show that the induced noise, appropriately scaled, converges to Gaussian noise. For the case that the limiting graph is the infinite regular tree of degree  $d$ , we are also able to compute explicitly the covariance structure of the limiting noise. An interesting phenomenon occurs when  $d=2$ , i.e., when the limiting graph is the integers. Then the noise is localised, meaning that in their dominant order, the effects of the perturbation on different eigenvalues are uncorrelated. In higher degree trees, this is not the case. The cause, in graph theoretic terms, of the singularity when  $d=2$  remains to be found.



*The covariance structure of the limiting noise for  $d=4$ ,  $3$ , and  $2.1$  viewed from above.*

*The point of the picture is that the last graph is very peaked on the diagonal, and it refers to the point in the text that talks about the  $d=2$  case (the integers).*

## **Statistical Information and Modelling (SIM)**

Mathematical statistics is an indispensable tool in all fields of modern science. SIM focuses on themes from areas presently undergoing vigorous development, and supplying major challenges to statistics and data-analysis: biology and image analysis. Each area presents its own unique types of problem, but the same fundamental ideas from theoretical statistics can be applied in both, giving insight and creating underlying links. The availability of huge amounts of data, having a complex stochastic structure depending on very many unknown parameters, calls for statistical modelling and analysis techniques having a different flavour from classical methodology. Despite modern computational power, the problems require a closer than ever intertwining of algorithms and theory: scientific ambition and the size and complexity of data grow faster than our ability to mechanically process those same data.

## **5. Board, Scientific Council and Directors**

### **Board**

Professor dr. F.A. van der Duyn Schouten (member / treasurer until 24-06-2008, since that date chair / treasurer)

Professor dr.ir. C.J. van Duijn (member)

Professor dr.ir. G. van Oortmerssen (member since 24-06-2008)

### **Scientific Council**

Professor S. Asmussen (Aarhus University, Sweden)

Professor F. Baccelli (École Normale Supérieure, Paris, France) (until July 2008)

Professor J. Beirlant (KU Leuven, Belgium)

Professor E. Bolthausen (University of Zürich, Switzerland) (until July 2008)

Professor S. Borst (Eindhoven University of Technology and Lucent, Murray Hill, USA)

Professor D. Dawson - Chair (Carleton University, Ottawa & McGill University, Montreal, Canada)

Professor F. Delbaen (Eidgenössische Technische Hochschule Zürich, Switzerland)

Professor A. Frigessi (University of Oslo, Norway)

Professor P. Green (University of Bristol, United Kingdom)

Professor A. Greven (Friedrich-Alexander Universität, Erlangen-Nürnberg, Germany)

Professor P. Hall (Australian National University, Canberra, Australia)

Professor P. Massart (Université Paris Sud XI, Orsay, France) (until July 2008)

Professor Ph. Robert (Centre de Recherche INRIA Paris-Rocquencourt) (from July 2008)

Professor V. Schmidt (Ulm University, Germany)

Professor V. Sidoravicius (CWI, The Netherlands) (from July 2008)

Professor A.W. van der Vaart (Vrije Universiteit Amsterdam, The Netherlands) (from July 2008)

Professor N. Veraverbeke (Hasselt University, Diepenbeek, Belgium)

