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Estonian ICT research and its impact – bibliometric analysis

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Introduction

In the contemporary society research is not the elevated pastime isolated from the concerns of society like it once used to be. Rapid technological development and change that draw much of their power from research demand more and better output. So do the enlightened governments that have realised the driving power of R&D in the process of economic development.

Once demand is created and governments face growing pressure on redistribution of funds (Butler 2003, Verbeek et al 2002, Weingart 2005) they also see to it that the output be measured and evaluated. Peer review was once the primary tool for research assessment. Now it is increasingly just a vital complement to the more operational bibliometric assessment of research (Debackere and Glänzel 2004, Weingart 2005). Bibliometric measures are seen as a more objective (Debackere and Glänzel 2004, Weingart 2005), cost-effective (Hix 2004) and less time-consuming (Hix 2004) tool of evaluating research. Starting with UK (Weingart 2005) and the Netherlands (Luwel et al 1999) in the 1980s, the bibliometric method of research assessment has thus been included in the research assessment exercises of most developed countries in the world with particularly extensive use by Finland and Australia (Butler 2003).

Estonia, now a full-fledged member of the European Union and global research community, is dealing with the same pressures for enhanced research performance at the ever tightening budget negotiations. After studying the experiences of other countries (the nearby Finland playing an important role again), Estonia decided in 2004 to introduce bibliometrics into the funding distribution formula of its newly reinstated base-line funding instrument. Organisation of Research and Development Act states that one of the criteria for distribution of funding is the number of publications in internationally recognised research journals (minor acts later specify that the set of journals is determined by what is included in the ISI *Web of Science*).

Such a situation has led to the need to gain a better overview of what is Estonia's current position in regard to its publications record. While the Flemish government decided to have a thorough analysis of the bibliometric records of their research institutions prior to actually including the bibliometric tool into the funding distribution formula (Debackere and Glänzel 2004), no such analysis was conducted in Estonia. Therefore it is high time to raise some discussion on what the actual situation is and what impact this new policy may have on the future of Estonian research and technology development performance.

Contributing to this discussion is certainly the broader goal of this article. The more specific objective, however, is to present a bibliometric overview of one field of research in Estonia in order to supply some actual evidence for the policy discussions. The field of information and communication technology (ICT) was chosen primarily due to the interest from the relevant research community. This choice is further supported by the prominence of ICT field in the strategic debates of Estonian R&D developments (e.g. see *Estonian R&D strategy for 2002-2006. Knowledge-based Estonia* and other national

R&D documents and studies). A lot of expectations are set on the developments in this sector in Estonia and the service sector especially has demonstrated much success already. Hence one of the indirect goals of this study is also to analyse how much potential there is in Estonian ICT research field to support the relevant industry.

The study presents a bibliometric overview of 5 ICT research institutions that are responsible for nearly all of Estonian ICT research and advanced teaching. In addition to the publication counts that are important in view of the new legislation, a closer look is also taken at the impact indicators of the ICT research. The results are then analysed in regard to potential implications about the institutional strength and developments. Comparisons of the institutional status lead to a brief discussion of possible funding outcomes from national budget.

Methodology

The data for this study was collected from the ISI *Web of Science*. This database is nowadays the most widely used source for bibliometric data both abroad (Inönü 2003, Verbeek et al 2002, Weingart 2005) as well as in Estonia (Allik 2003, Must 2006). The database does suffer from some shortcomings like relative bias towards English-language publications and limited presence of specific sub-fields (Losekoot et al 2001, Verbeek et al 2002), but to this day it is still the most comprehensive source for cross-subject international bibliometric analysis.

A bibliometric study of ICT research could yield much better results in case it were based on INSPEC, the worldwide bibliometric database in Physics, Electronic & Electrical Engineering, and Computer Science (Luwel et al, 1999). Current study, however, does not merely intend to give a simple overview of the field, but attempts to give the picture that is being and increasingly will be used by universities and funding institutions in their assessment exercises and decision-making. Thus, the results are certainly not all-inclusive, but give a realistic impression of the data used in actual policy processes.

The publication data is collected for a list of researchers from 5 major Estonian ICT research institutions, which should basically cover more or less the whole field. The researchers of these institutions are listed (see Appendix 1) on the basis of the following criteria:

- The researcher must have at least a master's degree that makes him/her liable to officially engage in research activities. Thus only people actually engaged in ICT research are included.
- Only researchers that are staff members of these institutions are included. This means, however, that some of the researcher may be listed as part-time staff members in more than one institution, and in such case the researchers are included under both institutions. The defining criterion here is whether the person is a staff member or not. Several of the researchers teach in other institutions as well, but only on a contract basis. Such contractual relations are not included.

- The field of research of the listed people is ICT in the broader sense (see explanation below).

On the basis of these criteria a list of all ICT staff researchers of the 5 major Estonian ICT research institutions was compiled. The list inevitably has some shortcomings in regard to the identification of the ICT sector – some scholars in this list could most probably be categorised as focusing on other fields than ICT. However, it is the very characteristic of paradigm-building technologies that they influence all fields of activity and thus very often change the whole pattern of looking at things. This process of spreading is to be welcomed both in technology and research. As a result, no extra effort was made in this research to discriminate between the "pure ICT" and the "extensions of ICT" in other sectors.

With the sample limited to 5 Estonian research institutions it also misses the records for the expatriates that are known to excel abroad. The study does recognise that there is remarkable potential in these people, and efforts should be made to enhance Estonian ICT research by attracting the expatriates as well as foreign researchers to come and work in Estonia. However, the goal of this analysis is to first identify what we have. Only then we can make realistic assessments of what we could or should have in the future.

This study does not focus on the profile of individual researchers. Some of the researchers have made major contribution to product development; others have spent more time on academic research. This study appreciates all their contribution. The focus here, however, is on the potential of Estonian ICT research as a whole and not on the benchmarking of individual researches.

All the articles (no limited timeframe set) of all the researchers were listed and counted, so were the citations to these articles. All this data was collected within the period of October till November 2004. The initial list of articles (Appendices 2 and 3) includes the following information:

- name of the author;
- name of the article;
- year of publication of the article;
- name of the journal where the article appeared;
- names and number of the co-authors of the article;
- citations to this article in the ISI Web of Science by the author of the article;
- citations to this article in the ISI Web of Science by the co-author(s) of the article;
- citations to this article in the ISI Web of Science by people other than the author or the co-author(s);
- abstract of the article.

This initial list provided the raw data for further analysis. The data was then aggregated and compared in regard to productivity and impact indicators.

First the most common productivity and impact indicators (see Debackere and Glänzel 2004, Glänzel and Thijs 2004, Hix 2004, Verbeek et al 2002 for further elaboration on bibliometric indicators) were derived:

- general productivity or the total number of articles – A
- general impact or the total number of citations – C (for informational purposes this indicator is further broken down into self-citations (SC), co-author citations (CAS) and normal citations or citations by people other than the author or the co-author(s) of the article (NC))
- article impact or average number of citations per article – CPA

These indicators were then aggregated on the level of country, institution and person, and various calculations presented.

One additional indicator was created for the purpose of this study in order to try and combine the quantity and quality indicators. Citations are generally treated as the primary indicator of research quality and sometimes even seen as a more important indicator than the number of publications (Butler 2003, Debackere and Glänzel 2004, Glänzel and Thijs 2004, Hix 2004). Thus this paper presents a grade (G) indicator that combines the number of publications and citations. The grade is again presented on all the three levels of aggregation – average grade per person (AGPP), grade per institution (GPI) and the country grade (CG).

The first level of aggregation presents the data for each person (Appendix 4) with the following indicators:

- name of the researcher;
- institution(s) where the researcher appears as a staff member;
- number of articles - A;
- total number of citations - C;
- average number of citations per article - CPA;
- final grade - G.

Further aggregation is presented in various aspects of data presentation.

Results

The final list of the staff researchers of 5 major Estonian ICT research institutions included 155 people as shown in Figure 1. As mentioned above, some of the researchers are listed as staff members of more than one institution, which is why the total in the Figure 1 is slightly more than 155.

Figure 1: Number of researchers from each institution included in the study.

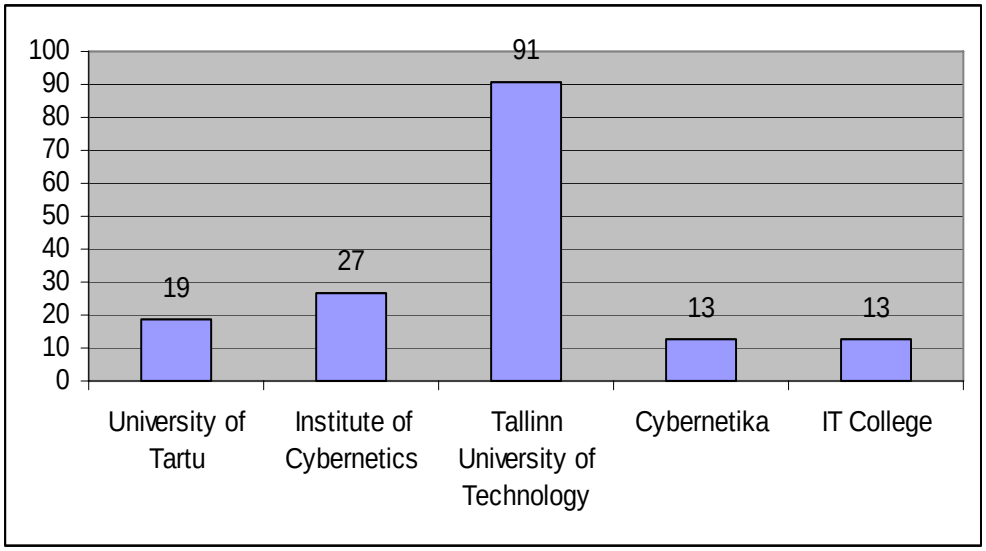


Figure 1 shows that more than half of the ICT researchers in Estonia are employed by Tallinn University of Technology. The second largest ICT research institution is Institute of Cybernetics. University of Tartu, Cybernetica and IT College all employ roughly the same amount of staff researchers.

The specialisations of research represented in the sample were the following:

- bioinformatics;
- optics;
- programming;
- programming/logics;
- semiconductors;
- time-stamping;
- computer technology and diagnostics;
- hardware technology;
- general informatics;
- system software and many others.

The aggregated productivity and impact indicators for the 5 institutions are presented in Table 1 below. The results for the University of Tartu are presented twice in order to show the average results for this institution without the one most extensively cited ICT researcher in Estonia.

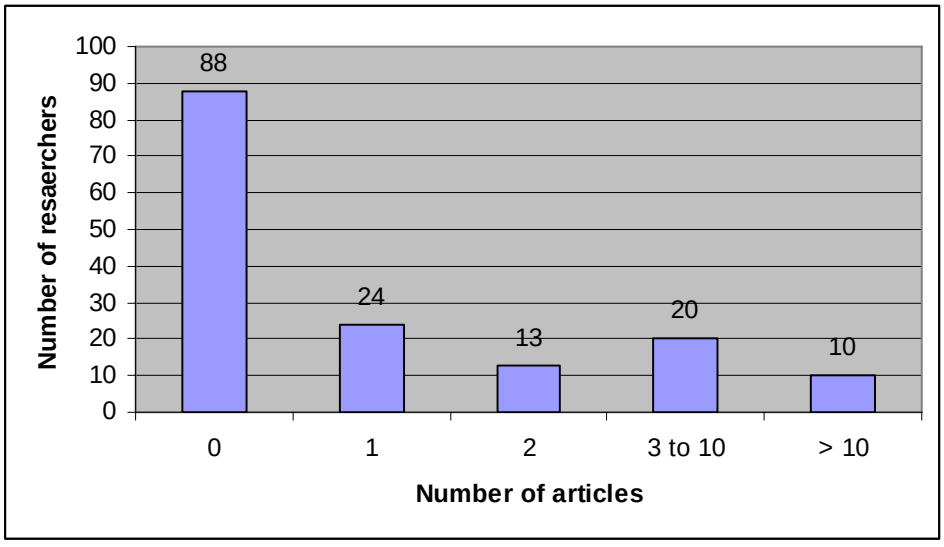
Table 1: Aggregated results of the publications data for each of the 5 major Estonian ICT research institutions.

	Researchers	A	C	CPA	GPI	AGPP
TU	19	41	778	18.98	819	43.11
Inst. Of Cyb.	27	143	272	1.87	411	15.22
TUT	91	149	169	1.13	317	3.48
TU*	18	27	44	1.63	71	3.94
Cybernetika	13	11	10	0.91	21	1.62
IT College	13	5	1	0.20	6	0.46

* TÜ without Jaak Vilo, the most extensively cited ICT researcher in Estonia
A – number of articles
C- number of citations
CPA – average number of citations per article in this institution
GPI – total grade for the institution
AGPP – average grade per person in this institution

The total number of articles published by the 155 researchers was 326 and these articles received a total of 1202 citations. Thus the total grade for this sample was 1528 and the average number of citations per article (CPA) is 3.69. Then again, as shown in Figure 2 below, 88 researchers out of the total of 155 researchers did not have any articles listed in the ISI Web of Science, which means that the total grade of 1528 only represents the results for 67 researchers. These 67 researchers had the total number of 326 articles listed in the ISI Web of Science. The results are further outlined in Table 1 and Figure 2.

Figure 2: Distribution of articles among the ICT researchers



The data in Table 1 show that initially the University of Tartu stands out with a very high result. However, once the one person with the highest record is removed, the results for the institution drop drastically. Thus the general picture shows a relative strength of the Institute of Cybernetics, though the impact indicator remains roughly similar for the Institute of Cybernetics, Tartu University and Tallinn University of Technology.

The case of Mr Vilo, the most widely cited ICT staff researcher in Estonia (see Table 3 below), is an example of the so-called "extension of ICT" into other sectors. Namely, Mr Vilo cooperates actively with Estonian biotechnology researchers and has been engaged in developing ICT support for biotechnology research. Thus several among his articles are co-authored by various biotechnology researchers and are widely cited by other biotechnology researchers. In regard to the evaluation of Estonian ICT research, however, his research is only to be pointed out as crossing the boundaries, but most certainly not to be discarded. ICT and biomedicine are two out of the total of three research areas prioritised in *Estonian Research and Development Strategy 2002-2006. Knowledge-Based Estonia.* In addition, ICT as a paradigm-changing technology is increasingly occupying the role of an enabling industry that is "responsible for the increase in productivity throughout the economy" (Wessner 2003). The fact that researchers have found ways to realise the enabling role of ICT industry only enhances the strength of Estonian R&D in general as well as both the ICT and biotechnology research in their own right.

Another comment to be made about the results presented in Table 1 concerns the IT College that ranks lowest in regard to institutional ICT research results. This can partially be explained away by the nature of this institution. As the IT College website so nicely explains, Estonian educational system has a gap that the College was created (1999/2000) to fill. Namely, most of the public universities offering ICT specialisations were very much focused on research. While strong ICT research is most certainly needed, the market demand is also very high for the simple ICT experts that have good insights in ICT systems and are highly skilled in practical applications. Thus the IT College primarily strives to fill this very market demand, though with the remarkable expertise in the field, the College can be expected to gradually develop its own respectable research base.

As mentioned above, the sample of this study includes a lot of researchers that do not have any publication record in the ISI *Web of Science*. Thus the sample was further analysed and results in Table 2 show that a significant part of the whole publication record can actually be ascribed to top 10 ICT researchers.

Table 2: Publications record of top 10 researchers compared to the total sample.

	Total	Top 10	Share of the Top 10
Articles	326	167	51.2%
Citations	1202	1063	88.4%
Grade	1528	1230	80.4%

Table 2 demonstrates that more than half of the articles in this set are published by top 10 researchers and their work has received 88.4% of all citations. Table 3 below illustrates further details about the results of these top 10 ICT researchers in Estonia. The most stunning outcome is that about two thirds of the whole citations score is actually the result of one man's work. Consequently, the researcher also exceeds all other researchers in regard to the average number of citations per article. This again indicates that remarkable outcomes can be achieved in interdisciplinary research.

Table 3: Publications data for the top 10 ICT researchers.

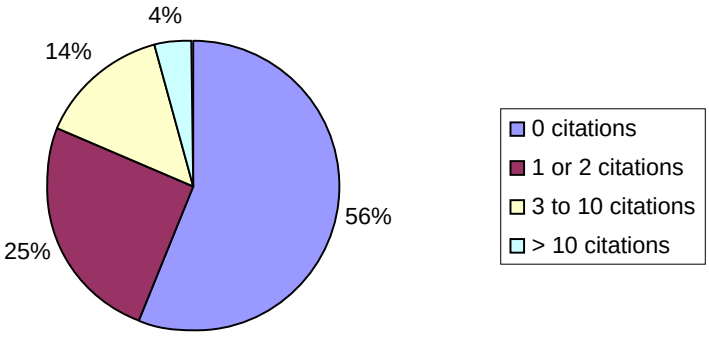
Name	Surname	Institution	A	C	CPA	G
Jaak	**Vilo**	TU	14	734	52.43	748
Hillar	**Aben**	Inst. Of Cyb.	30	88	2.93	118
Ülle	**Kotta**	Inst. Of Cyb.	30	80	2.67	110
Enn	**Tõugu**	Inst. Of Cyb.	33	39	1.18	72
Tanel	**Tammet**	TUT	10	45	4.50	55
Leo	**Ainola**	Inst. Of Cyb.	13	19	1.46	32
Andres	**Udal**	TUT	12	14	1.17	26
Enn	**Velmre**	TUT	14	11	0.79	25
Jaan	**Penjam**	TUT/Inst. of Cyb.	7	16	2.29	23
Ahto	**Buldas**	TUT/TU	4	17	4.25	21
		Total:	**167**	**1063**	**6.37**	**1230**

Table 3 shows that the major contribution in citations comes from one researcher at Tartu University, 3 other researchers at the Institute of Cybernetics are to be acknowledged for a considerable role in the total articles count. Each among the three above-mentioned researchers has produced at least 30 articles, which is an absolute maximum among Estonian ICT researchers.

As was mentioned earlier, Estonia's ICT research CPA is 3.69. However, as half of all the citations come from one researcher, the country average has become somewhat distorted with only four researchers actually achieving this level of CPA (there are 3 researchers in Table 3 above, plus one more researcher who has written one article and received 6 citations to this article). In order to gain a more accurate picture of the actual CPA, the contribution of that one top-cited researcher is removed. Thus the normalised data would be 312 articles and 468 citations resulting in the country ICT research CPA being only 1.5.

Figure 3 below further illustrates the impact distribution among the articles in the database. This figure only accounts for the actual 326 articles and does not include the researchers that do not have any articles at all.

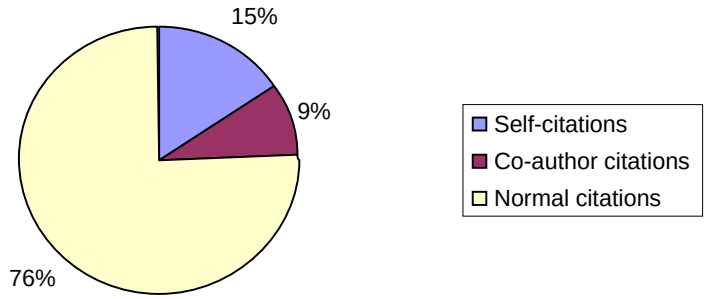
Figure 3: Share of articles (%) with the various impact levels (number of citations)



This figure shows that more than half of Estonian ICT research articles published in ISI *Web of Science* have not yet received any citations. This may partially be explained by the fact that there is a significant amount of very recently published articles that still have hope for being cited in the coming years. However, as the share of non-cited articles amounts to 56% this fact cannot, by no means, account for the lack of citations to all these articles. A quarter of all articles have received only 1 or 2 citations and another 14% up to ten citations. The share of truly extensively cited articles is a bare 4%.

Another aspect that is often monitored in bibliometric studies (Debackere and Glänzel 2004, Glänzel and Thijis 2004, Verbeek et al 2002) is the share of self-citations to the published articles. In this study, the citation results were thus also screened for self-citations and co-author citations (see Figure 4 below).

Figure 4: Share (%) of each type of citations among the total of 1202 citations.



The share of self-citations among all the citations appears to constitute only 15% and co-author citations add another 9% of author-related citations. With the proportion of non-author citations as high as 76%, this indicator does not seem to be causing much problem in Estonian ICT research.