## An example of research in SIM

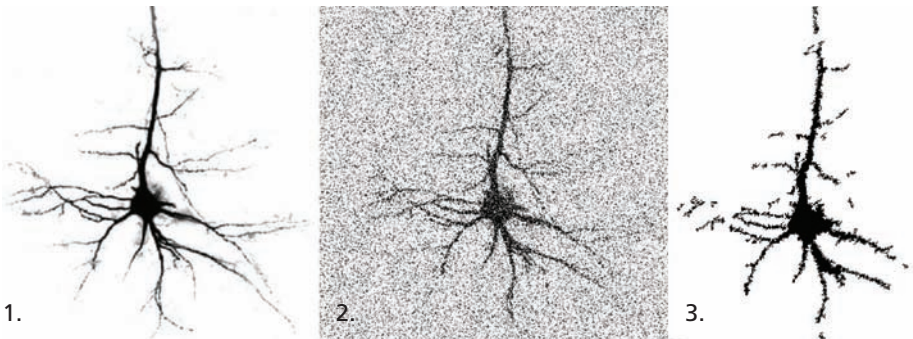
Mikhail Langovoy

In October 2008 I started to work on the topic of statistical and probabilistic image analysis in the group of professor Laurie Davies. We proposed a novel probabilistic method for detection of objects and reconstruction of images in the presence of random noise. The method uses delicate results from percolation theory and random graph theory. We are able to detect and estimate not only regular signals in the images, but also weak signals, as well as fine structures such as curves (even possibly those that are not visible by the human eye).

Together with Laurie Davies and Olaf Wittich, we proposed a randomised algorithm that permits detection of objects in noisy images very quickly: it seems that our algorithm works substantially quicker than, say, wavelets-based algorithms. Our detection algorithm is optimal in the sense that it has linear complexity and exponential accuracy.

Moreover, we designed an algorithm that produces a crude estimate of an object based on the noisy picture. This algorithm also has linear complexity and is appropriate for real-time systems.

Currently we are exploring properties of our algorithms by proving consistency of our estimates under different model assumptions, as well as by analysing performance of the procedures in different situations. Such analysis requires fine results from modern theories of discrete stochastic systems, but EURAN-DOM has good ties with many experts in those fields. We are already benefiting from discussions with scientists from the RSS group.



1. Negative of a part of a real neuron.
2. A neuron in a real-life study (e.g., a photo through a human body). In biomedical studies, most of the images are with some noise. For a human eye, it is quite obvious that there is some object in this picture, even despite the noise - but not for a computer. It is an important problem in neuroscience, biology, medicine and image analysis to teach a machine to detect irregular and unusual objects (as, for example, neurons) in noisy pictures.
3. A new type of reconstruction from noisy images from the above shown neuron

## Directors

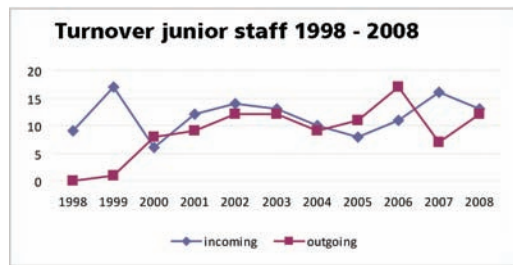
Professor O.J. Boxma, scientific director (since October 2005);  
Drs. C.M.M. Cantrijn, managing director (since December 2006).

## 6. Scientific Staff

At any time about 25 junior researchers are working at EURANDOM, from which in 2008 almost 20 were employed by the institute (through TU/e). Each program hosts on average eight postdocs and graduate students, supervised by senior fellows, and guided by an international steering committee. Since its start, over 100 PD's and PhD's have been working at the institute.

Most of the researchers found tenured positions in academia or industry after leaving the institute; about 10 were appointed full professor at different universities.

About one third of the former employees found a position at a Dutch university or in a research program of a Dutch company. About two third has secured tenured positions in academia or industry.



## Senior Fellows

January 1, 2008 a new senior fellow started in the SIM program: Geurt Jongbloed from Delft University of Technology. His research interests are: inverse problems, shape restricted statistical inference, incomplete data problems, nonparametric estimation, computational statistics, asymptotic statistics, applications of statistics in biology, medicine, computer science, business, river studies, and earth sciences.



In 2008 we said goodbye to Richard Gill (Leiden University, The Netherlands) and to Alessandro Di Bucchianico (TU/e, Eindhoven, The Netherlands) who both acted for 10 years as senior fellow of the SIM program. At the end of the year we also said farewell to senior fellow Bas Werker (Tilburg University, The Netherlands). We thank them all for their valuable contributions.

Remco van der Hofstad, senior fellow of the RSS program, received the "Innovative Research VICI Scheme".