No overview is truly complete without an outline of existing trends that render themselves to predictions about possible future directions. This study attempts to provide an account of all Estonian ICT research articles in the ISI *Web of Science* and therefore the constructed database provides an excellent summary of the research work though the past decades. Figure 5 below offers a concise picture of the developments through the years.

Figure 5: Number of Estonian ICT research articles in ISI Web of Science (1979-2004)

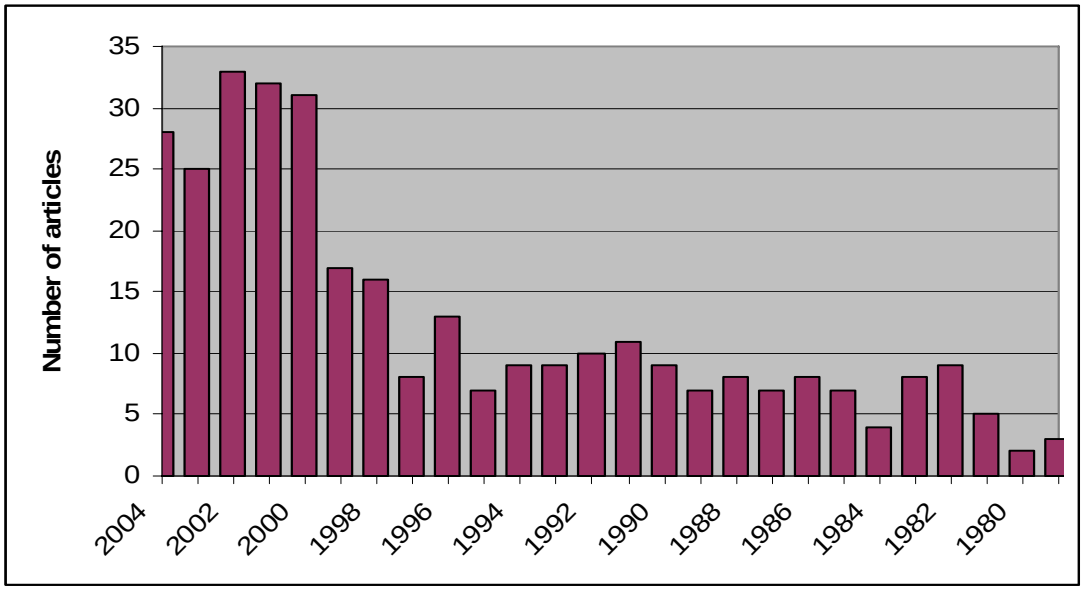


Figure 5 demonstrates a clear growth trend in the number of Estonian ICT articles in the databases of the ISI *Web of Science*. The relatively low number of such articles in for the 1980s is most probably explicable by the Soviet heritage and relative scarcity of USSR journals in the databases of the ISI *Web of Science*. There can be several reasons for a relative lack of increase in the number of articles in the 1990s with transitional problems certainly playing their part in this. One thing is clear, however, – the number of articles annually listed on the ISI *Web of Science* has more than doubled at the turn of the millennium. While the year 2002 only presents 25 articles, the general level for the past 5 years seems to reach beyond 30 articles annually (since the data was collected in Oct/Nov 2004, it is most probable that the score for the year 2004 actually also achieved the level of 30 articles).

Discussion

Bibliometric indicators are a good complementary tool for research assessment and are thus increasingly used worldwide. At the same time many bibliometric analysts warn against potential drawbacks that careless use of these tools can have on the research environment (Debackere and Glänzel 2004, Jansz 2000, Verbeek et al 2002, Weingart

2005). Australia, for instance, has used the method for its research assessment purposes for a couple of decades by now and the study by Butler (2003) proves that the use of publications counting (and not the citations counting) has led to an increase in the quantity of research at the expense of quality with the impact indicators dropping. This example should be a clear warning to Estonian research institutions and government as the current formula for the distribution of base-line also includes the publication count, and not the citation count. Particularly, since no bibliometric analysis was conducted prior to the introduction of the new distribution formula, more analysis and discussion on the potential impact of bibliometric measurements is needed now in order to avoid long-term setbacks.

The results above provide a detailed account of the bibliometric data for ICT research field. With less than half of all the potential research stuff actually engaged in the publication of internationally cited scientific articles and only 30 people having published more than 2 articles, Estonian ICT research does not seem to excel much on the global scale. The same results are reported by Allik (2003) and Must (2006) with the latter noting: “Estonia is, for example, among the most e-ready societies in the world yet the research level in this field is close to zero. This, in the long run, makes further Estonian developments in the ICT sector very doubtful.” There always is, of course, the option to focus on technology transfer and strong applied research, but this already is a topic for another paper.

Allik (2003) and Must (2006) report impact indicators for the computer science as low as 0.85 and 0.89, respectively. In their studies, even the neighbouring Latvia and Lithuania reach beyond that level. Current study took an intentionally broader view of ICT area and identified the normalised impact of 1.5. In addition, an exceptional case of very high impact was discovered for one researcher whose articles would be usually classified under the biotechnology research. This case touches upon the complicated issue of interdisciplinary research that is extremely difficult to account for in bibliometric studies.

This case also indicates an important aspect. Namely, different disciplines tend to have rather different publication and citation practices (Verbeek 2002) with more application-oriented fields clearly less published and cited (Jansz 2000). Mathematics, computer sciences and engineering are generally known for relatively moderate impact scores with world average impact level of 2.51, 2.31 and 2.88, respectively (Must 2006). At the same time the field of molecular biology and genetics has a world average citation score as high as 24.26 citations per paper with microbiology at 13.55 and biochemistry at 15.05 levels (Must 2006). Thus the 1.5 impact score calculated in this paper is not necessarily a bad result. What must be kept in mind, though, is that the funding formulas are not constructed to take account of these disciplinary variances.

The disciplinary variances also partially explain the case of the one most cited ICT researcher in Estonia. As mentioned earlier, his field of research is bioinformatics and he’s articles are usually co-authored by biotechnology researchers and published in respective journals. On the other hand, there is also a certain type of statistical regularity that plays a role here. Aksnes and Sivertsen (2004) show in their paper how the well-

known pattern of citation distribution usually has 40% of papers that do not get cited at all or get cited no more than once or twice; at the same time it is the top 10% of papers that receive half of all citations. The data above shows that Estonian ICT research is a little worse off with as many as 81% of articles that have not received any citations or only have 1 or 2 citations. In addition, only one researcher is responsible for way more than half of all citations. This phenomenon is, however, also explained by Aksnes and Sivertsen (2004) who describe this as a result of small population of researchers where each highly-cited paper will have more prominence than in a bigger population with more highly cited papers.

Mathematics, computer science and engineering are also known for relatively high level of self-citations with the world average self-citation rate for these fields at the level as high as 40% (Glänzel and Thijs 2004). Estonian ICT research performs much better in this regard with only 15% of self-citations (plus another 9% of co-author citations). Even if the level of self-citations were higher, most authors that have studied this aspect agree that on the increased level of aggregation the share of self-citations does not really change comparative outcomes (Debackere and Glänzel 2004, Glänzel and Thijs 2004). Thus, just like in the current study, self-citations are simply monitored, but not really excluded from the formulae.

All that has been said above seems to indicate that there certainly is some cause for concern in Estonia, especially if we want to uphold the currently successful ICT environment with strong research basis. Then again, looking at the worldwide indicators and general statistical patterns it is clear that the situation is by far not hopeless. In addition, the publication trend also shows that over the past few years there has been a significant increase in the number of Estonian ICT research articles annually appearing in the ISI *Web of Science* databases. Maintaining this trend, however, will certainly take much effort from the government, academic as well as private sector.

Conclusion

Publication and citation data of Estonian ICT research as presented in the ISI *Web of Science* shows clearly that there are a few top ICT researchers. Though the patterns encountered in the bibliometric data of ICT research do not deviate too much from the world average, the general level of ICT research in Estonia might not be sufficient to support sustained research activities in the field nor to reinforce the current success in ICT applications. At the same time, there is a bulk of people engaged in ICT teaching and development activities and increasingly more research gets published. This means that there is still good amount of potential in case the support structure is well managed and the funding level does not get undermined by the disciplinary variance in publication practices.

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Appendix 1: List of researchers and institutions

No	Name	Surname	Institution
1.	**Margit**	*Aarna*	TUT
2.	**Hillar**	**Aben**	Inst. of Cyb.
3.	**Leo**	**Ainola**	Inst. of Cyb.
4.	**Kaarel**	**Allik**	TUT
5.	**Tanel**	**Alumäe**	Inst. of Cyb.
6.	**Irina**	**Amitan**	TUT
7.	**Arne**	**Ansper**	Cybernetika
8.	**Johan**	**Anton**	Inst. of Cyb.
9.	**Ilmar**	**Arro**	TUT
10.	**Igor**	**Astrov**	TUT
11.	**Marina**	**Brik**	TUT
12.	**Ahto**	**Buldas**	TUT
13.	**Julia**	**Derkats**	TUT
14.	**Arvo**	**Eek**	Inst. of Cyb.
15.	**Erki**	**Eessaar**	TUT
16.	**Peeter**	**Ellervee**	TUT
17.	**Juhan-Peep**	**Ernits**	TUT
18.	**Teet**	**Evartson**	TUT
19.	**Jelena**	**Fomina**	TUT
20.	**Margus**	**Freudenthal**	Cybernetika
21.	**Alina**	**Gavrijaseva**	TUT
22.	**Boris**	**Gordon**	TUT
23.	**Ksenia**	**Grigorjeva**	TUT
24.	**Heldur**	**Haak**	TUT
25.	**Hele-Mai**	**Haav**	Inst. of Cyb.
26.	**Rein**	**Haavel**	Cybernetika
27.	**Kristiina**	**Hakk**	IT College
28.	**Mait**	**Harf**	Inst. of Cyb.
29.	**Kristo**	**Heero**	Cybernetika
30.	**Sven**	**Heiberg**	Cybernetika
31.	**Helle**	**Hein**	TU
32.	**Jaak**	**Henno**	TUT
33.	**Raul**	**Isotamm**	TUT
34.	**Ain**	**Isotamm**	TU
35.	**Eero**	**Ivask**	TUT
36.	**Artur**	**Jutman**	TUT
37.	**Rein**	**Jõers**	TUT
38.	**Ahto**	**Kalja**	TUT
39.	**Taivo**	**Kangilaski**	TUT
40.	**Jüri**	**Kiho**	TU
41.	**Kaido**	**Kikkas**	IT College
42.	**Rein**	**Kipper**	Cybernetika
43.	**Mare**	**Koit**	TU

44.	**Toomas**	**Kont**	TUT
45.	**Marko**	**Koort**	TUT
46.	**Oleg**	**Korolkov**	TUT
47.	**Vahur**	**Kotkas**	Inst. of Cyb.
48.	**Ülle**	**Kotta**	Inst. of Cyb.
49.	**Valeri**	**Kozevnikov**	TUT
50.	**Valeri**	**Kravets**	TUT
51.	**Helena**	**Kruus**	TUT
52.	**Margus**	**Kruus**	TUT
53.	**Maarja**	**Kruusmaa**	IT College
54.	**Vello**	**Kukk**	TUT
55.	**Mati**	**Kutser**	Inst. of Cyb.
56.	**Alar**	**Kuusik**	TUT
57.	**Rein**	**Kuusik**	TUT
58.	**Marko**	**Kääramees**	Inst. of Cyb.
59.	**Raul**	**Land**	TUT
60.	**Peeter**	**Laud**	TU
61.	**Paul**	**Leis**	TUT
62.	**Harri**	**Lensen**	TUT
63.	**Toomas**	**Lepikult**	IT College
64.	**Marion**	**Lepmets**	TUT
65.	**Viktor**	**Leppikson**	TUT
66.	**Raul**	**Liivrand**	TUT
67.	**Grete**	**Lind**	TUT
68.	**Eerik**	**Lossmann**	TUT
69.	**Teodor**	**Luczkowski**	TUT
70.	**Martin**	**Luts**	IT College
71.	**Urve**	**Madar**	TUT
72.	**Peep**	**Martverk**	TUT
73.	**Ants**	**Meister**	TUT
74.	**Einar**	**Meister**	Inst. of Cyb.
75.	**Mart**	**Min**	TUT
76.	**Andres**	**Mulin**	IT College
77.	**Tanel**	**Mullari**	Inst. of Cyb.
78.	**Leo**	**Mõtus**	TUT
79.	**Harri**	**Mägi**	TUT
80.	**Olev**	**Märtens**	TUT
81.	**Kaili**	**Müürisepp**	TU
82.	**Härmel**	**Nestra**	TU
83.	**Ülo**	**Nurges**	TUT
84.	**Sven**	**Nõmm**	Inst. of Cyb.
85.	**Tõnu**	**Näks**	TUT
86.	**Monika**	**Oit**	Cybernetika
87.	**Elmet**	**Orasson**	TUT
88.	**Avo**	**Ots**	TUT
89.	**Toivo**	**Paavle**	TUT
90.	**Rein**	**Paluoja**	TUT

91.	**Toomas**	**Parve**	TUT
92.	**Jaan**	**Penjam**	TUT
93.	**Mihhail**	**Pikkov**	TUT
94.	**Rein**	**Prank**	TU
95.	**Valdo**	**Praust**	IT College
96.	**Uuno**	**Puus**	Cybernetika
97.	**Jaanus**	**Pöial**	IT College
98.	**Jaan**	**Raik**	TUT
99.	**Aimur**	**Raja**	TUT
100.	**Ingmar**	**Randvee**	Inst. of Cyb.
101.	**Toomas**	**Rang**	TUT
102.	**Priit**	**Raspel**	IT College
103.	**Karin**	**Rava**	TUT
104.	**Andri**	**Riid**	TUT
105.	**Tiit**	**Riismaa**	Inst. of Cyb.
106.	**Tarmo**	**Robal**	TUT
107.	**Mart**	**Rohtla**	Inst. of Cyb.
108.	**Ants**	**Ronk**	TUT
109.	**Meelis**	**Roos**	Cybernetika
110.	**Tiit**	**Roosmaa**	TU
111.	**Mart**	**Roost**	TUT
112.	**Andres**	**Rähni**	TUT
113.	**Ennu**	**Rüstern**	TUt
114.	**Märt**	**Saarepera**	Cybernetika
115.	**Eduard**	**Schults**	IT College
116.	**Asko**	**Seeba**	Cybernetika / Helsinki University of Technology
117.	**Olga**	**Sokratova**	TU
118.	**Viljo**	**Soo**	IT College
119.	**Krista**	**Strandson**	TU
120.	**Aleksander**	**Sudnitsõn**	TUT
121.	**Andres**	**Taklaja**	TUT
122.	**Tõnu**	**Tamme**	TU
123.	**Kalle**	**Tammemäe**	TUT
124.	**Tanel**	**Tammet**	TUT
125.	**Harry**	**Tani**	Cybernetika
126.	**Arvi**	**Tavast**	IT College
127.	**Ander**	**Tenno**	TUT
128.	**Jaak**	**Tepandi**	TUT
129.	**Mati**	**Tombak**	TU
130.	**Arvo**	**Toomsalu**	TUT
131.	**Ants**	**Torim**	TUT
132.	**Sergei**	**Tupailo**	Inst. of Cyb.
133.	**Eno**	**Tõnisson**	TU
134.	**Maris**	**Tõnso**	Inst. of Cyb.
135.	**Enn**	**Tõugu**	Inst. of Cyb.
136.	**Ermo**	**Täks**	TUT
137.	**Raimund-Johannes**	**Ubar**	TUT

138.	**Andres**	**Udal**	TUT
139.	**Heli**	**Uibo**	TU
140.	**Aivar**	**Uisk**	Cybernetika
141.	**Tarmo**	**Uustalu**	TUT
142.	**Jüri**	**Vain**	TUT
143.	**Stanislav**	**Vassiljev**	TUT
144.	**Enn**	**Velmre**	TUT
145.	**Jelena**	**Vendelin**	TUT
146.	**Varmo**	**Vene**	TU
147.	**Tarmo**	**Veskioja**	TUT
148.	**Vladimir**	**Viies**	TUT
149.	**Jüri**	**Vilipõld**	TUT
150.	**Anne**	**Villems**	TU
151.	**Jan**	**Villemson**	TU
152.	**Jaak**	**Vilo**	TU
153.	**Leo**	**Võhandu**	TUT
154.	**Tiina**	**Zingel**	TUT
155.	**Enn**	**Õunapuu**	TUT

Appendix 2: Publication data for Estonian ICT researchers

First name	Surname	Name of the article	Year	Journal	Co-authors		SC	CAC	NC
Margit	**Aarna**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Hillar	**Aben**	On the optical theory of photoelastic tomography	2004	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		0	n.a.	n.a.
Hillar	**Aben**	A new relationship for the experimental-analytical solution of the axisymmetric thermoelasticity problem	2004	Zeitschrift fur Angewandte Mathematik und Mechanik	Ainola L (1)		0	n.a.	n.a.
Hillar	**Aben**	On hybrid thermomechanics for multilayered cylinders	2004	Journal of Thermal Stresses	Ainola L (1)		0	n.a.	n.a.
Hillar	**Aben**	Theory of magnetophotoelasticity with multiple reflections	2004	Journal of Optics A-Pure and Applied Optics	Ainola L (1)		0	n.a.	n.a.
Hillar	**Aben**	Alternative equations of magnetophotoelasticity and approximate solution of the inverse problem	2002	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		2	0	0
Hillar	**Aben**	Simplified interpretation of an integrated photoelastic fringe pattern	2001	Experimental Techniques		0	0	n.a.	n.a.
Hillar	**Aben**	Transformation equations in polarization optics of inhomogeneous birefringent media	2001	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		3	0	1
Hillar	**Aben**	Optical tomography of the laser's Gaussian electric field	2001	Optics and Laser Technology	Ainola L (1)		0	0	1
Hillar	**Aben**	Hybrid mechanics for axisymmetric thermoelasticity problems	2000	Journal of Thermal Stresses	Ainola L (1)		2	0	0
Hillar	**Aben**	Integrated photoelasticity for nondestructive residual stress measurement in glass	2000	Optics and Laser in Engineering	Ainola L, Anton J (2)		2	0	1

Hillar	**Aben**	Isochormatic fringes in photoelasticity	2000	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		0	n.a.	n.a.
Hillar	**Aben**	Duality in optical theory of twisted birefringent media	1999	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		2	0	0
Hillar	**Aben**	Editor's page	1999	Oil Shale		0	0	n.a.	n.a.
Hillar	**Aben**	Interference blots and fringe dislocations in optics of twisted birefringent media	1998	Journal of the Optical Society of America A-Optics Image Science and Vision	Ainola L (1)		5	0	0
Hillar	**Aben**	Strange interference blots in the interferometry of inhomogeneous birefringent objects	1997	Applied Optics	Josepson J (1)		5	0	2
Hillar	**Aben**	Photoelastic tomopraphy for three-dimensional flow birefringence studies	1997	Inverse Problems	Puro A (1)		0	2	0
Hillar	**Aben**	Nonaxisymmetric residual stress distribution in axisymmetric glass articles	1996	Glastechnische Berichte-Glass Science and Technology	Anton J, Josepson J (2)		2	0	0
Hillar	**Aben**	Edge and boundary stress measurement in glass	1995	Glass Technology		0	0	n.a.	n.a.
Hillar	**Aben**	On the precision of integrated photoelasticity for hollow glassware	1995	Optics and Lasers in Engineering	Josepson J (1)		0	n.a.	n.a.
Hillar	**Aben**	The use of differential scanning calorimetry in chemical education .2. A graduate experiment, the melting behaviour of ultra-high-molecular-weight polythylene fiber	1992	Journal of Thermal Analysis	Vanderplaats G, Meier L, Scherrer O, Truttmann R (4)		0	1	0
Hillar	**Aben**	The case of weak birefringence in integrated photoelasticity	1989	Optics and Lasers in Engineering	Josepson JI, Kell KJE (2)		5	1	7
Hillar	**Aben**	Light-intensity in 3-D photoelastic analysis	1988	Journal of Engineering Mechanics-ASCE		0	0	n.a.	n.a.
Hillar	**Aben**	Kerr effect tomography for general axisymmetrical field	1987	Applied Optics		0	2	0	12