August 1, 2008 Bert Zwart (CWI, The Netherlands) joined the QPA program as senior fellow. His research interests are probability and stochastic networks. In August 2008 Bert Zwart obtained an NWO VIDI-grant.

In December 2008 Ivo Adan has been appointed parttime professor at the University of Amsterdam. Former postdoc and research fellow Peter Grünwald as well as Vladas Sidoravicius, senior fellow and member of the scientific council, have been appointed parttime professor at the Mathematical Institute of Leiden University.

Two new senior fellows will start in 2009. In the RSS program Vladas Sidoravicius from CWI (Amsterdam, The Netherlands). His research interests are probability theory and stochastic processes. In the MRM program Roger Laeven (Tilburg University, The Netherlands). Roger's research interests are Probability and Mathematical Statistics, (Micro) Economic Theory, Actuarial Science and Quantitative Finance.

### **Awards**

Former postdoc Christian Gromoll won the prestigious best publication award, an award of the INFORMS Applied Probability Society for outstanding contributions to the field of applied probability. The award is accompanied by a plaque and a honorarium and is given once every two years. Some of the award winning research was done at EURANDOM.



At the 9th INFORMS Tele-communications Conference Tele-communications Modelling, Policy, and Technology (March 27-29, 2008, Robert H. Smith School of Business, University of Maryland, College Park, MD, USA) the Doctoral Dissertation Award for Operations Research in Telecommunications 2008 has been awarded to Johan van Leeuwen. The award aims to recognize outstanding scholarly achievements of young people in the field.



At the INFORMS conference in Washington Bert Zwart, senior fellow, received the Erlang Prize. This is an award for the best researcher under the age of 36 in the area of applied probability. He is the first person working at a non-American institute to receive this prize.



## 7. Facts and Figures

### Workshops and Conferences 2008

Workshop topics are chosen by the senior fellows and by the steering committees of the research programs. Ideas for topics are collected from postdocs and visitors, and through the various European networks and programs in which EURANDOM participates. An overview of all workshops is available on: [http://www.eurandom.tue.nl/events/workshops/all\\_workshops.htm](http://www.eurandom.tue.nl/events/workshops/all_workshops.htm)

January 9-12, 2008 (RSS)

Workshop "Metastability"

March 10-14, 2008 (RSS)

YEP V (Young European Probabilists) workshop: "Statistical Mechanics on Random Structures"

July 16-28, 2008 (RSS)

mini-workshop "Random Interactions and Statistical Mechanics"

August 26-28, 2008 (General)

10th Anniversary EURANDOM

A Random Tour through a Decade of Research

October 6-8, 2008 (SIM)

YES II (Young European Statisticians) workshop: High dimensional statistics

October 22-24, 2008 (QPA-MVR)

Handling and modelling of asset backed securities

November 3-7, 2008 (RSS)

Hitting, returning and matching in dynamical systems, information theory & mathematical biology

November 24-26, 2008 (SIM)

Locally adaptive filters in signal and image processing

December 1-3, 2008 (QPA)

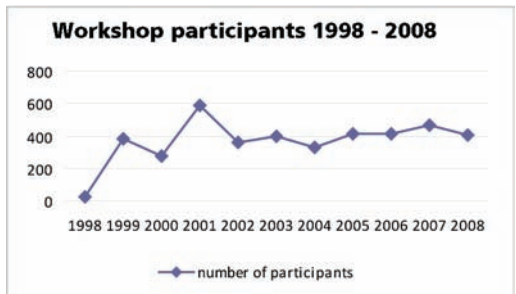
YEQT II (Young European Queueing Theorists) workshop: Stochastic analysis of modern communication networks

### Number of workshops in 2008: 9

### Total number of participants in 2008: 404

Furthermore,

- we organized a Public Evening on stochastics in everyday life;
- we co-sponsored the 5th European Congress of Mathematics;
- the EURANDOM Chair, professor Gordon Slade, gave a Public Lecture and a lecture series.