Hillar	**Aben**	Characteristic directions in optics of twisted birefringent media	1986	Journal of Optical Society of America A-Optics Image Science and Vision		0	6	0	2
Hillar	**Aben**	Integrated photoelasticity as tensor field tomography	1986	Zeitschrift fur Angewandte Mathematik und Mechanik	Kell KJ (1)		2	1	4
Hillar	**Aben**	Correction	1985	Transactions of the Canadian Society for Mechanical Engineering		0	0	n.a.	n.a.
Hillar	**Aben**	Nonrectilinear light-propagation in integrated photoelasticity of axisymmetric-bodies	1984	Transactions of the Canadian Society for Mechanical Engineering	Krasnowski BR, Pindera JT (2)		1	5	1
Hillar	**Aben**	Integral Tension Optics	1984	Zeitschrift fur Angewandte Mathematik und Mechanik	Idnurm S, Josepson J, Kell KJ (3)		0	n.a.	n.a.
Hillar	**Aben**	On the existence of characteristic directions in 3-dimensional photoelasticity	1982	Ingenieur Archiv		0	1	0	0
Hillar	**Aben**	Integrated photoelasticity of axisymmetric-bodies	1982	Optical Engineering		0	5	0	2
Leo	**Ainola**	On the optical theory of photoelastic tomography	2004	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)		0	n.a.	n.a.
Leo	**Ainola**	A new relationship for the experimental-analytical solution of the axisymmetric thermoelasticity problem	2004	Zeitschrift fur Angewandte Mathematik und Mechanik	Aben H (1)		0	n.a.	n.a.
Leo	**Ainola**	On hybrid thermomechanics for multilayered cylinders	2004	Journal of Thermal Stresses	Aben H (1)		0	n.a.	n.a.
Leo	**Ainola**	Theory of magnetophotoelasticity with multiple reflections	2004	Journal of Optics A-Pure and Applied Optics	Aben H (1)		0	n.a.	n.a.
Leo	**Ainola**	Alternative equations of magnetophotoelasticity and approximate solution of the inverse problem	2002	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)		2	0	0

Leo	**Ainola**	Transformation equations in polarization optics of inhomogeneous birefringent media	2001	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)	3	0	1
Leo	**Ainola**	Optical tomography of the laser's Gaussian electric field	2001	Optics and Laser Technology	Aben H (1)	0	0	1
Leo	**Ainola**	Hybrid mechanics for axisymmetric thermoelasticity problems	2000	Journal of Thermal Stresses	Aben H (1)	2	0	0
Leo	**Ainola**	Integrated photoelasticity for nondestructive residual stress measurement in glass	2000	Optics and Lasers in Engineering	Aben H, Anton J (2)	2	0	1
Leo	**Ainola**	Isochormatic fringes in photoelasticity	2000	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)	0	n.a.	n.a.
Leo	**Ainola**	Duality in optical theory of twisted birefringent media	1999	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)	2	0	0
Leo	**Ainola**	Interference blots and fringe dislocations in optics of twisted birefringent media	1998	Journal of the Optical Society of America A-Optics Image Science and Vision	Aben H (1)	5	0	0
Leo	**Ainola**	Approximate wall shear equation for unsteady laminar pipe flows - Discussion	1996	Journal of Hydralic Research	Liiv U (1)	0	n.a.	n.a.
Kaarel	**Allik**	Skyharp, an interactive electroacoustic instrument	1993	Leonardo Mucis Journal	Mulder RCF (1)	0	0	1
Kaarel	**Allik**	Arconet, a proposal for a standard network for communication and control in real-time performance	1990	Leonardo	Dunne S, Mulder R (1)	0	n.a.	n.a.
Tanel	**Alumäe**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Irina	**Amitan**	Stereoselective hydration of N-alkynes based on boronickel catalysts	1992	Izvestiya Vysshikh Uchebnykh Zavedenii Khimiya I Khimicheskaya Tekhnologiya	Petrova SS, Siimer EK (2)	0	n.a.	n.a.
Arne	**Ansper**	Improving the availability of time-stamping services	2001	Lecture Notes in Computer Science	Buldas A, Saarepera M, Willemson J (3)	0	0	1
Arne	**Ansper**	Efficient long-term validation of digital signatures	2001	Lecture Notes in Computer Science	Buldas A, Roos M, Willemson J (3)	0	0	1

Johan	**Anton**	Integrated photoelasticity for nondestructive residual stress measurement in glass	2000	Optics and Lasers in Engineering	Aben H, Ainola L (2)	0	2	1
Johan	**Anton**	Nonaxisymmetric residual stress distribution in axisymmetric glass articles	1996	Glastechnische Berichte-Glass Science and Technology	Aben H, Josepson J (2)	1	1	0
Ilmar	**Arro**	A generalised algorithm for reduced computation of the discrete fourier transformation	1987	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	0	0	n.a.	n.a.
Igor	**Astrov**	Evaporated AGBR layers as a recording material in ionization semiconductor photographic system	1979	Journal fur Signalaufzeichnungsmaterialen	Assa J, Gorlin GB, Malinowski J, Paritzkij LG, Ryvkin SM, Zhelev V (6)	0	n.a.	n.a.
Marina	**Brik**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ahto	**Buldas**	Improving the availability of time-stamping services	2001	Lecture Notes in Computer Science	Ansper A, Saarepera M, Willemson J (3)	0	0	1
Ahto	**Buldas**	Efficient long-term validation of digital signatures	2001	Lecture Notes in Computer Science	Ansper A, Roos M, Willemson J (3)	0	0	1
Ahto	**Buldas**	Optimally efficient accountable time-stamping	2000	Lecture Notes in Computer Science	Lipmaa H, Schoenmakers B (2)	1	1	3
Ahto	**Buldas**	Time-stampting with binary linking schemes	1998	Lecture Notes in Computer Science	Laud P, Lipmaa H, Villemson J (3)	3	1	6
Julia	**Derkats**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Arvo	**Eek**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Erki	**Eessaar**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Peeter	**Ellervee**	Evaluating fault emulation on FPGA	2004	Lecture Notes in Computer Science	Raik J, Tihhomirov V, Tammemäe K (3)	0	n.a.	n.a.
Peeter	**Ellervee**	System-level data-format exploration for dynamically allocated data structures	2001	IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems	Miranda M, Catthoor F, Hemani A (3)	0	n.a.	n.a.
Juhan-Peep	**Ernits**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Teet	**Evartson**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jelena	**Fomina**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Margus	**Freudenthal**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Alina	**Gavrijaseva**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Boris	**Gordon**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ksenia	**Grigorjeva**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Heldur	**Haak**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Hele-Mai	**Haav**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rein	**Haavel**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kristiina	**Hakk**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Mait	**Harf**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kristo	**Heero**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sven	**Heiberg**	Analysing pair-programmer's satisfaction with the method, the result, and the partner	2004	Lecture Notes in Computer Science	Puus U, Seeba A, Salumaa P (3)	0	n.a.	n.a.
Helle	**Hein**	Optimization of clamped plastic shallow shells subjected to initial impulsive loading	2002	Engineering Optimization	Lellep J (1)	0	n.a.	n.a.
Helle	**Hein**	Optimal plastic design of shallow curved beams with step-wise varying cross sections	2000	Mechnanics of Structures and Machines	Lellep J (1)	0	n.a.	n.a.
Helle	**Hein**	Optimization of shallow shells with different yield stresses in tension and compression	1999	Structural Optimization	Lellep J (1)	0	n.a.	n.a.
Helle	**Hein**	Optimization of rigid-plastic shallow curved beams	1996	Structural Optimization	Lellep J (1)	2	0	0
Helle	**Hein**	Optimization of clamped rigid-plastic shallow shells of piecewise-constant thickness	1994	International Journal of Non-Linear Mechanics	Lellep J (1)	4	1	1
Helle	**Hein**	Optimization of rigid-plastic shallow spherical-shells of piecewise constant thickness	1993	Structural Optimization	Lellep J (1)	2	3	0
Jaak	**Henno**	User-friendly syntax - design and presentation	1988	International Journal of Man-Machine Studies	0	0	0	1
Jaak	**Henno**	On equivalent sets of functions	1982	Discrete Applied Mathematics	0	0	n.a.	n.a.

Raul	**Isotamm**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ain	**Isotamm**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Eero	**Ivask**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Artur	**Jutman**	Design error diagnosis in digital circuits with stuck-at fault model	2000	Microelectronics Reliability	Ubar R (1)	0	n.a.	n.a.
Rein	**Jõers**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ahto	**Kalja**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Taivo	**Kangilaski**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jüri	**Kiho**	Retrieval-system of CIS-Tartu data-bank	1988	Organic reactivity	Jalas A (1)	0	n.a.	n.a.
Jüri	**Kiho**	A specialized subsystem for coding and input of mosaic structures	1988	Organic reactivity	Jalas A (1)	0	n.a.	n.a.
Kaido	**Kikkas**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rein	**Kipper**	Optical transparency spectral-analysis of two-dimensional film	1985	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Antonov NN, Melnik VI (2)	0	n.a.	n.a.
Rein	**Kipper**	Information capacity of multichannel acoustooptic modulators	1982	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Bannov VY, Gusev VA (2)	0	n.a.	n.a.
Mare	**Koit**	Directives in Estonian information dialogues	2003	Lecture Notes in Artcificial Intelligence	Hennoste T, Rääbis A, Strandson K, Valdisoo M, Vutt E (5)	0	n.a.	n.a.
Mare	**Koit**	On a method for designing a dialogue system and the experience of its application	2003	Journal of Computer and Systems Sciences International	Valdisoo MN, Vutt EV	0	n.a.	n.a.
Toomas	**Kont**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Marko	**Koort**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Oleg	**Korolkov**	The basic parameters of diffusion welded Al Schottky contacts to p- and n-SiC	2004	Materials Science Forum	Kuznetsova N, Ruut J, Rang T (3)	0	n.a.	n.a.
Oleg	**Korolkov**	Diffusion-welded Al contacts to p-type SiC	2002	Materials Science Forum	Rang T, Syrkin A, Dmitriev V(3)	0	n.a.	n.a.
Oleg	**Korolkov**	Some comparative properties of diffusion-welded contacts to 6H and 4H silicon carbide	2002	Materials Science Forum	Rang T (1)	0	n.a.	n.a.

Oleg	**Korolkov**	Formation of large area Al contacts on 6H- and 4H-SiC substrates	2000	Materials Science Forum	Rang T (1)	0	n.a.	n.a.
Vahur	**Kotkas**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ülle	**Kotta**	A geometric solution to the dynamic disturbance decoupling for discrete-time nonlinear systems	2004	Kybernetika	Aranda-Bricaire E (1)	0	n.a.	n.a.
Ülle	**Kotta**	Generalization of transfer equivalence for discrete-time non-linear systems: comparison of two definitions	2004	International Journal of Control	Pawluszewicz E, Nõmm S (2)	0	n.a.	n.a.
Ülle	**Kotta**	Nonlinear discrete-time models: state-space vs. I/O representations	2004	Journal of Process Control	Pearson RK	0	n.a.	n.a.
Ülle	**Kotta**	Classical state space realizability of input-output bilinear models	2003	International Journal of Control	Nõmm S, Zinober ASI (2)	0	n.a.	n.a.
Ülle	**Kotta**	Linear algebraic tools for discrete-time nonlinear control systems with Mathematica	2003	Lecture Notes in Control and Information Sciences	Tõnso M (1)	0	n.a.	n.a.
Ülle	**Kotta**	Systems with associative dynamics	2002	Kybernetika	Pearson RK, Nõmm S (2)	1	0	0
Ülle	**Kotta**	Two approaches for state space realization of NARMA models: Bridging the gap	2002	Mathematical and Computer Modelling of Dynamical Systems	Sadegh N (1)	2	0	0
Ülle	**Kotta**	Transfer equivalence and realization of nonlinear higher order input-output different equations	2001	Automatica	Zinober ASI, Liu P (2)	4	0	1
Ülle	**Kotta**	Generalized controlled invariance for discrete-time nonlinear systems with an application to the dynamic disturbance decoupling problem	2001	IEEE Transactions on Automatic Control	Aranda-Bricaire E (1)	1	1	1
Ülle	**Kotta**	Comments on "On the discrete-time normal form"	2000	IEEE Transactions on Automatic Control	0	1	0	0
Ülle	**Kotta**	Input-output decoupling of nonlinear recursive systems	2000	Kybernetika	0	0	n.a.	n.a.

Ülle	**Kotta**	Transfer equivalence and realization of nonlinear higher order input/output difference equations using Mathematica	1999	Journal of Circuits Systems and Computers	Tõnso M (1)		4	0	0
Ülle	**Kotta**	Linearization of discrete-time systems	1996	Siam Journal on Control and Optimization	Aranda-Bricaire E, Moog CH (2)		8	1	12
Ülle	**Kotta**	Solvability and right-inversion of implicit nonlinear discrete-time systems	1996	Siam Journal on Control and Optimization	Flinger T, Nijmeijer H (2)		0	1	0
Ülle	**Kotta**	Immersion of discrete-time nonlinear system by regular dynamic state feedback into a linear system	1996	International Journal of Control	Nijmeijer H (1)		0	n.a.	n.a.
Ülle	**Kotta**	Inversion method in the discrete-time nonlinear control systems synthesis problems - Introduction	1995	Lecture Notes in Control and Information Sciences		0	0	n.a.	n.a.
Ülle	**Kotta**	On dynamic input-output linearization of discrete-time nonlinear-systems	1994	International Journal of Control		0	3	0	3
Ülle	**Kotta**	Comments on a structural approach to the nonlinear model-matching problem	1994	Siam Journal on Control and Optimization		0	1	0	0
Ülle	**Kotta**	Matching of discrete-time nonlinear models	1993	Automation and Remote Control		0	0	n.a.	0
Ülle	**Kotta**	Synthesizing nonlinear-systems with specified input-output mapping - sampling effects	1993	Journal of Computer and Systems Sciences International		0	0	n.a.	n.a.
Ülle	**Kotta**	Dynamic compensation for perturbations in discrete nonlinear-systems	1992	Soviet Journal of Computer and Systems Sciences	Nijmeijer H (1)		0	n.a.	n.a.
Ülle	**Kotta**	Linearization of linear-analytic systems by the method of right-inverse systems - the effects of discretization	1990	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.

Ülle	**Kotta**	Designing nonlinear discrete-time-systems which are invariant under disturbances	1990	Automation and Remote Control		0	0	n.a.	n.a.
Ülle	**Kotta**	Decomposition of nonlinear discrete controlled systems	1989	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Ülle	**Kotta**	Right inverse of a discrete-time nonlinear-system	1990	International Journal of Control		0	7	0	9
Ülle	**Kotta**	On the stability of discrete-time sliding mode control-systems - comments	1989	IEEE Transactions on Automatic Control		0	0	0	18
Ülle	**Kotta**	Matching a nonlinear discrete-time system with a prescribed linear input-output behaviour	1988	Automation and Remote Control		0	0	n.a.	n.a.
Ülle	**Kotta**	The ensuring of autonomy of a nonlinear dynamical system with discrete-time	1987	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Ülle	**Kotta**	Application of inverse system for linearization and decoupling	1987	System & Control Letters		0	0	0	1
Ülle	**Kotta**	Derivation of the inverse system for discrete nonlinear-systems	1986	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Valeri	**Kozevnikov**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Valeri	**Kravets**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Helena	**Kruus**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Margus	**Kruus**	Automatic FSM synthesis for low-power mixed synchronous/asynchronous implementation	2001	Vlsi Design	Oelmann B, Tammemäe K, O'Nils M (3)		0	n.a.	n.a.
Maarja	**Kruusmaa**	Global level path planning for mobile robots in dynamic environments	2003	Journal of Intelligent & Robotic Systems		0	0	n.a.	n.a.
Maarja	**Kruusmaa**	Covering the path space: a casebase analysis for mobile robot path planning	2003	Knowledge-Based Systems	Willemson J (1)		0	n.a.	n.a.

Maarja	**Kruusmaa**	Global navigation in dynamic environments using case-based reasoning	2003	Autonomous Robots		0	n.a.	n.a.
Vello	**Kukk**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	2002	IEEE Transactions on Instrumentation and Measurement	Min M, Parve T, Kuhlberg A (3)	0	n.a.	n.a.
Mati	**Kutser**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Alar	**Kuusik**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rein	**Kuusik**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Marko	**Kääramees**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Raul	**Land**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Peeter	**Laud**	Sound computational interpretation of formal encryption with composed keys	2004	Lecture Notes in Computer Science	Corin R (1)	0	n.a.	n.a.
Peeter	**Laud**	Handling encryption in an analysis for secure information flow	2003	Lecture Notes in Computer Science		0	0	1
Peeter	**Laud**	Semantics and program analysis of computationally secure information flow	2001	Lecture Notes in Computer Science		0	1	0	3
Peeter	**Laud**	Time-stamping with binary linking schemes	1998	Lecture Notes in Computer Science	Buldas A, Lipmaa H, Willemson J (3)	0	4	6
Paul	**Leis**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Harri	**Lensen**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Toomas	**Lepikult**	Optimal design of rigid-plastic beams subjected to dynamical loading	1999	Structural Optimization	Schmidt WH, Werner H (2)	0	1	0
Marion	**Lepmets**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Viktor	**Leppikson**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Raul	**Liivrand**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Grete	**Lind**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Eerik	**Lossmann**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Teodor	**Luczkowski**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Martin	**Luts**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Urve	**Madar**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Peep	**Matverk**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ants	**Meister**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Einar	**Meister**	SpeechDat-like Estonian database	2003	Lecture Notes on Artificial Intelligence	Lasn J, Meister L (2)	0	n.a.	n.a.
Martin	**Min**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	2002	IEEE Transactions on Instrumentation and Measurement	Parve T, Kukk V, Kuhlberg A (3)	0	n.a.	n.a.
Martin	**Min**	Lock-in measurement of bio-impedance variations	2000	Measurement	Martens O, Parve T (2)	1	1	0
Martin	**Min**	Thoracic bioimpedance as a basis for pacing control	1999	Annals of the New York Academy of Sciences	Parve T, Kink A (2)	1	0	1
Martin	**Min**	Design concepts of instruments for vector parameter-identification	1992	IEEE Transactions on Instrumentation and Measurement	Parve T, Ronk A (2)	3	0	2
Andres	**Mulin**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Tanel	**Mullari**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Leo	**Mõtus**	Using models in real-time software design - Model-driven development based on the Unified Modeling Language	2003	IEEE Control Systems Magazine	Selic B (1)	0	n.a.	n.a.
Leo	**Mõtus**	On models for time-sensitive interactive computing	2002	Lecture Notes on Computer Science	Meriste M (1)	0	n.a.	n.a.
Leo	**Mõtus**	Untitled	2000	Engineering Applications of Artificial Intelligence	Vingerhoeds R (1)	0	n.a.	n.a.
Leo	**Mõtus**	Formal timing analysis of OMT designs using LIMITS	1998	Computer Systems Science and Engineering	Naks T (1)	1	0	0
Leo	**Mõtus**	Untitled	1998	Engineering Applications of Artificial Intelligence	Vingerhoeds R (1)	0	0	1
Leo	**Mõtus**	The design and analysis of low-cost real-time fieldbus systems	1998	Control Engineering Practice	Rodd MG, Dimyati K (2)	0	n.a.	n.a.

Leo	**Mõtus**	Message for the editor-in-chief	1996	Engineering Applications of Artificial Intelligence		0	0	n.a.	n.a.
Leo	**Mõtus**	Untitled	1995	Engineering Applications of Artificial Intelligence		0	0	n.a.	n.a.
Leo	**Mõtus**	Intelligent autonomous vehicles	1994	Engineering Applications of Artificial Intelligence		0	0	n.a.	n.a.
Leo	**Mõtus**	Architectures for integrating manufacturing activities and enterprises	1993	IFIP Transactions B - Applications in Technology	Williams TJ, Bernus P, Brosvic J, Chen D, Doumeingts G, Nemes L, Nevins JL, Vallespir B, Vlietstra J, Zoetekouwj D, Dafel FG, Inamoto A, Olling GJ, Tomljanovich M, Aranguren R, Astrom KJ, Benveniste A, Chen JL, Fox MS, Fukuda Y, Han ZJ, Ljung L, Kovacs G, Rodd MG		0	0	4
Leo	**Mõtus**	Methods and tools for specifying software of embedded systems	1991	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Leo	**Mõtus**	Features of modeling software for embedded multiprocessor systems	1985	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Leo	**Mõtus**	A model of distributed computer control software	1983	Programming and Computer Software		0	0	n.a.	n.a.
Harri	**Mägi**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Olev	**Märtens**	Precise synchronous deterctors with improved dynamic reserve	2000	IEEE Transactions on Instrumentation and Measurement		0	0	n.a.	n.a.
Olev	**Märtens**	Lock-in measurement of bio-impedance variations	2000	Measurement	Min M, Parve T (2)		1	1	0
Olev	**Märtens**	Precision average-sensing ac dc converts	1993	IEEE Transactions on Instrumentation and Measurement	Pungas T (1)		1	0	0
Kaili	**Müürisepp**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Härmel	**Nestra**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Ülo	**Nurges**	Comparison of reflection coefficient approach to pole shifting for robust control of discrete-time systems	2003	Dynamics of Continuous Discrete and Impulsive Systems - Series B - Applications & Algorithms	Luus R (1)		0	n.a.	n.a.

Ülo	**Nurges**	On the robust stability of discrete-time systems	1999	Journal of Circuits Systems and Computers	Rüstern E (1)		0	n.a.	n.a.
Ülo	**Nurges**	Synthesis of a controller on the basis of the Laguerre model	1994	Automation and Remote Control		0	0	n.a.	n.a.
Ülo	**Nurges**	Adaptive-control with prediction using the Laguerre model	1991	Automation and Remote Control		0	0	n.a.	n.a.
Ülo	**Nurges**	Laguerre models in problems of approximation and identification of discrete-systems	1987	Automation and Remote Control		0	0	0	8
Sven	**Nõmm**	Generalization of transfer equivalence for discrete-time non-linear systems: comparison of two definitions	2004	International Journal of Control	Kotta Ü, Pawluszewicz E (2)		0	n.a.	n.a.
Sven	**Nõmm**	Classical state space realizability of input-output bilinear models	2003	International Journal of Control	Kotta Ü, Zinober ASI (2)		0	n.a.	n.a.
Sven	**Nõmm**	Systems with associative dynamics	2002	Kybernetika	Pearson RK, Kotta Ü (2)		1	0	0
Tõnu	**Näks**	Formal timing analysis of OMT designs using LIMITS	1998	Computer Systems Science and Engineering	Mõtus L (1)		0	1	0
Monika	**Oit**	Stroop-like interference in chess players imagery - an uneplored possibility to be revealed by the adapted moving-spot task	1992	Psychological Research - Psychologische Forschung	Bachmann T (1)		0	0	6
Elmet	**Orasson**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Avo	**Ots**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Toivo	**Paavle**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rein	**Paluoja**	A local area network for distributed control-systems	1986	Avtomatika i Vychislitelnaya Tekhnika	Vajn YI (1)		0	n.a.	n.a.
Toomas	**Parve**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	2002	IEEE Transactions on Instrumentation and Measurement	Min M, Kukk V, Kuhlberg A (3)		0	n.a.	n.a.
Toomas	**Parve**	Lock-in measurement of bio-impedance variations	2000	Measurement	Min M, Märtens O		1	1	0

Toomas	**Parve**	Thoracic bioimpedance as a basis for pacing control	1999	Annals of the New York Academy of Sciences	Min M, Kink A (2)	1	0	1
Toomas	**Parve**	Design concepts of instruments for vector parameter-identification	1992	IEEE Transactions on Instrumentation and Measurement	Min M, Ronk A (2)	3	0	2
Jaan	**Penjam**	Program construction in the context of evolutionary computation	2003	Lecture Notes in Computer Science	Sanko J (1)	0	n.a.	n.a.
Jaan	**Penjam**	Application of structural synthesis of programs	1999	Lecture Notes in Computer Science	Tõugu E, Matskin M (2)	0	3	0
Jaan	**Penjam**	Attributed models of executable specifications	1995	Lecture Notes in Computer Science	Meriste M (1)	0	n.a.	n.a.
Jaan	**Penjam**	Toward knowledge-based specifications of languages	1991	Lecture Notes in Computer Science	Meriste M (1)	0	n.a.	n.a.
Jaan	**Penjam**	Computational and attribute models of formal languages	1990	Theoretical Computer Science		0	1	0	5
Jaan	**Penjam**	Compiler construction by object-oriented system nut	1989	Lecture Notes in Computer Science		0	0	n.a.	n.a.
Jaan	**Penjam**	Nut - an object-oriented language	1986	Computers and Artificial Intelligence	Tõugu E, Matskin M, Eomois PV (3)	2	3	2
Mihhail	**Pikkov**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rein	**Prank**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Valdo	**Praust**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Uuno	**Puus**	Analyzing pair-programmer's satisfaction with the method, the result, and the partner	2004	Lecture Notes in Computer Science	Seeba A, Salumaa P, Heiberg S (3)	0	n.a.	n.a.
Jaanus	**Pöial**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jaan	**Raik**	Evaluating fault emulation on FPGA	2004	Lecture Notes in Computer Science	Ellervee P, Tihhomirov V, Tammemäe K (3)	0	n.a.	n.a.
Jaan	**Raik**	Hierarchical test generation for combinational circuits with real defects coverage	2002	Microelectronics Reliability	Cibakova T, Fischerova M, Gramatova E, Kuzmicz W, Pleskauz WA (5)	0	n.a.	n.a.

Jaan	**Raik**	Probabilistic analysis of CMOS physical defects in VLSI circuits for test coverage improvement	2001	Microelectronics Reliability	Blyzniuk M, Kazymyra I, Kuzmicz W, Pleskacz WA, Ubar R	1	0	0
Jaan	**Raik**	Fast test pattern generation for sequential circuits using decision diagram represeantations	2000	Journal of Electronic Testing-Theory and Applications	Ubar R (1)	0	n.a.	n.a.
Aimur	**Raja**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ingmar	**Randvee**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Toomas	**Rang**	The basic parameters of diffusion welded Al Schottky contacts to p- and n-SiC	2004	Materials Science Forum	Korolkov O, Kuznetsova N, Ruut J (3)	0	n.a.	n.a.
Toomas	**Rang**	Numerical study of current crowding phenomenon in complementary 4H-SiC JBS rectifiers	2004	Materials Science Forum	Higelin G, Kurel R (2)	0	n.a.	n.a.
Toomas	**Rang**	Diffusion-welded Al contacts to p-type SiC	2002	Materials Science Forum	Korolkov O, Syrkin A, Dmitriev V (3)	0	n.a.	n.a.
Toomas	**Rang**	Some comparative properties of diffusion-welded contacts to 6H and 4H silicon carbide	2002	Materials Science Forum	Korolkov O (1)	0	n.a.	n.a.
Toomas	**Rang**	Formation of large area Al contacts on 6H- and 4H-SiC substrates	2000	Materials Science Forum	Korolkov O (1)	0	n.a.	n.a.
Toomas	**Rang**	Correction	1985	Physica Status Solidi A - Applied Research	0	0	n.a.	n.a.
Toomas	**Rang**	One-dimensional numerical-simulation of complementary power Schottky structures	1985	IEEE Proceedings - I Communications Speech and Vision	0	0	n.a.	n.a.
Toomas	**Rang**	Carrier impact ionization rates and their temperature-dependence in silicon	1985	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	0	0	0	1
Toomas	**Rang**	Computer-aided numerical modeling of powerful Schottky diodes	1983	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Udal A (1)	1	0	0

Toomas	**Rang**	Temperature-dependence of the exponent in the equation of avalanche multiplication factors	1983	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika		0	0	n.a.	n.a.
Toomas	**Rang**	Simple relationship between the breakdown voltage, concentration, and junction depth for diffused PN junctions	1982	Physica Status Solidi A - Applied Research		0	1	0	1
Toomas	**Rang**	Computer-aided examination of the I2L current source and of the behavior of the I2L flip-flop used in static memory cells	1981	Periodica Polytechnica - Electrical Engineering		0	0	n.a.	n.a.
Toomas	**Rang**	The DC modeling of the I2L gate with the non-linear circuit analysis program tranz-tran	1981	Periodica Polytechnica - Electrical Engineering		0	1	0	0
Toomas	**Rang**	Computer-aided examination of I2L structures	1981	International Journal of Electronics		0	0	n.a.	n.a.
Priit	**Raspel**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Karin	**Rava**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Andri	**Riid**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Tiit	**Riismaa**	Description and optimization of the structure of hierarchical systems	1993	Automation and Remote Control		0	0	n.a.	n.a.
Tarmo	**Robal**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Mart	**Rohtla**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Ants	**Ronk**	Analysis and reproduction of a signal's periodic components by means of an extended block-adaptive Fourier analyzer	2003	IEEE Transactions on Instrumentation and Measurement		0	0	n.a.	n.a.
Ants	**Ronk**	Design concepts of instruments for vector parameter-identification	1992	IEEE Transactions on Instrumentation and Measurement	Min M, Parve T (2)		0	3	2
Meelis	**Roos**	Efficient long-term validation of digital signatures	2001	Lecture Notes in Computer Science	Ansper A, Buldas A, Willemson J (3)		0	0	1
Tiit	**Roosmaa**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Mart	**Roost**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.

Andres	**Rähni**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ennu	**Rüstern**	On the robust stability of discrete-time systems	1999	Journal of Circuits Systems and Computers	Nurges Ü (1)	0	n.a.	n.a.
Märt	**Saarepera**	Improving the availability of time-stamping services	2001	Lecture Notes in Computer Science	Ansper A, Buldas A, Willemson J (3)	0	0	1
Märt	**Saarepera**	Implementation of quasi delay-insensitive Boolean function blocks	2000	IEICE Transactions on Information and Systems	Yoneda T (1)	0	n.a.	n.a.
Eduard	**Schults**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Asko	**Seeba**	Analyzing pair-programmer's satisfaction with the method, the result, and the partner	2001	Lecture Notes in Computer Science	Puus U, Salumaa P, Heiberg S (3)	0	n.a.	n.a.
Olga	**Sokratova**	Reduction relations for monoid semirings	2001	Journal of Symbolic Computation	Otto F (1)	0	n.a.	n.a.
Olga	**Sokratova**	On congruences of automata defined by directed graphs	2003	Theoretical Computer Science	Kelarev A (1)	0	2	0
Olga	**Sokratova**	Projective semimodules	2002	Algebra Universalis	0	0	n.a.	n.a.
Olga	**Sokratova**	Two algorithms for languages recognized by graph algebras	2002	International Journal of Computer Mathematics	Kelarev A (1)	0	n.a.	n.a.
Olga	**Sokratova**	On semimodules over commutative, additively idempotent semirings	2002	Semigroup Forum	0	0	n.a.	n.a.
Olga	**Sokratova**	The Mal'cev Lemma and rewriting on semirings	2001	Theoretical Computer Science	0	1	0	0
Olga	**Sokratova**	Syntactic semigroups and graph algebras	2000	Bulletin of the Australian Mathematical Society	Kelarev A (1)	1	0	0
Viljo	**Soo**	Arrayed primer extension (APEX) for mutation detection using gene specific DNA chips	1997	American Journal of Human Genetics	Metspalu A, Saulep H, Tõnisson N, Kurg A, Shumaker JM (5)	0	n.a.	n.a.
Krista	**Strandson**	Directives in Estonian information dialogues	2003	Lecture Notes in Artcificial Intelligence	Hennoste T, Koit M, Rääbis A, Valdisoo M, Vutt E (5)	0	n.a.	n.a.
Aleksander	**Sudnitsõn**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Andres	**Taklaja**	Transmission of a Gaussian-beam through a circular aperture - comments	1987	Applied Optics	0	0	n.a.	n.a.

Tõnu	**Tamme**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kalle	**Tammemäe**	Evaluating fault emulation on FPGA	2004	Lecture Notes in Computer Science	Ellervee P, Raik J, Tihhomirov V (3)	0	n.a.	n.a.
Kalle	**Tammemäe**	Automatic FSM synthesis for low-power mixed synchronous/asynchronous implementation	2001	Vlsi Design	Oelmann B, Kruus M, O'Nils M (3)	0	n.a.	n.a.
Tanel	**Tammet**	Chain resolution for the semantic web	2004	Lecture Notes in Artcificial Intelligence	0	0	n.a.	n.a.
Tanel	**Tammet**	Combining an inference engine with databases: A rule server	2003	Lecture Notes in Computer Science	Kadarpik V (1)	0	n.a.	n.a.
Tanel	**Tammet**	Optimized encodings of fragments of type theory in first-order logic	1998	Journal of Logic and Computation	Smith JM (1)	0	n.a.	n.a.
Tanel	**Tammet**	Gandalf	1997	Journal of Automated Reasoning	0	2	0	10
Tanel	**Tammet**	Optimized encodings of fragments of type theory in first order logic	1996	Lecture Notes in Computer Science	Smith JM (1)	1	0	1
Tanel	**Tammet**	Completeness of resolution for definite answers	1995	Journal of Logic and Computation	0	0	n.a.	n.a.
Tanel	**Tammet**	Completeness of resolution for definite answers with case analysis	1995	Lecture Notes in Computer Science	0	0	n.a.	n.a.
Tanel	**Tammet**	Proof strategies in linear logic	1994	Journal of Automated Reasoning	0	0	0	14
Tanel	**Tammet**	Using resolution for deciding solvable classes and building finite-models	1991	Lecture Notes in Computer Science	0	0	0	14
Tanel	**Tammet**	The resolution program, able to decide some solvable classes	1990	Lecture Notes in Computer Science	0	1	0	2
Harry	**Tani**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Arvi	**Tavast**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ander	**Tenno**	A method for battery impedance analysis	2004	Journal of the Electrochemical Society	Tenno R, Suntio T (2)	0	n.a.	n.a.

Ander	**Tenno**	Evaluation of VRLA battery under overcharging: model for battery testing	2002	Journal of Power Sources	Tenno R, Suntio T (2)		1	0	0
Ander	**Tenno**	Charge-discharge behaviour of VRLA batteries: model calibration and application for state estimation and failure detection	2001	Journal of Power Sources	Tenno R, Suntio T (2)		2	0	1
Jaak	**Tepandi**	Simulation of conflict in an agent world: Access to resources and possibility of termination of the population	2002	Informatica		0	0	n.a.	n.a.
Jaak	**Tepandi**	Quality assurance of knowledge-based systems	1997	Engineering Applications of Artificial Intelligence		0	0	n.a.	n.a.
Jaak	**Tepandi**	A knowledge-based approach to the specification-based program testing	1988	Computers and Artificial Intelligence		0	0	n.a.	n.a.
Mati	**Tombak**	A compact look-up table structure for low-level binary image processing	1998	Real-Time Imaging	Sillitoe IPW (1)		0	n.a.	n.a.
Arvo	**Toomsalu**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Ants	**Torim**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Sergei	**Tupailo**	On the intuitionistic strength of monotone inductive definitions	2004	Journal of Symbolic Logic		0	0	n.a.	n.a.
Sergei	**Tupailo**	Realization of constructive set theory into explicit mathematics: a lower bound for impredicative Mahlo universe	2003	Annals of Pure and Applied Logic		0	1	0	0
Sergei	**Tupailo**	Realization of analysts into explicit mathematics	2001	Journal of Symbolic Logic		0	1	0	0
Sergei	**Tupailo**	Epsilon substitution method for elementary analysis	1996	Archive for Mathematical Logic	Mints G, Buchholz W (2)		0	3	3
Sergei	**Tupailo**	Gentzen-style and Novikov-style cut-elimination	1992	Lecture Notes in Computer Science		0	0	n.a.	n.a.
Eno	**Tõnisson**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.

Maris	**Tõnso**	Linear algebraic tools for discrete-time nonlinear control systems with Mathematica	2003	Lecture Notes in Control and Information Sciences	Kotta Ü (1)	0	n.a.	n.a.
Maris	**Tõnso**	Transfer equivalence and realization of nonlinear higher order input/output difference equations using Mathematica	1999	Journal of Circuits Systems and Computers	Kotta Ü (1)	1	3	0
Enn	**Tõugu**	Concurrent implementation of structurally synthesized programs	2001	Lecture Notes in Computer Science	Lammermann S, Vlassov V (2)	0	n.a.	n.a.
Enn	**Tõugu**	Strategies of structural synthesis of programs and its extensions	2001	Computing and Informatics	Matskin M (1)	0	n.a.	n.a.
Enn	**Tõugu**	Strateties of structural synthesis of programs and its extensions	2001	Computers and Artificial Intelligence	Matskin M (1)	0	1	0
Enn	**Tõugu**	Applications of structural synthesis of programs	1999	Lecture Notes in Computer Science	Matskin M, Penjam J (2)	3	0	0
Enn	**Tõugu**	Priz programming system	1999	Programming and Computer Software	Kakhro MI, Myannisalu MA, Saan YP (3)	0	n.a.	n.a.
Enn	**Tõugu**	From visual specifications to executable code	1998	Lecture Notes in Computer Science	0	0	n.a.	n.a.
Enn	**Tõugu**	NUTS: A distributed object-oriented platform with high level communication functions	1998	Computers and Artificial Intelligence	Vlassov V, Addibpour M (2)	2	0	0
Enn	**Tõugu**	Visual programming in NUT	1997	Journal of Visual Languages and Computing	Valt R (1)	1	0	0
Enn	**Tõugu**	Declarative reflection tools for agent shells	1996	Future Generation Computer Systems	Addibpour M (1)	0	n.a.	n.a.
Enn	**Tõugu**	Attribute models of design objects	1994	IFIP Transactions B - Applications in Technology	0	0	0	1
Enn	**Tõugu**	Large engineering knowledge bases	1993	Artificial Intelligence in Engineering	0	0	n.a.	n.a.
Enn	**Tõugu**	Higher-order data-flow schemas	1991	Theoretical Computer Science	0	1	0	0

Enn	**Tõugu**	The programming system PRIZ (Reprinted from J Symbolic Computation, Vol 5, pg 359-375, 1988)	1991	Lecture Notes in Computer Science	Mints G (1)		0	n.a.	n.a.
Enn	**Tõugu**	Type-theoretical semantics of some declarative languages	1991	Lecture Notes in Computer Science	Mints G, Smith JM (2)		0	n.a.	n.a.
Enn	**Tõugu**	Knowledge-based software tools from the USSR	1991	Knowledge-Based Systems		0	0	n.a.	n.a.
Enn	**Tõugu**	Knowledge-based programming environments	1991	Knowledge-Based Systems		0	0	0	1
Enn	**Tõugu**	3 new-generation software environments	1991	Communication of the ACM		0	5	0	1
Enn	**Tõugu**	Object-oriented programming	1990	Programming and Computer Software		0	0	n.a.	n.a.
Enn	**Tõugu**	Integration of knowledge	1990	Soviet Journal of Computer and Systems Sciences		0	0	n.a.	n.a.
Enn	**Tõugu**	Propositional logic programming and the PRIZ system	1990	Journal of Logic Programming	Mints GE (1)		0	0	2
Enn	**Tõugu**	Integration of conceptual and expert knowledge in CAD systems	1989	Soviet Journal of Computer and Systems Sciences	Koov MI, Matskin MB (2)		0	n.a.	n.a.
Enn	**Tõugu**	Propositional logic programming	1989	Computers and Artificial Intelligence		0	1	0	0
Enn	**Tõugu**	The programming system PRIZ	1988	Journal of Symbolic Computation	Mints G (1)		1	0	4
Enn	**Tõugu**	Presentation of the engineering models in knowledge bases and personal computerized designing systems	1988	Vestnik Akademii Nauk SSSR	Tamm BG (1)		0	n.a.	n.a.
Enn	**Tõugu**	Nut - an object-oriented language	1986	Computers and Artificial Intelligence	Matskin MB, Penjam JE, Eomois PV (3)		3	2	2
Enn	**Tõugu**	Semantics of a declarative language	1986	Information Processing Letters	Mints G (1)		2	1	0
Enn	**Tõugu**	Language and example of knowledge-based programming	1986	Lecture Notes in Computer Science		0	0	n.a.	n.a.