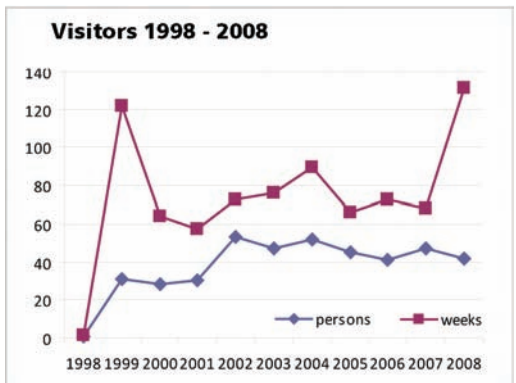
**Lectures and seminars**

**Number of lectures and seminars in 2008: 101**

Lectures and seminars are organised on a regular basis within the framework of each of the three research programs. Sometimes seminars are joint events, e.g. the Informal Meetings of Eindhoven Statisticians with TU/e.

An overview of all seminars is available on:

[http://www.eurandom.tue.nl/old/abstracts\\_seminars/2008tot.htm](http://www.eurandom.tue.nl/old/abstracts_seminars/2008tot.htm)



**Number of visitors (and visits) in 2008: 42**

**Total duration of stay in weeks: 131**

An overview of visitors is available on:

[http://www.eurandom.tue.nl/Past%20years/visitors\\_pastyears.htm#2008](http://www.eurandom.tue.nl/Past%20years/visitors_pastyears.htm#2008)

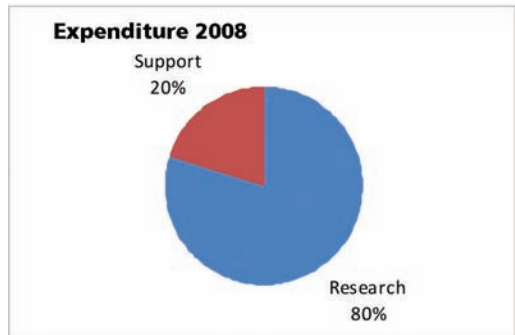
## Publications

In 2008, 56 EURANDOM reports were written, while the website of the Department of Mathematics and Computer Science mentions 74 external EURANDOM-linked publications.

[http://oametuep.uci.ru.nl/metue/pk\\_apan.onderzoek?p\\_url\\_id=4953](http://oametuep.uci.ru.nl/metue/pk_apan.onderzoek?p_url_id=4953)

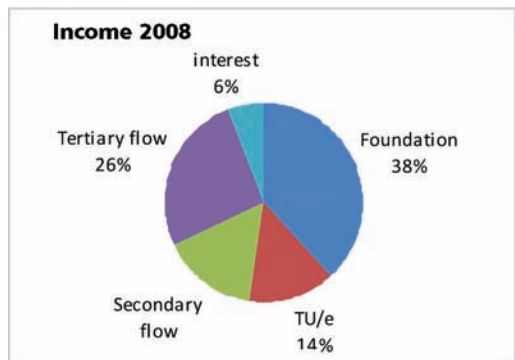
## Finance

The following figures report on income and expenditure:



*Research includes costs of salary of postdocs and graduate students, scientific director, senior fellows, EURANDOM chair, computing, library, workshops & visitors and travel costs.*

*Support includes salary of the administrative staff and managing director, depreciation and general costs.*



**Location**

EURANDOM is located on the campus of Eindhoven University of Technology, the Netherlands, Laplace building. The TU/e campus is situated close to the centre and the railway station of Eindhoven.

**Facilities**

EURANDOM provides office space and computing facilities. Lecture rooms and a modest library annex common room are also available. Full scale libraries may be found on the campus of the TU/e.

The TU/e campus offers facilities such as a sports centre, a language lab and restaurants, also available for EURANDOM staff.

Postdocs and long-term guests can be accommodated in one of the University guest houses. All employees are allowed to join the TU/e collective health insurance and can get help with procedures concerning visa, work permit etc.



Prof.dr.ir. Onno Boxma,  
scientific director

Eindhoven, June 2009