Enn	**Tõugu**	Description semantics in utopist language and automatic program synthesis	1985	Programming and Computer Software	Mints GE (1)		0	n.a.	n.a.
Enn	**Tõugu**	Computational frames and structural synthesis of programs	1982	Engineering Cybernetics		0	0	n.a.	n.a.
Enn	**Tõugu**	Justification of the structural synthesis programs	1983	Science of Computer Programming	Mints G (1)		4	0	0
Enn	**Tõugu**	The PRIZ system and propositional calculus	1982	Cybernetics	Volozh BB, Matskin MB, Mints GE (3)		0	1	0
Enn	**Tõugu**	Completeness of the structural synthesis rules	1982	Doklady Akademii Nauk SSSR	Mints GE (1)		0	n.a.	n.a.
Enn	**Tõugu**	Introduction to data-bases	1979	Engineering Cybernetics	Tamm BG (1)		0	n.a.	n.a.
Ermo	**Täks**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Raimund	**Ubar**	Design error diagnosis with re-synthesis in combinational circuits	2003	Journal of Electronic Testing-Theory and Applications		0	0	n.a.	n.a.
Raimund	**Ubar**	Hierarchical test generator for combinational circuits with real defects covverage	2002	Microelectronics Reliability	Cibakova T, Fischerova M, Gramatova E, Kuzmicz W, Pleskauz WA, Raik J (6)		0	n.a.	n.a.
Raimund	**Ubar**	Probabilistic analysis of CMOS physical defects in VLSI circuits for test coverage improvement	2001	Microelectronics Reliability	Blyzniuk M, Kazymyra I, Kuzmicz W, Pleskacz WA, Raik J (5)		1	0	0
Raimund	**Ubar**	Fast test pattern generation for sequential circuits using decision diagram representations	2000	Journal of Electronic Testing-Theory and Applications	Raik J (1)		0	n.a.	n.a.
Raimund	**Ubar**	Design error diagnosis in digital circuits with stuck-at fault model	2000	Microelectronics Reliability	Jutman A (1)		0	n.a.	n.a.
Raimund	**Ubar**	Special issue: Selected papers from the 1997 NORCHIP conference	1999	Analog Integrated Circuits and Signal Processing	Lande TS (1)		0	n.a.	n.a.
Raimund	**Ubar**	Dynamic analysis of digital circuits with multi-valued simulation	1998	Microelectronics Journal		0	0	n.a.	n.a.
Raimund	**Ubar**	Combinig functional and structural approaches in test generation for digital systems	1998	Microelectronics Reliability		0	0	n.a.	n.a.

Raimund	**Ubar**	Test synthesis with alternative graphs	1996	IEEE Design & Test of Computers	0	0	n.a.	n.a.
Raimund	**Ubar**	Digital Circuit Test Design Using the Alternative Graph Model	1980	Automation and Remote Control	Plakk MP (1)	0	n.a.	n.a.
Raimund	**Ubar**	Detection of Suspected Faults in Combinational-Circuits by Solving Boolean Differential-Equations	1979	Automation and Remote Control	0	0	n.a.	n.a.
Andres	**Udal**	High phonon-drag thermoelectric efficiency of SiC at low temperatures	2004	Materials Science Forum	Velmre E, Grivickas V (2)	0	n.a.	n.a.
Andres	**Udal**	Modeling of lattice heat conductivity and thermopower in SiC considering the four-phonon scattering process	2002	Materials Science Forum	Velmre E (1)	0	n.a.	n.a.
Andres	**Udal**	Impact of phonon drag effect on Seebeck coefficient in p-6H-SiC: Experiment and simulation	2002	Materials Science Forum	Bikbajevas V, Grivickas V, Stolzer M, Velmre E, Grivickas P, Syvajarvi M, Yakimova R (7)	0	n.a.	n.a.
Andres	**Udal**	Thermopwer measurements in 4H-SiC and theoretical calculations considering the phonon drag effect	2000	Materials Science Forum	Grivickas V, Stolzer M, Velmre E, Grivickas P, Syvajarvi M, Yakimova R, Bikbajevas V (7)	0	n.a.	n.a.
Andres	**Udal**	A theoretical study of electron drift mobility anisotropy in n-type 4H- and 6H-SiC	2000	Materials Science Forum	Velmre E (1)	1	0	1
Andres	**Udal**	Measurement of charge carrier lifetime temperature-dependence in 4H-SiC power diodes	2000	Materials Science Forum	Velmre E (1)	0	0	1
Andres	**Udal**	Corrected accounting of electron-hole scattering in cross-term current equations for Si and SiC	1999	Physica Scripta	Velmre E (1)	0	0	2
Andres	**Udal**	SiC-diodes forward surge current failure mechanisms: Experiment and simulation	1997	Microelectronics and Reliability	Velmre E (1)	1	0	1
Andres	**Udal**	A theoretically accurate mobility model for semiconductor-device drift-diffusion simulation	1994	Physica Scripta	Velmre E, Kocsis T, Masszi F (3)	2	0	0

Andres	**Udal**	A numerical transient analysis of a bulk-barrier diode	1983	Solid-State Electronics		0	1	0	1
Andres	**Udal**	Computer-aided numerical modeling of powerful Schottky diodes	1983	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Rang T (1)		0	1	0
Andres	**Udal**	Numerical-analysis of the on-state of diode structures based on direct-gap semiconductors	1981	Physica Scripta	Velmre E, Freidin B (2)		0	1	1
Heli	**Uibo**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Aivar	**Uisk**	n.a.	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Tarmo	**Uustalu**	Normalization by evaluation for lambda (-> 2)	2004	Lecture Notes in Computer Science	Alternkirch T (1)		0	n.a.	n.a.
Tarmo	**Uustalu**	Generalizing substitution	2003	Rairo - Theoretical Informatics and Applications		0	0	n.a.	n.a.
Tarmo	**Uustalu**	Monad translating inductive and coinductive types	2002	Lecture Notes in Computer Science		0	0	n.a.	n.a.
Tarmo	**Uustalu**	Generalized iteration and coiteration for higher-order nested datatypes	2003	Lecture Notes in Computer Science	Abel A, Matthes R (2)		0	n.a.	n.a.
Tarmo	**Uustalu**	CPS translating inductive and coinductive types	2002	ACM Sigplan Notices	Barthe G (1)		1	0	0
Tarmo	**Uustalu**	Least and greatest fixed points in intuitionistic natural deduction	2002	Theoretical Computer Science	Vene V (1)		0	n.a.	n.a.
Tarmo	**Uustalu**	Combining object-oriented and logic paradigms - a model logic programming approach	1992	Lecture Notes in Computer Science		0	0	0	1
Jüri	**Vain**	Integrating methods for the design of real-time systems	1996	Journal of Systems Architecture	Hooman J (1)		0	0	1
Jüri	**Vain**	Real-time specification and modeling with joint actions	1993	Science of Computer Programming	Kurkisuonio R, Systa K (2)		0	1	0
Jüri	**Vain**	Scheduling in real-time models	1991	Lecture Notes in Computer Science	Kurkisuonio R, Systa K (2)		0	n.a.	n.a.

Stanislav	**Vassiljev**	TO automation of theorem synthesis	1987	Lecture Notes in Computer Science	0	0	n.a.	n.a.
Enn	**Velmre**	High phonon-drag thermoelectric efficiency of SiC at low temperatures	2004	Materials Science Forum	Udal A, Gricvickas V (2)	0	n.a.	n.a.
Enn	**Velmre**	Modeling of lattice heat conductivity and thermopower in SiC considering the four-phonon scattering process	2002	Materials Science Forum	Udal A (1)	0	n.a.	n.a.
Enn	**Velmre**	Impact of phonon drag effect on Seebeck coefficient in p-6H-SiC: Experiment and simulation	2002	Materials Science Forum	Bikbajevas V, Grivickas V, Stolzer M, Udal A, Grivickas P, Syvajarvi M, Yakimova R (7)	0	n.a.	n.a.
Enn	**Velmre**	Thermopwer measurements in 4H-SiC and theoretical calculations considering the phonon drag effect	2000	Materials Science Forum	Grivickas V, Stolzer M, Udal A, Grivickas P, Syvajarvi M, Yakimova R, Bikbajevas V (7)	0	n.a.	n.a.
Enn	**Velmre**	A theoretical study of electron drift mobility anisotropy in n-type 4H- and 6H-SiC	2000	Materials Science Forum	Udal A (1)	1	0	1
Enn	**Velmre**	Measurement of charge carrier lifetime temperature-dependence in 4H-SiC power diodes	2000	Materials Science Forum	Udal A (1)	0	0	1
Enn	**Velmre**	Corrected accounting of electron-hole scattering in cross-term current equations for Si and SiC	1999	Physica Scripta	Udal A (1)	0	0	2
Enn	**Velmre**	SiC-diodes forward surge current failure mechanisms: Experiment and simulation	1997	Microelectronics and Reliability	Udal A (1)	1	0	1
Enn	**Velmre**	A theoretically accurate mobility model for semiconductor-device drift-diffusion simulation	1994	Physica Scripta	Udal A, Kocsis T, Masszi F (3)	2	0	0
Enn	**Velmre**	Numerical modeling of non-isothermal transient processes in power semiconductor-devices at the high forward current-density	1989	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Nurste IO, Freydin BP (2)	0	n.a.	n.a.

Enn	**Velmre**	Numerical modeling of non-isothermal transient processes in gaas structures	1984	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Freydin BP (1)	0	n.a.	n.a.
Enn	**Velmre**	Numerical modeling of the electrothermal transient process in diode structures based on direct-gap semiconductors	1983	Physica Status Solidi A - Applied Research	Freidin BP (1)	0	n.a.	n.a.
Enn	**Velmre**	Numerical modeling of transient processes in gaas diode structures	1983	Izvestiya Vysshikh Uchebnykh Zavedenii Radioelektronika	Freidin BP (1)	0	n.a.	n.a.
Enn	**Velmre**	Numerical-analysis of the on-state of diode structures based on direct-gap semiconductors	1981	Physica Scripta	Freidin B, Udal A (2)	1	0	1
Jelena	**Vendelin**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Varmo	**Vene**	Least and greatest fixed points in intuitionistic natural deduction	2002	Theoretical Computer Science	Uustalu T (1)	0	n.a.	n.a.
Tarmo	**Veskioja**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Vladimir	**Viies**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jüri	**Vilipõld**	A system for CAD CAM software-development and implementation	1984	Computers in Industry	Tamm B, Küttner R, Pruuden J (3)	0	n.a.	n.a.
Anne	**Villems**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jan	**Villemson**	Covering the path space: a casebase analysis for mobile robot path planning	2003	Knowledge-Based Systems	Kruusmaa M (1)	0	n.a.	n.a.
Jan	**Villemson**	Improving the availability of time-stamping services	2001	Lecture Notes in Computer Science	Ansper A, Buldas A, Saarepera M (3)	0	0	1
Jan	**Villemson**	Efficient long-term validation of digital signatures	2001	Lecture Notes in Computer Science	Ansper A, Buldas A, Roos M (3)	0	0	1
Jan	**Villemson**	Time-stampting with binary linking schemes	1998	Lecture Notes in Computer Science	Buldas A, Laud P, Lipmaa H (3)	2	2	6
Jaak	**Vilo**	Expression Profiler: next generation - an online platform for analysis of microarray data	2004	Nucleic Acids Research	Kapushesky M, Kemmeren P, Culhane AC, Durnick S, Ihmels J, Korner C, Kull M, Torrente A, Sarkans U, Brazma A (10)	0	n.a.	n.a.

Jaak	**Vilo**	ArrayExpress: a public database of gene expression data at EBI	2003	Comptes Rendus Biologies	Rocca-Serra P, Brazma A, Parkinson H, Sarkans U, Shojatalab M, Contrino S, Abeygunawardena N, Mukherjee G, Holloway E, Kapushesky M, Kemmeren P, Lara GG, Oezcimen A, Sansone SA (14)	0	n.a.	n.a.
Jaak	**Vilo**	ArrayExpress - a public repository for microarray gene expression data at the EBI	2003	Nucleic Acids Research	Brazma A, Parkinson H, Sarkans U, Shojatalab M, Abeygunawardena N, Holloway E, Kapushesky M, Kemmeren P, Lara GG, Oezcimen A, Rocca-Serra P, Sansone SA (12)	0	6	47
Jaak	**Vilo**	Correlating gene promoters and expression in gene disruption experiments	2002	Bioinformatics	Palin K, Ukkonen E, Brazma A (3)	0	0	3
Jaak	**Vilo**	Building and analysing genome-wide gene disruption networks	2002	Bioinformatics	Rung J, Schlitt T, Brazma A, Freivalds K (4)	0	1	5
Jaak	**Vilo**	A first-generation linkage disequilibrium map of human chromosome 22	2002	Nature	Dawson W, Avecasis GR, Bumpstead S, Chen Y, Hunt S, Beare DM, Pabial J, Dibling T, Tinsley E, Kirby S, Carter D, Papaspyridonos M, Livingstone S, Ganske R, Lohmussaar E, Zernant J, Tonisson N, Remm M, Magi R, Puurand T, Kurg A, Rice K, Deloukas P, Mott T, Metspalu A, Bentley DR, Cardon LR, Dunham I (28)	0	10	77
Jaak	**Vilo**	Protein interaction verification and functional annotation by integrated analysis of genome-scale data	2002	Molecular Cell	Kemmeren P, van Berkum NL, Bijma T, Donders R, Brazma A, Holstege FCP (6)	0	1	47

Jaak	**Vilo**	Minimum information about a microarray experiment (MIAME) - toward standards for microarray data	2001	Nature Genetics	Brazma A, Hingamp P, Quackenbush J, Sherlock G, Spellman P, Stoeckert C, Aach J, Ansorge W, Ball CA, Causton HC, Gaasterland T, Glennisson P, Holstege FCP, Kim IF, Markowitz V, Matese JC, Parkinson H, Robinson A, Sarkans U, Schulze-Kremer S, Stewart J, Taylor R, Vingron M (23)	2	23	278
Jaak	**Vilo**	Regulatory sequence analysis: application to the interpretation of gene expression	2001	European Neuropsychopharmacology	Kivinen K (1)	2	0	0
Jaak	**Vilo**	Gene expression data analysis	2001	Microbes and Infection	Brazma A (1)	0	0	7
Jaak	**Vilo**	Gene expression data analysis	2000	Febs Letters	Brazma A (1)	1	0	137
Jaak	**Vilo**	Predicting gene regulatory elements in silico on a genomic scale	1998	Genome Research	Brazma A, Jonassen I, Ukkonen E (3)	4	0	79
Jaak	**Vilo**	Discovering unbounded unions of regular pattern languages from positive examples	1996	Lecture Notes in Computer Science	Brazma A, Ukkonen E (2)	0	1	3
Jaak	**Vilo**	Implementing attribute grammars by computational models	1992	Lecture Notes in Computer Science	0	0	n.a.	n.a.
Leo	**Võhandu**	A comparative-study of cancer registries in the German-Democratic-Republic and the Estonian-SSR	1982	Archiv fur Geschwulstforschung	Staneczek W, Rahu M, Beckmann L, Haas J, Aareleid T, Mehnert WH (6)	0	7	1
Leo	**Võhandu**	New possibilities of data-analysis	1980	Bioinformatics	0	0	n.a.	n.a.
Tiina	**Zingel**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Enn	**Õunapuu**	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Appendix 3: Abstracts

First Name	Surname	Name of the article	Abstract
Margit	**Aarna**	n.a.	n.a.
Hillar	**Aben**	On the optical theory of photoelastic tomography	In recent years many authors have considered the possibility of using tomography for nondestructive determination of three-dimensional stress fields. A natural starting point for this is integrated photoelasticity. The problem is complicated since the stress field is a tenser field, and in the general case in integrated photoelasticity the relationships between the measurement data and the parameters of the stress field are nonlinear. To elucidate these relationships, we have systematically studied the propagation of polarized light in an inhomogeneous birefringent medium. The inverse problem of integrated photoelasticity is formulated in the general form, and particular cases in which the polarization transformation matrix is exactly determined by integrals of the stress tensor components are considered. The possibility of using the Radon inversion for approximate determination of the normal stress field in an arbitrary section of the test object is outlined.
Hillar	**Aben**	A new relationship for the experimental-analytical solution of the axisymmetric thermoelasticity problem	The following inverse problem of axisymmetric thermoelasticity is considered: stresses sigma(z) and sigma(rz) are determined experimentally but the temperature distribution is not known; the stresses sigma(r) and sigma(theta) are to be determined. By eliminating temperature from the compatibility equations and using the equilibrium equations, a new relationship between the stress components for the axisymmetric thermoelasticity problem has been derived. Using this relationship, a closed form solution of the problem has been obtained.
Hillar	**Aben**	On hybrid thermomechanics for multilayered cylinders	The following inverse thermoelasticity problem for a stepwise inhomogeneous cylinder is considered. The axial stress distribution has been measured experimentally but the temperature field is not known. By eliminating temperature from the equations of thermoelasticity in the case of plane deformation, new relationships between the stress components are derived and a closed-form solution of the problem is found. The classical sum rule is generalized for stepwise inhomogeneous cylinders. Because residual stress in glass can be described by the equations of thermoelasticity, the results make it possible to completely determine stresses in step-index optical fibers and fiber preforms. An experimental example illustrates application of the method presented.
Hillar	**Aben**	Theory of magnetophotoelasticity with multiple reflections	In magnetophotoelasticity, photoelastic models are investigated in transmitted light with the wave normal parallel to the magnetic field. Transformation of polarization in the model is caused both by stress birefringence and by the Faraday effect. Due to the latter, the integral Wertheim law is not valid and it is possible to measure stress distributions that are in equilibrium through the model like bending stresses in plates and parabolic residual stresses in glass plates. One of the drawbacks of magnetophotoelasticity is the need for very precise optical measurements since the angle of rotation of the plane of polarization is small. In this paper we investigate the case when multiple reflection of the light is used to increase the rotation of the plane of polarization. It is shown that 2n multiple reflections correspond to a (2n + 1)(1/2)-fold increase of the magnetic field.

Hillar	**Aben**	Alternative equations of magnetophotoelasticity and approximate solution of the inverse problem	In magnetophotoelasticity, photoelastic models are investigated in a magnetic field in order to initiate rotation of the plane of polarization that is due to the Faraday effect. The method has been used for the measurement of stress distributions that are in equilibrium on the wave normal and therefore cannot be measured with the traditional photoelastic technique. In this category belong bending stresses in plates and shells and residual stresses in glass plates. Two new systems of equations of magnetophotoelasticity are derived. One of them describes evolution of the polarization of light in a magnetophotoelastic medium in terms of eigenvectors, the other in terms of distinctive parameters. For the latter system, an approximate closed-form solution has been found. The integral Wertheim law has been generalized for the case of stress states in equilibrium when rotation of the plane of polarization is present.
Hillar	**Aben**	Simplified interpretation of an integrated photoelastic fringe pattern	A simple method for the interpretation of the integrated fringe pattern under a concentrated load is presented. By comparing photoelastic phenomena in the case of the Flamant and the Boussinesq problem, an assessment of the error that is made by over-simplified interpretation of the fringe pattern is given. An interesting result is that the fringe pattern for the Flamant problem is practically the same as the integrated fringe pattern for Boussinesq problem.
Hillar	**Aben**	Transformation equations in polarization optics of inhomogeneous birefringent media	The quaternion formalism has been used to derive new systems of equations that describe transformation of the polarization of light in inhomogeneous birefringent media. In quaternion algebra the problem of parametric representation of the unitary transformation matrix reduces to the problem of formulation of the quaternion in trigonometric form. It is shown that this can be done in 30 different ways and that to each trigonometric form corresponds its own system of transformation equations. The six simplest systems of transformation equations have been derived.
Hillar	**Aben**	Optical tomography of the laser's Gaussian electric field	A method for the measurement of the spatial distribution of birefringence, caused by intense femtosecond laser pulses in condensed plasma, is presented for the case of a Gaussian laser beam. For that only two light intensities are to be measured on the probe beam in a polariscope.
Hillar	**Aben**	Hybrid mechanics for axisymmetric thermoelasticity problems	The present article extends the integrated photoelasticity technique for the case where stresses are due to an unknown axisymmetric temperature field. Relationships that express radial and circumferential stresses through the axial and shear stresses are derived. Since residual stresses in glass can be described by the equations of thermoelasticity, the results of this article offer a means for complete determination of the residual stresses in axisymmetric glass articles using integrated photoelasticity. The results are verified by numerical and physical experiments.
Hillar	**Aben**	Integrated photoelasticity for nondestructive residual stress measurement in glass	The paper gives a review of integrated photoelasticity and of its application for residual stress measurement in glass. By considering the basic theory of the method, two particular cases, the case of weak birefringence and that of constant principal stress axes, are picked up. It is shown that integrated photoelasticity is actually optical tensor field tomography. Its peculiarities in comparison with scalar field tomography are considered. Since directly integrated photoelasticity allows for the measurement of only some of the stress components, analytical or numerical methods are to be used for complete determination of the stress field. Nonlinear optical phenomena, interference blots and fringe bifurcation, are briefly considered. Several examples illustrate the application of the method.
Hillar	**Aben**	Isochormatic fringes in photoelasticity	The structure of the isochromatic fringe pattern in a two-dimensional photoelastic model is investigated with the phase diagram method of the theory of dynamic systems. Isochromatics are interpreted as phase paths (or level curves) of a Hamiltonian system. Possible singularities of the fringe pattern are analyzed.

Hillar	**Aben**	Duality in optical theory of twisted birefringent media	Two classical treatments of the transformation of the polarization of light in twisted birefringent media belong to Neumann and Kuske [see H. Aben, Integrated Photoelasticity (McGraw-Hill, New York, 1979)]. Since these authors have chosen parameters that characterize the state of polarization differently, the equations derived by them have been considered to be independent of one another. We show that duality exists between these equations. By the appropriate exchange of parameters, the first system of equations is transformed into the second one and vice versa. This duality follows from the duality between the two different parametric representations of the unitary unimodular matrix that describes the transformation of polarization in twisted birefringent media.
Hillar	**Aben**	Editor's page	n.a.
Hillar	**Aben**	Interference blots and fringe dislocations in optics of twisted birefringent media	The appearance of interference blots and of the dislocation of interference fringes is studied by means of modeling an arbitrary inhomogeneous birefringent medium with rotating principal optical axes by a system of two birefringent plates. A theoretical explanation of these irregularities is given. Conditions for the appearance of interference blots and fringe dislocations are derived. A method of classification of singular points in the fringe patterns is presented.
Hillar	**Aben**	Strange interference blots in the interferometry of inhomogeneous birefringent objects	We show both experimentally and by numerical simulation that in the polarization interferometry of inhomogeneous birefringent objects, besides the usual interference fringes, interference blots may appear. ;In a light-field circular polariscope, interference blots are dark areas that may expand through a number of interference fringes. In a dark-field circular polariscope, interference blots are bright. In the vicinity of the interference blots interference hinges are deformed and their bifurcation may occur. It is shown that the cause of the interference blots is rotation of the principal birefringence axes.
Hillar	**Aben**	Photoelastic tomopraphy for three-dimensional flow birefringence studies	The possibility of applying photoelastic tomography (integrated photoelasticity) for investigating a three-dimensional birefringent flow is studied. Tomographic equations of the strain rates are reduced to a vector analogue of the Radon equation by dividing the flow-velocity field into an axial component, a transversal rotational, and a transversal potential component. It is shown how the axial and potential parts can be determined by tomographic photoelastic measurements.
Hillar	**Aben**	Nonaxisymmetric residual stress distribution in axisymmetric glass articles	Residual stress measurements in many bottles, tumblers and in other axisymmetric glass articles by using integrated photoelasticity have shown that the residual stress distribution often deviates from the axially symmetric one. A method is developed which enables determination of nonaxisymmetric residual stress distribution. A computer-controlled polariscope has been developed for automatic measurements. Several examples of residual stress distributions, which deviate strongly from the axisymmetric one, are given. It is shown that deviations from axial symmetry lead to less favorable distribution of the residual stresses; e.g., they may lead to tensile residual stresses on the external surface of bottles.
Hillar	**Aben**	Edge and boundary stress measurement in glass	n.a.
Hillar	**Aben**	On the precision of integrated photoelasticity for hollow glassware	This paper analyses two sources of errors which may occur by measuring stress in hollow glassware using integrated photoelasticity. First, the mismatch of the refractive indexes of glass and of the immersion fluid is considered. Using real measurement data, stress distribution in three different glass articles is calculated assuming various mismatching of the refractive indexes. Secondly, bending of the light rays due to the stress-induced refractive index gradient has been calculated. It has been shown that in order to keep the error of surface stresses below 5%, the immersion fluid should match the glass with a precision of about 0.001. In all three samples, bending of the light rays was negligible.

Hillar	**Aben**	The use of differential scanning calorimetry in chemical education .2. A graduate experiment, the melting behaviour of ultra-high-molecular-weight polythylene fiber	An overview is given of the potential of DSC in chemical education, both in the undergraduate and in the graduate phase. The way in which the introduction of DSC in chemical education is facilitated, is outlined. A comprehensive description is given of a graduate experiment, the melting behaviour of ultra-high molecular weight polyethylene fiber. It is shown that, using such an experiment, various chemical and physical processes in substances can be easily demonstrated.
Hillar	**Aben**	The case of weak birefringence in integrated photoelasticity	n.a.
Hillar	**Aben**	Light-intensity in 3-D photoelastic analysis	n.a.
Hillar	**Aben**	Kerr effect tomography for general axisymmetrical field	n.a.
Hillar	**Aben**	Characteristic directions in optics of twisted birefringent media	n.a.
Hillar	**Aben**	Integrated photoelasticity as tensor field tomography	n.a.
Hillar	**Aben**	Correction	n.a.
Hillar	**Aben**	Nonrectilinear light-propagation in integrated photoelasticity of axisymmetric-bodies	
Hillar	**Aben**	Integral Tension Optics	n.a.
Hillar	**Aben**	On the existence of characteristic directions in 3-dimensional photoelasticity	n.a.
Hillar	**Aben**	Integrated photoelasticity of axisymmetric-bodies	n.a.
Leo	**Ainola**	On the optical theory of photoelastic tomography	In recent years many authors have considered the possibility of using tomography for nondestructive determination of three-dimensional stress fields. A natural starting point for this is integrated photoelasticity. The problem is complicated since the stress field is a tenser field, and in the general case in integrated photoelasticity the relationships between the measurement data and the parameters of the stress field are nonlinear. To elucidate these relationships, we have systematically studied the propagation of polarized light in an inhomogeneous birefringent medium. The inverse problem of integrated photoelasticity is formulated in the general form, and particular cases in which the polarization transformation matrix is exactly determined by integrals of the stress tensor components are considered. The possibility of using the Radon inversion for approximate determination of the normal stress field in an arbitrary section of the test object is outlined.
Leo	**Ainola**	A new relationship for the experimental-analytical solution of the axisymmetric thermoelasticity problem	The following inverse problem of axisymmetric thermoelasticity is considered: stresses sigma(z) and sigma(rz) are determined experimentally but the temperature distribution is not known; the stresses sigma(r) and sigma(theta) are to be determined. By eliminating temperature from the compatibility equations and using the equilibrium equations, a new relationship between the stress components for the axisymmetric thermoelasticity problem has been derived. Using this relationship, a closed form solution of the problem has been obtained.

Leo	**Ainola**	On hybrid thermomechanics for multilayered cylinders	The following inverse thermoelasticity problem for a stepwise inhomogeneous cylinder is considered. The axial stress distribution has been measured experimentally but the temperature field is not known. By eliminating temperature from the equations of thermoelasticity in the case of plane deformation, new relationships between the stress components are derived and a closed-form solution of the problem is found. The classical sum rule is generalized for stepwise inhomogeneous cylinders. Because residual stress in glass can be described by the equations of thermoelasticity, the results make it possible to completely determine stresses in step-index optical fibers and fiber preforms. An experimental example illustrates application of the method presented.
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Leo	**Ainola**	Approximate wall shear equation for unsteady laminar pipe flows - Discussion	n.a.
Kaarel	**Allik**	Skyharp, an interactive electroacoustic instrument	n.a.
Kaarel	**Allik**	Arconet, a proposal for a standard network for communication and control in real-time performance	n.a.
Tanel	**Alumäe**	n.a.	n.a.
Irina	**Amitan**	Stereoselective hydration of N-alkynes based on boronickel catalysts	n.a.
Arne	**Ansper**	Improving the availability of time-stamping services	We discuss the availability questions that arise when digital time stamps are used for preserving the evidentiary value of electronic documents. We analyze the time-stamping protocols known to date and point out some weaknesses that have not been addressed so far in scientific literature. Without addressing and solving them, any advantage of the linkage-based protocols over the hash-and-sign time-stamping would be questionable. We present several new techniques and protocols for improving the availability of both the hash-and-sign and the linkage-based time-stamping services. We introduce fault-tolerant linking as a new concept to neutralize fault-sensitivity as the main

			weakness of linkage-based time-stamping.
Arne	**Ansper**	Efficient long-term validation of digital signatures	Digitally signed documents (e.g. contracts) would quickly lose their validity if the signing keys were revoked or the signature scheme was broken. The conventional validation techniques have been designed just for ephemeral use of signatures and are impractical for long-term validation. We present a new scheme that: (1) provides fast revocation while giving no extra power to on-line service providers; (2) supports long-term validation; (3) is lightweight and scalable.
Johan	**Anton**	Integrated photoelasticity for nondestructive residual stress measurement in glass	The paper gives a review of integrated photoelasticity and of its application for residual stress measurement in glass. By considering the basic theory of the method, two particular cases, the case of weak birefringence and that of constant principal stress axes, are picked up. It is shown that integrated photoelasticity is actually optical tensor field tomography. Its peculiarities in comparison with scalar field tomography are considered. Since directly integrated photoelasticity allows for the measurement of only some of the stress components, analytical or numerical methods are to be used for complete determination of the stress field. Nonlinear optical phenomena, interference blots and fringe bifurcation, are briefly considered. Several examples illustrate the application of the method.
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Ilmar	**Arro**	A generalised algorithm for reduced computation of the discrete fourier transformation	n.a.
Igor	**Astrov**	Evaporated AGBR layers as a recording material in ionization semiconductor photographic system	n.a.
Marina	**Brik**	n.a.	n.a.
Ahto	**Buldas**	Improving the availability of time-stamping services	We discuss the availability questions that arise when digital time stamps are used for preserving the evidentiary value of electronic documents. We analyze the time-stamping protocols known to date and point out some weaknesses that have not been addressed so far in scientific literature. Without addressing and solving them, any advantage of the linkage-based protocols over the hash-and-sign time-stamping would be questionable. We present several new techniques and protocols for improving the availability of both the hash-and-sign and the linkage-based time-stamping services. We introduce fault-tolerant linking as a new concept to neutralize fault-sensitivity as the main weakness of linkage-based time-stamping.

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Ahto	**Buldas**	Optimally efficient accountable time-stamping	Efficient secure time-stamping schemes employ a 2-level approach in which the time-stamping service operates in rounds. We say that a time-stamping service is accountable if if it makes the TSA and other authorities accountable for their actions by enabling a principal to detect and later prove to a judge any frauds, including attempts to reorder time-stamps from the same round. We investigate the paradigm of time-stamping services based on simply connected graphs, and propose a simple, yet optimal, accountable time-stamping service, using what we call threaded tree schemes. We improve upon the previously best scheme by Buldas and Laud by reducing the size of a time stamp by a factor of about 3.786 and show that our construction is optimal in a strict sense. The new protocols also increase the trustworthiness of the publication process, which takes place at the end of each round.
Ahto	**Buldas**	Time-stampting with binary linking schemes	We state the basic requirements for time-stamping systems applicable as the necessary support to the legal use of electronic documents. We analyze the main drawbacks of the time-stamping systems proposed to date and present a new system that meets all the stated requirements. We prove that these requirements cannot be significantly tightened.
Julia	**Derkats**	n.a.	n.a.
Arvo	**Eek**	n.a.	n.a.
Erki	**Eessaar**	n.a.	n.a.
Peeter	**Ellervee**	Evaluating fault emulation on FPGA	We present an evaluation of accelerating fault simulation by hardware emulation on FPGA, Fault simulation is an important subtask in test pattern generation and it is frequently used throughout the test generation process. In order to evaluate possible simulation speed possibilities, we made a feasibility study of using reconfigurable hardware by emulating circuit under analysis together with fault insertion structures on FPGA. Experiments showed that it is beneficial to use emulation for circuits/methods that require large numbers of test vectors, e.g., sequential circuits and/or genetic algorithms.
Peeter	**Ellervee**	System-level data-format exploration for dynamically allocated data structures	System-level exploration of memory organizations is a key issue in successful implementation of data dominated applications based on dynamically allocated data structures involving records and access keys. This paper presents a formalized technique for exploring different memory data-format alternatives when only the system level functional behavior of the application has been defined. Our data-format exploration approach allows to substantially minimize the number of accessed bits by rearranging the format of the data records. The technique exploits parallelism in the data transfer by analyzing the dependencies between data-record accesses. As a result, significant reduction in memory size, bandwidth, and power are obtained. We have validated our techniques using several real-life asynchronous transfer mode cell processing applications, where we have obtained reductions in memory size (up to 20%), power (up to a 60%), and bandwidth.
Juhan-Peep	**Ernits**	n.a.	n.a.
Teet	**Evartson**	n.a.	n.a.
Jelena	**Fomina**	n.a.	n.a.

Margus	**Freudenthal**	n.a.	n.a.
Alina	**Gavrijaseva**	n.a.	n.a.
Boris	**Gordon**	n.a.	n.a.
Ksenia	**Grigorjeva**	n.a.	n.a.
Heldur	**Haak**	n.a.	n.a.
Hele-Mai	**Haav**	n.a.	n.a.
Rein	**Haavel**	n.a.	n.a.
Kristiina	**Hakk**	n.a.	n.a.
Mait	**Harf**	n.a.	n.a.
Kristo	**Heero**	n.a.	n.a.
Sven	**Heiberg**	Analysing pair-programmer's satisfaction with the method, the result, and the partner	This paper gives an overview of a programmer satisfaction survey in pair-programming experiment. The experiment took place at Institute of Computer Science, University of Tartu (UT), Estonia. The paper includes the problem statement, description of the questionnaire, and the survey results.
Helle	**Hein**	Optimization of clamped plastic shallow shells subjected to initial impulsive loading	An optimization technique is suggested for shallow spherical shells made of a ductile material and subjected to initial impact loading. The shell under consideration is pierced with a central hole and clamped at the outer edge. The optimal design of the shell of piece-wise constant thickness is established under the condition that the maximal residual deflection attains its minimal value for given total weight. The material of the shell is assumed to obey the Tresca yield condition and associated flow law. By the use of the method of mode form motions the problem is transformed into a particular problem of non-linear programming and solved numerically.
Helle	**Hein**	Optimal plastic design of shallow curved beams with step-wise varying cross sections	The problem of designing minimum weight thin curved beams with piece-wise constant thickness is studied. The material of the beam is assumed to be rigid-plastic that obeys the yield condition and associated flow law. The influence of geometric changes that occur in the post-yield stage an taken into account. The weight minimization is performed under conditions where the maximum deflection of the beam coincides with the deflection of a reference beam of constant thickness. Necessary optimality conditions are derived with the aid of variational methods from optimal control theory. Numerical results are presented for shallow circular beams with two, three, and four steps in thickness.
Helle	**Hein**	Optimization of shallow shells with different yield stresses in tension and compression	The minimum weight problem of thin rigid-plastic shallow spherical shells is studied. The thickness of the shell is piece-wise constant and the material has different yield stresses in tension and compression. The flow theory of plasticity is employed. Both solid and sandwich shells are considered. Necessary optimality conditions are derived with the aid of optimal control theory.
Helle	**Hein**	Optimization of rigid-plastic shallow curved beams	The minimum weight problem of a shallow circular beam is studied in the case when the beam has a piece-wise constant thickness. The minimum of the weight is sought under the condition that the deflections of the beam of piece-wise constant thickness do not exceed those of the reference beam of constant thickness for given values of the external loading. The beam is subjected to uniformly distributed transverse pressure and to axial dead load. The material of the beam is assumed to be ideally rigid-plastic. Moderately large deflections are taken into account. Necessary optimality conditions are derived and used in order to establish the optimal values of the design parameters.

Helle	**Hein**	Optimization of clamped rigid-plastic shallow shells of piecewise-constant thickness	The minimum weight problem is studied under the condition that the considered shell has a piecewise constant thickness. The shell with free internal edge and clamped outer edge is subjected to uniformly distributed internal pressure. Moderately large deflections are taken into account and a deformation-type theory of plasticity is employed. The optimization problem includes the additional restriction, which demands that the maximal deflections of the shell of piecewise constant thickness and of the reference shell, of constant thickness, coincide. Employing the variational methods of the optimal control theory, necessary optimality conditions are established. The results obtained are used to establish the optimal parameters for the shell of piecewise constant thickness.
Helle	**Hein**	Optimization of rigid-plastic shallow spherical-shells of piecewise constant thickness	An approximate method developed earlier for the investigation of large plastic deflections of circular and annular plates is accommodated for shallow spherical shells. The material of the shells is assumed to obey Tresca's yield condition and the associated deformation law. The minimum weight problem concerning shells operating in the post-yield range is posed under the conditions that (i) the thickness of the structure is piece-wise constant and (ii) the maximal deflections of the optimized shell and a reference shell of constant thickness, respectively, coincide. Necessary optimality conditions are derived with the aid of the variational methods of the optimal control theory. The set of equations obtained is solved numerically.
Jaak	**Henno**	User-friendly syntax - design and presentation	n.a.
Jaak	**Henno**	On equivalent sets of functions	n.a.
Raul	**Isotamm**	n.a.	n.a.
Ain	**Isotamm**	n.a.	n.a.
Eero	**Ivask**	n.a.	n.a.
Artur	**Jutman**	Design error diagnosis in digital circuits with stuck-at fault model	In this paper we describe in detail a new method for the single gate-level design error diagnosis in combinational circuits. Distinctive features of the method are hierarchical approach (the localizing procedure starts at the macro level and finishes at the gate level), use of stuck-at fault model (it is mapped into design error domain only in the end), and design error diagnostic procedure that uses only test patterns generated by conventional gate-level stuck-at fault test pattern generators (ATPG). No special diagnostic tests are used because they are much more time consuming. Binary decision diagrams (BDD) are exploited for representing and localizing stuck-at faults on the higher signal path level. On the basis of detected faulty signal paths, suspected stuck-at faults at gate inputs are calculated, and then mapped into suspected design error(s). This method is enhanced compared to our previous work. It is applicable to redundant circuits and allows using incomplete tests for error diagnosis. Experimental data on ISCAS benchmark circuits shows the advantage of the proposed method compared to the known algorithms of design error diagnosis.
Rein	**Jõers**	n.a.	n.a.
Ahto	**Kalja**	n.a.	n.a.
Taivo	**Kangilaski**	n.a.	n.a.
Jüri	**Kiho**	Retrieval-system of CIS-Tartu data-bank	n.a.
Jüri	**Kiho**	A specialized subsystem for coding and input of mosaic structures	n.a.

Kaido	**Kikkas**	n.a.	n.a.
Rein	**Kipper**	Optical transparency spectral-analysis of two-dimensional film	n.a.
Rein	**Kipper**	Information capacity of multichannel acoustooptic modulators	n.a.
Mare	**Koit**	Directives in Estonian information dialogues	The paper gives an overview of a typology of dialogue acts we use for annotating Estonian spoken dialogues. Our dialogue corpus includes calls for information and to travel agencies (114 annotated dialogues). Directives (request, proposal, offer) and possible reactions are considered in the paper. Our further aim is to develop a dialogue system that will interact with the user in natural language following the norms and rules of human-human communication.
Mare	**Koit**	On a method for designing a dialogue system and the experience of its application	The known Wizard of Oz method designed for the development of dialogue systems interacting with a user using a natural language is considered. The method is based on the hypothesis on "computer speech," which states that a human interacts with a computer in a different way to how he/she interacts with other humans. Therefore, before simulating a natural dialogue corresponding to the rules and norms of human conversation using a computer, one should try to model "computer speech" that is simpler than human speech in its structure. We describe our experience in the application of the Wizard of Oz method and analyze the dialogues collected by this method with the aim of developing the principles of functioning of the control module of our dialogue system.
Toomas	**Kont**	n.a.	n.a.
Marko	**Koort**	n.a.	n.a.
Oleg	**Korolkov**	The basic parameters of diffusion welded Al Schottky contacts to p- and n-SiC	Aluminium Schottky contacts to n- and p-type SiC were fabricated by diffusion welding. Forward current-voltage measurements were made in a temperature range of 300divided by773degreesK. The basic Schottky parameters, such as saturation current (J(S)), barrier height (Phi(B)), the ideality factor (eta), the effective Richardson's constant (A**) and the series on-resistance (R-sp) were obtained from U-I curves at different temperatures. The comparative analysis of temperature variations of these parameters is presented.
Oleg	**Korolkov**	Diffusion-welded Al contacts to p-type SiC	The first experimental results on Diffusion Welding (DW) applied to p-type 6H- and 4H-SiC are described. Using the extrapolation method and available measurement apparatus the specific series on-state resistance and current-voltage characteristics of Schottky contacts in comparison with the n-type Schottky contacts were obtained.
Oleg	**Korolkov**	Some comparative properties of diffusion-welded contacts to 6H and 4H silicon carbide	The results of experimental investigations of diffusion welded large area Al/SiC contacts are presented. The specific contact resistance is determined for Al/6H- and 4H-SiC. The particular importance of inflatness and non-parallelism for diffusion welding process is shown. The influence of imperfections and structural defects of SiC structures on reverse characteristics is discussed.
Oleg	**Korolkov**	Formation of large area Al contacts on 6H- and 4H-SiC substrates	The results of experimental investigations of diffusion welded (bonded) large area Al/SiC contacts are presented. The novel data on adhesion of Al to 4H- and 6H-SiC are proposed. The specific contact resistance is determined for Al-6H-SiC contacts. The V-I characteristics for Al-4H-SiC Schottky contacts are measured.
Vahur	**Kotkas**	n.a.	n.a.

Ülle	**Kotta**	A geometric solution to the dynamic disturbance decoupling for discrete-time nonlinear systems	The notion of controlled invariance under quasi-static state feedback for discrete-time nonlinear systems has been recently introduced and shown to provide a geometric solution to the dynamic disturbance decoupling problem (DDDP). However, the proof relies heavily on the inversion (structure) algorithm. This paper presents an intrinsic, algorithm-independent, proof of the solvability conditions to the DDDP.
Ülle	**Kotta**	Generalization of transfer equivalence for discrete-time non-linear systems: comparison of two definitions	The problem of system reduction is studied for discrete-time non-linear single-input single-output systems described by high-order input-output (i/o) difference equations, that is, given the i/o equation, we can find a minimal representation which is equivalent to the original system with the order being as small as possible. Comparison of two definitions of reducibility is provided. The reducibility concepts addressed are both generalizations of the well-known notion of transfer equivalence to the case of non-linear control systems. Two roles of transfer equivalence are covered by these extensions. The first is that of identity of the outputs for any fixed control sequence under zero initial conditions. The second property is that of pole/zero cancellation that may occur in the transfer function of equivalent systems. The relationship between two reducibility definitions related to two equivalence notions is examined and the reducibility definition which extends pole/zero cancellation property is shown to be stronger. Finally, the computational aspects of system reduction are discussed.
Ülle	**Kotta**	Nonlinear discrete-time models: state-space vs. I/O representations	This paper compares state-space and input-output realizations for nonlinear discrete-time dynamic models. For linear models, these two realizations are essentially equivalent and their structures are closely related, but these statements do not hold for nonlinear models. We illustrate this point with simple, realistic examples for which only one of the two realizations exists or for which both exist but their structures are profoundly different. Overall, the main point of this paper is the importance of the choice of realization in the development of nonlinear dynamic models.
Ülle	**Kotta**	Classical state space realizability of input-output bilinear models	This paper studies the realizability property of bilinear input-output (i/o) models in the classical state space form. Constraints on the parameters of the bilinear i/o model are suggested that lead to realizable models. The complete list of 2nd and 3rd order realizable input-output bilinear models together with the corresponding state equations is given. In the general case some subclasses of realizable bilinear models together with their state-space realizations are presented, including the diagonal bilinear model and the special subclass of the superdiagonal bilinear model.
Ülle	**Kotta**	Linear algebraic tools for discrete-time nonlinear control systems with Mathematica	This paper presents a contribution to the development of symbolic computation tools for discrete-time nonlinear control systems. A set of functions is developed in Mathematica 4.0 on the basis of linear algebraic approach that allows the solution of several modelling, analysis and synthesis problems. In all these problems, a certain sequence of subspaces, associated to a control system and based on the classification of one-forms according to their relative degree, provides the solution.
Ülle	**Kotta**	Systems with associative dynamics	This paper introduces a class of nonlinear discrete-time dynamic models that generalize familiar linear model structures; our motivation is to explore the extent to which known results for the linear case do or do not extend to this nonlinear class. The results presented here are based on a complete characterization of the solution of the associative functional equation F[F(x, y), z] = F[x, F(y, z)] due to J. Aczel, leading to a class of invertible binary operators that includes addition, multiplication, and infinitely many others. We present some illustrative examples of these dynamic models, give a simple explicit representation for their inverses, and present sufficient conditions for bounded-input, bounded-output stability. Finally, we propose a generalization of this model class and we demonstrate that these models have classical state-space realizations, unlike arbitrarily structured NARMA models.

Ülle	**Kotta**	Two approaches for state space realization of NARMA models: Bridging the gap	This paper studies the necessary and sufficient conditions for observable realization of a general class of nonlinear high-order input-output difference equations. In particular, it proves the equivalence of the two seemingly different existing approaches in the literature. The paper also provides a subclass of NARMA input-output models that are guaranteed to have an observable realization. It is shown that this class covers several important subclasses of existing NARMA models.
Ülle	**Kotta**	Transfer equivalence and realization of nonlinear higher order input-output different equations	Two fundamental modelling problems in nonlinear discrete-time control systems are studied using the language of differential forms. The discrete-time nonlinear single-input single-output systems to be studied are described by input-output (i/o) difference equations, i.e. a high order difference equation relating the input, the output and a finite number of their time shifts. A new definition of equivalence is introduced which generalizes the notion of transfer equivalence well known for the linear case. Our definition is based upon the notion of an irreducible differential form of the system and was inspired by the analogous definition for continuous-time systems. The second problem to be addressed is the realization problem. The i/o difference equation is assumed to be in the irreducible form so that one can obtain an accessible and observable realization. Necessary and sufficient conditions are given for the existence of a (local) state-space realization of the irreducible i/o difference equation. These conditions are formulated in terms of the integrability of certain subspaces of one-forms, classified according to their relative degree. The sufficiency part of the proof gives a constructive procedure (up to finding the integrating factors and integration of the set of one-forms) for obtaining a locally observable and accessible state-space system. If the system is not in the irreducible form, one has first to apply the reduction procedure to transform the system into the irreducible form.
Ülle	**Kotta**	Generalized controlled invariance for discrete-time nonlinear systems with an application to the dynamic disturbance decoupling problem	In analogy with the continuous-time case, a general notion of controlled invariance with respect to quasi-static-state feedback is introduced for discrete-time nonlinear systems which incorporates the earlier definition of controlled invariance with respect to regular static-state feedback. This new notion is used to derive a geometric solution to the dynamic disturbance decoupling problem, The proposed solution is a natural generalization of the geometric solution to the static disturbance decoupling problem.
Ülle	**Kotta**	Comments on "On the discrete-time normal form"	This paper shows briefly that the necessary and sufficient algebraic conditions for transformability of the discrete-time nonlinear system into the special case of the normal form, given the above paper,(1) can be restated in a more transparent way.
Ülle	**Kotta**	Input-output decoupling of nonlinear recursive systems	The input-output decoupling problem is studied for a class of recursive nonlinear systems (RNSs), i.e. for systems, modelled by higher order nonlinear difference equations, relating the input, the output and a finite number of their time shifts. The solution of the problem via regular static feedback known for discrete-time nonlinear systems in state space form, is extended to RNSs. Necessary and sufficient conditions for local solvability of the problem are proposed. This is the alternative to be used when some nonlinear input-output models cannot be realized in the state-space form.
Ülle	**Kotta**	Transfer equivalence and realization of nonlinear higher order input/output difference equations using Mathematica	This paper presents a contribution to the development of symbolic computation tools for discrete-time nonlinear control systems. A set of functions is developed in Mathematica 3.0 that test if the higher order input/output difference equation is realizable in the classical state-space form, and for simple examples, also find such state equations. The approach relies on a new notion of equivalence of higher order difference equations which yields a minimal (i.e. accessible and observable) realization and generalizes the notion of transfer equivalence to the nonlinear case. The application of the developed functions is demonstrated on three examples obtained via identification.

Ülle	**Kotta**	Linearization of discrete-time systems	The algebraic formalism developed in this paper unifies the study of the accessibility problem and various notions of feedback linearizability for discrete-time nonlinear systems. The accessibility problem for nonlinear discrete-time systems is shown to be easy to tackle by means of standard linear algebraic tools, whereas this is not the case for nonlinear continuous-time systems, in which case the most suitable approach is provided by differential geometry. The feedback linearization problem for discrete-time systems is recasted through the language of differential forms. In the event that a system is not feedback linearizable, the largest feedback linearizable subsystem is characterized within the same formalism using the notion of derived flag of a Pfaffian system. A discrete-time system may be linearizable by dynamic state feedback, though it is not linearizable by static state feedback. Necessary and sufficient conditions are given for the existence of a so-called linearizing output, which in turn is a sufficient condition for dynamic state feedback linearizability.
Ülle	**Kotta**	Solvability and right-inversion of implicit nonlinear discrete-time systems	In this paper the problems of solvability and right-invertibility for implicit nonlinear discrete-time control systems are investigated. The concept ''solvability'' is defined in such a way that consistency of the implicit system equations is locally guaranteed for all input sequences, and an algorithm is introduced to verify the solvability of an implicit system in that sense. It is demonstrated how this mechanism may be used to decide on the right-invertibility or functional reproducibility of a given system. In contrast to previous work on right-invertibility for special classes of implicit nonlinear systems, the approach is not restricted to the characterization of right-invertibility, but it is shown in addition how an inverse system can actually be obtained. The theory is illustrated by a realistic economic example in which the inversion procedure is applied using formula manipulation.
Ülle	**Kotta**	Immersion of discrete-time nonlinear system by regular dynamic state feedback into a linear system	Necessary and sufficient conditions for local solvability of the title problem around a given trajectory are obtained. The proposed conditions are less restrictive than those obtained by Lee and Marcus for the problem of immersion a nonlinear system into a linear system via static state feedback. Instrumental in the problem solution is the inversion (structure) algorithm for a discrete-time nonlinear system. The solvability conditions are expressed in terms of the inversion algorithm. Moreover, the construction of both the dynamic state feedback and the immersion map relies on this algorithm Finally, it is shown that, for locally right-invertible systems, the considered problem, unlike the problem of immersion via static state feedback, is always solvable.
Ülle	**Kotta**	Inversion method in the discrete-time nonlinear control systems synthesis problems - Introduction	n.a.
Ülle	**Kotta**	On dynamic input-output linearization of discrete-time nonlinear-systems	This paper studies the problem of linearizing the input-output map of an analytic discrete-time nonlinear system locally around a given trajectory. Necessary and sufficient conditions are given for the existence of a regular dynamic state feedback control law under which the input-dependent part of the response of a nonlinear system becomes linear in the input and independent of the initial state. The proposed conditions are less restrictive than those obtained by Lee and Marcus for linearizing the input-output map via a static-state feedback. Instrumental in the problem solution is the inversion (structure) algorithm for a discrete-time nonlinear system. Firstly, the solvability conditions are expressed in terms of the inversion algorithm. Secondly, the proof of the existence and construction of the dynamic state feedback compensator relies on this algorithm.
Ülle	**Kotta**	Comments on a structural approach to the nonlinear model-matching problem	It is shown that, under certain regularity assumptions, the sufficient conditions for solvability of the model matching problem (MMP) in terms of structural invariants presented by Moog, Perdon, and Conte [SIAM J. Control Optim., 29 (1991), pp. 769-785] are also necessary. The seeming controversy involving the example of Huijberts is resolved.

Ülle	**Kotta**	Matching of discrete-time nonlinear models	Matching of a discrete nonlinear control object with a given model is studied. Necessary and sufficient conditions have been derived for the existence of a local solution to this model matching problem in the neighborhood of a strongly regular equilibrium point of the extended system consisting of the control object and a model. An algorithm has been designed for constructing the solution in the form of dynamic state feedback. The solution is based on the inversion algorithm of discrete nonlinear systems.
Ülle	**Kotta**	Synthesizing nonlinear-systems with specified input-output mapping - sampling effects	The effects of digital realization of a control law which solves the problem of matching the input-output mappings of nonlinear systems by dynamic state feedback are studied. It is shown that a digital realization of the control law which is synthesized for continuous systems guarantees in the general case that the system reaches, at the specified time instants, its goal with accuracy T, where T is the sampling step. A procedure for increasing the accuracy to T(s) by introducing a correcting term into the control law is proposed. A refined approximate control law is obtained by an approximate solution of an equivalent problem which uses discrete models of the continuous system. It is proven that the equivalent problem is solvable for discrete models if the problem of matching nonlinear continuous systems is solvable, although the construction of the control law by using discrete models and the shape of the control law itself become noticeably more complex.
Ülle	**Kotta**	Dynamic compensation for perturbations in discrete nonlinear-systems	The article takes up, for discrete nonlinear systems with many inputs and outputs, the problem of constructing a compensator in the form of a dynamic state feedback, in particular, a compensator that ensures invariance of the output of a closed system under perturbations. Necessary and sufficient conditions for local solvability of a problem in the neighborhood of an equilibrium point of a control object are given for systems that are reversible when there is no perturbation. The cases of measurable and nonmeasurable perturbations are examined separately. In solving the basic problem, the algorithm for inversion is generalized, and the introduction of new structural parameters of a system with discrete time (known as the indices of invertibility) is put on a firm foundation. The theoretical results are illustrated with an example.
Ülle	**Kotta**	Linearization of linear-analytic systems by the method of right-inverse systems - the effects of discretization	n
Ülle	**Kotta**	Designing nonlinear discrete-time-systems which are invariant under disturbances	n.a.
Ülle	**Kotta**	Decomposition of nonlinear discrete controlled systems	n.a.
Ülle	**Kotta**	Right inverse of a discrete-time nonlinear-system	n.a.
Ülle	**Kotta**	On the stability of discrete-time sliding mode control-systems - comments	n.a.
Ülle	**Kotta**	Matching a nonlinear discrete-time system with a prescribed linear input-output behaviour	n.a.
Ülle	**Kotta**	The ensuring of autonomy of a nonlinear dynamical system with discrete-time	n.a.
Ülle	**Kotta**	Application of inverse system for linearization and decoupling	n.a.

Ülle	**Kotta**	Derivation of the inverse system for discrete nonlinear-systems	n.a.
Valeri	**Kozevnikov**	n.a.	n.a.
Valeri	**Kravets**	n.a.	n.a.
Helena	**Kruus**	n.a.	n.a.
Margus	**Kruus**	Automatic FSM synthesis for low-power mixed synchronous/asynchronous implementation	Power consumption in a synchronous FSM (Finite-State Machine) can be reduced by partitioning it into a number of coupled sub-FSMs where only the part that is involved in a state transition is clocked. Automatic synthesis of a partitioned FSM includes a partitioning algorithm and sub-FSM synthesis to an implementation architecture. In this paper, we first introduce an implementation architecture for partitioned FSMs that uses gated-clock technique for disabling idle parts of the circuits and asynchronous controllers for communication between the sub-FSMs. We then describe a new transformation procedure for the sub-FSM. The FSM synthesis how has been automated in a prototype tool that accepts an FSM specification. The tool generates synthesizable RT-level VHDL code with identical cycle-to-cycle input/output behavior in accordance with the specification. An average power reduction of 45% has been obtained for a set standard FSM benchmarks.
Maarja	**Kruusmaa**	Global level path planning for mobile robots in dynamic environments	This paper presents a self- adapting approach to global level path planning in dynamic environments. The aim of this work is to minimize risk and delays in possible applications of mobile robots (e. g., in industrial processes). We introduce a hybrid system that uses case-based reasoning as well as grid-based maps for decision-making. Maps are used to suggest several alternative paths between specific start and goal point. The casebase stores these solutions and remembers their characteristics. Environment representation and casebase design are discussed. To solve the problem of exploration vs. exploitation, a decision-making strategy is proposed that is based on the irreversibility of decisions. Forgetting strategies are discussed and evaluated in the context of case-based maintenance. The adaptability of the system is evaluated in a domain based on real sensor data with simulated occupancy probabilities. Forgetting strategies and decision-making strategies are evaluated in simulated environments. Experiments show that a robot is able to adapt in dynamic environments and can learn to use paths that are less risky to follow.
Maarja	**Kruusmaa**	Covering the path space: a casebase analysis for mobile robot path planning	This paper presents a theoretical analysis of a casebase used for mobile robot path planning in dynamic environments. Unlike other casebased path planning approaches. we use a grid map to represent the environment that permits the robot to operate in unstructured environments. The objective of the mobile robot is to learn to choose paths that are less risky to follow. Our experiments with real robots have shown the efficiency of our concept. In this paper, we replace a heuristic path planning algorithm of the mobile robot with a seed casebase and prove the upper and lower bounds for the cardinality of the casebase. The proofs indicate that it is realistic to seed the casebase with some solutions to a path-finding problem so that no possible solution differs too much from some path in the casebase. This guarantees that the robot would theoretically find all paths from start to goal. The proof of the upper bound of the casebase cardinality shows that the casebase would in a long run grow too large and all possible solutions cannot be stored. In order to keep only the most efficient solutions the casebase has to be revised at run-time or some other measure of path difference has to be considered.
Maarja	**Kruusmaa**	Global navigation in dynamic environments using case-based reasoning	This paper presents a global navigation strategy for autonomous mobile robots in large-scale uncertain environments. The aim of this approach is to minimize collision risk and time delays by adapting to the changes in a dynamic environment. The issue of obstacle avoidance is addressed on the global level. It focuses on a navigation strategy that prevents the robot from facing the

			situations where it has to avoid obstacles. To model the partially known environment, a grid-based map is used. A modified wave-transform algorithm is described that finds several alternative paths from the start to the goal. Case-based reasoning is used to learn from past experiences and to adapt to the changes in the environment. Learning and adaptation by means of case-based reasoning permits the robot to choose routes that are less risky to follow and lead faster to the goal. The experimental results demonstrate that using case-based reasoning considerably increases the performance of the robot in a difficult uncertain environment. The robot learns to take actions that are more predictable, minimize collision risk and traversal time as well as traveled distances.
Vello	**Kukk**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	An on-chip implantable lock-in analyzer of variations of the electrical bio-impedance has been designed, and pilot ASICs have been fabricated and tested. A mixed signal approach as the most suitable way for accomplishing a low-voltage and low-power ASIC for use in implantable devices for various biomedical applications is discussed in this paper.
Mati	**Kutser**	n.a.	n.a.
Alar	**Kuusik**	n.a.	n.a.
Rein	**Kuusik**	n.a.	n.a.
Marko	**Kääramees**	n.a.	n.a.
Raul	**Land**	n.a.	n.a.
Peeter	**Laud**	Sound computational interpretation of formal encryption with composed keys	The formal and computational views of cryptography have been related by the seminal work of Abadi and Rogaway. In their work, a formal treatment of encryption that uses atomic keys is justified in the computational world. However, many proposed formal approaches allow the use of composed keys, where any arbitrary expression can be used as encryption key. In this paper we consider an extension of the formal model presented by Abadi and Rogaway, in which it is allowed to use composed keys in formal encryption. We then provide a computational interpretation for expressions that allow us to establish the computational soundness of formal encryption with composed keys.
Peeter	**Laud**	Handling encryption in an analysis for secure information flow	This paper presents a program analysis for secure information flow. The analysis works on a simple imperative programming language containing a cryptographic primitive-encryption-as a possible operation. The analysis captures the intuitive qualities of the (lack of) information flow from a plaintext to its corresponding ciphertext. The analysis is proved correct with respect to a complexity-theoretical definition of the security of information flow. In contrast to the previous results, the analysis does not put any restrictions on the structure of the program, especially on the ways of how the program uses the encryption keys.
Peeter	**Laud**	Semantics and program analysis of computationally secure information flow	This paper presents a definition of secure information flow. It is not based on noninterference, but on computational indistinguishability of the secret inputs, when the public outputs are observed. This definition allows cryptographic primitives to be handled. This paper also presents a Denning-style information-flow analysis for programs that use encryption as a primitive operation. The proof of the correctness of the analysis is sketched.
Peeter	**Laud**	Time-stampting with binary linking schemes	We state the basic requirements for time-stamping systems applicable as the necessary support to the legal use of electronic documents. We analyze the main drawbacks of the time-stamping systems proposed to date and present a new system that meets all the stated requirements. We prove that these requirements cannot be significantly tightened.
Paul	**Leis**	n.a.	n.a.
Harri	**Lensen**	n.a.	n.a.

Toomas	**Lepikult**	Optimal design of rigid-plastic beams subjected to dynamical loading	In the present paper the optimization problem of dynamically loaded simply supported beams is handled. The concept of a rigid-plastic body is used. The shape of the beam is sought, for which the integral residual deflection for a given time-instant and load is minimal. Two numerical methods for solving the problem are proposed. The numerical results are compared with those obtained by Lepik (1982).
Marion	**Lepmets**	n.a.	n.a.
Viktor	**Leppikson**	n.a.	n.a.
Raul	**Liivrand**	n.a.	n.a.
Grete	**Lind**	n.a.	n.a.
Eerik	**Lossmann**	n.a.	n.a.
Teodor	**Luczkowski**	n.a.	n.a.
Martin	**Luts**	n.a.	n.a.
Urve	**Madar**	n.a.	n.a.
Peep	**Matverk**	n.a.	n.a.
Ants	**Meister**	n.a.	n.a.
Einar	**Meister**	SpeechDat-like Estonian database	A speech database project has been launched last year, which aims the collection of telephone speech from a large number of speakers for speech and speaker recognition purposes. Up to 2000 speakers are expected to participate in recordings. To achieve this target,different recruitment schemes have been implemented. SpeechDat databases, especially Finnish SpeechDat, have been chosen as a prototype for the Estonian database. The paper is a progress report of the project.
Martin	**Min**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	An on-chip implantable lock-in analyzer of variations of the electrical bio-impedance has been designed, and pilot ASICs have been fabricated and tested. A mixed signal approach as the most suitable way for accomplishing a low-voltage and low-power ASIC for use in implantable devices for various biomedical applications is discussed in this paper.
Martin	**Min**	Lock-in measurement of bio-impedance variations	Electrical impedance measured between suitably placed electrodes can give a reasonable amount of information about the basic physiological parameters of the patient's body and its organs and vital systems. High noise immunity of the lock-in demodulation technology allows one to obtain, from the bio-impedance variations, the signals corresponding to breathing and heart beating, even using the handles of the veloergometer or other similar equipment as the electrodes. From these signals it is possible to get not only simple physiological parameters like the breathing rate and heart rate, but also to derive more complex parameters like the tidal volume and minute volume of respiration, and stroke volume and cardiac output of the heart. The application specific integrated circuit (ASIC) has been designed for electrical bio-impedance measurements in portable and implantable equipment.

Martin	**Min**	Thoracic bioimpedance as a basis for pacing control	Periodic variations of the thoracic bioimpedance due to breathing and heartbeating carry confidential information that is used for pacing rate control in rate-adaptive pacemakers. The respiratory parameters-the respiration rate and tidal volume-are detected from the filtered breathing signal component (0.1 to 1.0 Hz), and are used for fuzzy feed-forward adaptive control of the pacing rate to meet the needs of the organism. The cardiac parameters-the actual heart rate and stroke volume-are measured from the heartbeating signal component (1.0 to 3.0 Hz) and are proposed for feedback correction of the feed-forward control to meet the heart's ability. The problems of electrical bioimpedance measurement and design of the rate-adaptive pacemaker, wherein the intracardiac impedance is used as the main information source for pacing control, are discussed in this paper.
Martin	**Min**	Design concepts of instruments for vector parameter-identification	The concepts for design of phase-sensitive measuring instruments, based on two-phase synchronous detection, are proposed in this paper. The main idea of the design is to utilize the advantages of both analog and digital signal processing methods via combining the principles of synchronous detection and averaging with the principles of integrating analog-to-digital and functional digital-to-analog conversion.
Andres	**Mulin**	n.a.	n.a.
Tanel	**Mullari**	n.a.	n.a.
Leo	**Mõtus**	Using models in real-time software design - Model-driven development based on the Unified Modeling Language	n.a.
Leo	**Mõtus**	On models for time-sensitive interactive computing	Agent-based paradigm is increasingly applied to building computing systems where conventionally latent requirements, e.g. time-sensitivity of data and event validity, and/or truth-values of predicates, timeliness of communication, and others become essential for correct functioning of systems. In many such cases empirical demonstration of expected behaviour is not sufficient, formal verification of certain properties becomes desirable. This assumes that interaction-based models of computing are to be enhanced by introducing sufficiently sophisticated time. Such enhancement is not too simple since time has been abstracted away from models of computing during the evolution of computer science. This paper introduces some preliminary ideas for developing time-sensitive interaction-based models of computations.
Leo	**Mõtus**	Untitled	n.a.
Leo	**Mõtus**	Formal timing analysis of OMT designs using LIMITS	It is widely known that object-oriented methodologies, in spite of all their virtues, are pretty awkward in verifying quantitative time correctness of the specification, design and implementation of the developed product. This paper is based on an underlying theory and implementation of a new generation software tool LIMITS, which is designed and built as a co-processor to an OMT tool (EU grant COP-94-1577). LIMITS insists on introduction of non-functional requirements (timing, safety, reliability, etc.) early in the requirements specification stage and on selection of time model with appropriate complexity to support formal verification of all the timing properties, It can support all life-cycle stages and combines formal verification with informal (simulation) study.
Leo	**Mõtus**	Untitled	n.a.

Leo	**Mõtus**	The design and analysis of low-cost real-time fieldbus systems	Extensively discussed for decades, it is only relatively recently that a demand for true real-time industrial communication systems has become evident. However, when the requirements of such systems are understood, few of the offered solutions are appropriate. This paper suggests that, in order to produce such systems, rigorous specification, design and verification processes are necessary, and that these must all be capable of handling logical and temporal analysis and design. To achieve this, it is suggested that a mixture of tools is (currently) necessary, and that these tools should include object-oriented design techniques with temporal extensions. The points are illustrated by reference to the recent development of a real-time fieldbus system, built around the CAN protocol, which supports true real-time communication over an existing, commercial system.
Leo	**Mõtus**	Message for the editor-in-chief	n.a.
Leo	**Mõtus**	Untitled	n.a.
Leo	**Mõtus**	Intelligent autonomous vehicles	n.a.
Leo	**Mõtus**	Architectures for integrating manufacturing activities and enterprises	This paper is a summary of the major technical report (Williams et al. 1993) of the IFAC/IFIP Task Force on Architectures for Integrating Manufacturing Activities and Enterprises. It presents a synopsis of the investigations of pertinent architectures undertaken, and the findings generated relating to the suitability of various architectures for the integration task. It also presents the Task Force's recommendations for achieving a "complete" architecture in terms of the necessary capabilities by "completing" a currently available architecture. The Task Force also outlined how a "best" architecture could be achieved by selecting and combining the best features of the available architectures.
Leo	**Mõtus**	Methods and tools for specifying software of embedded systems	The problem of specification is examined for an exceedingly important class of program systems embedded in the structure of an actual control system. The article is of a survey nature.
Leo	**Mõtus**	Features of modeling software for embedded multiprocessor systems	n.a.
Leo	**Mõtus**	A model of distributed computer control software	n.a.
Harri	**Mägi**	n.a.	n.a.
Olev	**Märtens**	Precise synchronous deterctors with improved dynamic reserve	The current paper describes a special class of synchronous (phase-sensitive) detectors (SDs) for measurement purposes. They are precise and have high dynamic range. Proposed solutions are based on op-amps, having synchronously switched capacitors in the negative feedback path. Such structures give significant improvement of several specifications, especially of the input dynamic reserve. Functioning principles, circuit diagrams and gain equations are given.
Olev	**Märtens**	Lock-in measurement of bio-impedance variations	Electrical impedance measured between suitably placed electrodes can give a reasonable amount of information about the basic physiological parameters of the patient's body and its organs and vital systems. High noise immunity of the lock-in demodulation technology allows one to obtain, from the bio-impedance variations, the signals corresponding to breathing and heart beating, even using the handles of the veloergometer or other similar equipment as the electrodes. From these signals it is possible to get not only simple physiological parameters like the breathing rate and heart rate, but also to derive more complex parameters like the tidal volume and minute volume of respiration, and stroke volume and cardiac output of the heart. The application specific integrated circuit (ASIC) has been designed for electrical bio-impedance measurements in portable and implantable equipment.
Olev	**Märtens**	Precision average-sensing ac dc converts	Various configurations of average-sensing ac/dc converters for precision ac voltage measurements are described. Due to the unique electrical configurations in which the influence of the inaccuracy of ratio resistors is suppressed, these converters have high accuracy (better than 0.01%) and resolution (0.0001%) at medium frequencies. Their frequency range is from 10 Hz to 1 MHz, with a

settling time less than 1 s.

Kaili	**Müürisepp**	n.a.	n.a.
Härmel	**Nestra**	n.a.	n.a.
Ülo	**Nurges**	Comparison of reflection coefficient approach to pole shifting for robust control of discrete-time systems	In this paper we show that two approaches may be used to construct stabilizing control of discrete-time systems. The use of reflection coefficient approach leads to a quadratic programming problem that can be solved easily with readily available software. The approach of shifting the poles of the extreme systems towards the center of the unit circle leads to an optimization problem that can be solved with direct search optimization. General problem formulation and numerical procedures are presented together with a second-order system to demonstrate the viability of the approaches.
Ülo	**Nurges**	On the robust stability of discrete-time systems	A sufficient stability condition for monic Schur polynomials is obtained via the so-called reflection coefficients of polynomials and the discrete version of Kharitonov's weak theorem. The discrete Kharitonov theorem defines only (n - 1)-dimensional stable hyperrectangle for n-degree monic polynomials. By the use of a linear Schur invariant transformation we put stable line segments through vertices of this hyperrectangle and find an n-dimensional stable polytope with all vertices on the stability boundary.
Ülo	**Nurges**	Synthesis of a controller on the basis of the Laguerre model	A new method is suggested for the synthesis of digital controllers with the aid of the Laguerre model. This method is an extension of the method of controller design which relies on weighting functions. The procedure of synthesis involves freely selected parameters, such as the expansion constant and Laguerre spectrum length, which permit one to vary the controller properties over a wide range.
Ülo	**Nurges**	Adaptive-control with prediction using the Laguerre model	An adaptive control scheme with prediction using Laguerre spectra is proposed for linear dynamic systems. The spectra of the expansion in orthonormal difference Laguerre polynomials are computed recursively. Least-squares identification of the weighting-function Laguerre model and a simple prediction law ensure stability of the closed-loop system even in the presence of nonstationary delays.
Ülo	**Nurges**	Laguerre models in problems of approximation and identification of discrete-systems	n.a.
Sven	**Nõmm**	Generalization of transfer equivalence for discrete-time non-linear systems: comparison of two definitions	The problem of system reduction is studied for discrete-time non-linear single-input single-output systems described by high-order input-output (i/o) difference equations, that is, given the i/o equation, we can find a minimal representation which is equivalent to the original system with the order being as small as possible. Comparison of two definitions of reducibility is provided. The reducibility concepts addressed are both generalizations of the well-known notion of transfer equivalence to the case of non-linear control systems. Two roles of transfer equivalence are covered by these extensions. The first is that of identity of the outputs for any fixed control sequence under zero initial conditions. The second property is that of pole/zero cancellation that may occur in the transfer function of equivalent systems. The relationship between two reducibility definitions related to two equivalence notions is examined and the reducibility definition which extends pole/zero cancellation property is shown to be stronger. Finally, the computational aspects of system reduction are discussed.

Sven	**Nõmm**	Classical state space realizability of input-output bilinear models	This paper studies the realizability property of bilinear input-output (i/o) models in the classical state space form. Constraints on the parameters of the bilinear i/o model are suggested that lead to realizable models. The complete list of 2nd and 3rd order realizable input-output bilinear models together with the corresponding state equations is given. In the general case some subclasses of realizable bilinear models together with their state-space realizations are presented, including the diagonal bilinear model and the special subclass of the superdiagonal bilinear model.
Sven	**Nõmm**	Systems with associative dynamics	This paper introduces a class of nonlinear discrete-time dynamic models that generalize familiar linear model structures; our motivation is to explore the extent to which known results for the linear case do or do not extend to this nonlinear class. The results presented here are based on a complete characterization of the solution of the associative functional equation F[F(x, y), z] = F[x, F(y, z)] due to J. Aczel, leading to a class of invertible binary operators that includes addition, multiplication, and infinitely many others. We present some illustrative examples of these dynamic models, give a simple explicit representation for their inverses, and present sufficient conditions for bounded-input, bounded-output stability. Finally, we propose a generalization of this model class and we demonstrate that these models have classical state-space realizations, unlike arbitrarily structured NARMA models.
Tõnu	**Näks**	Formal timing analysis of OMT designs using LIMITS	It is widely known that object-oriented methodologies, in spite of all their virtues, are pretty awkward in verifying quantitative time correctness of the specification, design and implementation of the developed product. This paper is based on an underlying theory and implementation of a new generation software tool LIMITS, which is designed and built as a co-processor to an OMT tool (EU grant COP-94-1577). LIMITS insists on introduction of non-functional requirements (timing, safety, reliability, etc.) early in the requirements specification stage and on selection of time model with appropriate complexity to support formal verification of all the timing properties, It can support all life-cycle stages and combines formal verification with informal (simulation) study.
Monika	**Oit**	Stroop-like interference in chess players imagery - an uneplored possibility to be revealed by the adapted moving-spot task	A group of highly skilled chess players and two control groups of subjects (nonskilled players and nonplayers) participated in a moving-spot task (cf. Attneave & Curlee, 1983). They had to move either a spot or one of several chess pieces within an imaginary grid according to instructions given by the experimenter (the imaginary motion of the imaginary object consisted of a quasirandom sequence of steps in the direction-up, right, left, or down). The general findings were as follows: (1) chess players' error rates were lower than those in the nonplayer group; (2) in a moving-spot condition there were no significant differences in the efficiency of skilled vs. nonskilled player groups; (3) in a moving chess-piece condition, ranges of spatial errors differed for chess-player and nonplayer groups, depending on the symbolic meaning of the chess pieces in the former group; (4) in a moving chess-piece condition we also found tendencies for Stroop-like interference in the group of skilled players (e. g., bishop moving illegally up, fight, etc.); (5) all groups benefitted from the use of a checkerboard instead of an 8 x 8 grid as the imaginary spatial framework within which to move a piece; (6) the post hoc analysis showed that the two small selected subgroups of subjects comprising those who used either pure visual strategy or pure chess-annotation strategy were susceptible to some Stroop-like interference and that the set of pieces with the highest incongruity of moves (bishop, knight) yielded higher error rates than the set of pieces that had congruity of moves (king, rook). Taken together, these results seem to indicate that visuospatial tasks like Attneave and Curlee's (1983) moving-spot task are performed neither on the basis of a static "picture-in-the-head" type of visual image, for which it is just the same whether one or another type of piece is imaginarily moved, nor on the basis of purely symbolic or propositional operations that bear no relation to the visual-configurational and spatial-localizational representations. Imagery seems to constitute a dynamic process of interplay between visuospatial and verbal-propositional

			codes.
Elmet	**Orasson**	n.a.	n.a.
Avo	**Ots**	n.a.	n.a.
Toivo	**Paavle**	n.a.	n.a.
Rein	**Paluoja**	A local area network for distributed control-systems	n.a.
Toomas	**Parve**	An implantable analyzer of bio-impedance dynamics: Mixed signal approach	An on-chip implantable lock-in analyzer of variations of the electrical bio-impedance has been designed, and pilot ASICs have been fabricated and tested. A mixed signal approach as the most suitable way for accomplishing a low-voltage and low-power ASIC for use in implantable devices for various biomedical applications is discussed in this paper.
Toomas	**Parve**	Lock-in measurement of bio-impedance variations	Electrical impedance measured between suitably placed electrodes can give a reasonable amount of information about the basic physiological parameters of the patient's body and its organs and vital systems. High noise immunity of the lock-in demodulation technology allows one to obtain, from the bio-impedance variations, the signals corresponding to breathing and heart beating, even using the handles of the veloergometer or other similar equipment as the electrodes. From these signals it is possible to get not only simple physiological parameters like the breathing rate and heart rate, but also to derive more complex parameters like the tidal volume and minute volume of respiration, and stroke volume and cardiac output of the heart. The application specific integrated circuit (ASIC) has been designed for electrical bio-impedance measurements in portable and implantable equipment.
Toomas	**Parve**	Thoracic bioimpedance as a basis for pacing control	Periodic variations of the thoracic bioimpedance due to breathing and heartbeating carry confidential information that is used for pacing rate control in rate-adaptive pacemakers. The respiratory parameters-the respiration rate and tidal volume-are detected from the filtered breathing signal component (0.1 to 1.0 Hz), and are used for fuzzy feed-forward adaptive control of the pacing rate to meet the needs of the organism. The cardiac parameters-the actual heart rate and stroke volume-are measured from the heartbeating signal component (1.0 to 3.0 Hz) and are proposed for feedback correction of the feed-forward control to meet the heart's ability. The problems of electrical bioimpedance measurement and design of the rate-adaptive pacemaker, wherein the intracardiac impedance is used as the main information source for pacing control, are discussed in this paper.
Toomas	**Parve**	Design concepts of instruments for vector parameter-identification	The concepts for design of phase-sensitive measuring instruments, based on two-phase synchronous detection, are proposed in this paper. The main idea of the design is to utilize the advantages of both analog and digital signal processing methods via combining the principles of synchronous detection and averaging with the principles of integrating analog-to-digital and functional digital-to-analog conversion.
Jaan	**Penjam**	Program construction in the context of evolutionary computation	Many optimization algorithms that imitate certain principles of nature have been proven useful in various application domains. The following paper shows how Evolutionary Algorithm (EA) can be applied to model (program) construction for solving the discrete time system identification problem. NoD-linear system identification is used as an example problem domain for studying possibilities of EA to discover the relationship between parameters in response to a given set of inputs.
Jaan	**Penjam**	Application of structural synthesis of programs	This is an experience report on the automatic and hidden usage of program synthesis in several application domains. The structural synthesis of programs has been implemented in an object-oriented programming environment NUT and used for development of simulation software, engineering calculations software, implementing a benchmark for safety critical systems and development of highly interactive visual modeling of radar coverage of landscape.

Jaan	**Penjam**	Attributed models of executable specifications	n.a.
Jaan	**Penjam**	Toward knowledge-based specifications of languages	In this paper the problem of embedding language design and implementation tools in knowledge-based systems is considered. On the one hand, this is the question of using object-oriented paradigm for the specification of a language treated as a collection of classes of concepts. On the other hand, this is the question of employing syntax-directed methods for software construction in knowledge-based systems.
Jaan	**Penjam**	Computational and attribute models of formal languages	n.a.
Jaan	**Penjam**	Compiler construction by object-oriented system nut	n.a.
Jaan	**Penjam**	Nut - an object-oriented language	n.a.
Mihhail	**Pikkov**	n.a.	n.a.
Rein	**Prank**	n.a.	n.a.
Valdo	**Praust**	n.a.	n.a.
Uuno	**Puus**	Analyzing pair-programmer's satisfaction with the method, the result, and the partner	This paper gives an overview of a programmer satisfaction survey in pair-programming experiment. The experiment took place at Institute of Computer Science, University of Tartu (UT), Estonia. The paper includes the problem statement, description of the questionnaire, and the survey results.
Jaanus	**Pöial**	n.a.	n.a.
Jaan	**Raik**	Evaluating fault emulation on FPGA	We present an evaluation of accelerating fault simulation by hardware emulation on FPGA, Fault simulation is an important subtask in test pattern generation and it is frequently used throughout the test generation process. In order to evaluate possible simulation speed possibilities, we made a feasibility study of using reconfigurable hardware by emulating circuit under analysis together with fault insertion structures on FPGA. Experiments showed that it is beneficial to use emulation for circuits/methods that require large numbers of test vectors, e.g., sequential circuits and/or genetic algorithms.
Jaan	**Raik**	Hierarchical test generation for combinational circuits with real defects coverage	This paper deals with the automatic test pattern generation (ATPG) technique at the higher level using a functional fault model and defect-fault relationship in the form of a defect coverage table at the lower level. The paper contributes to test pattern generation (TPG) techniques taking into account physical defect localisation. A new parameter-probabilistic effectiveness of input patterns-has been used in the TPG technique with the goal of increasing real defect coverage. This parameter is based on probabilities of physical defects in digital cells which may occur in real integrated circuits. This improvement has been implemented into the existing DefGen ATPG system for combinational circuits.

Jaan	**Raik**	Probabilistic analysis of CMOS physical defects in VLSI circuits for test coverage improvement	A new methodology of probabilistic analysis of CMOS physical defects in complex gates for the defect-based test is proposed. It is based on the developed approach for the identification and estimation or the probability of actual faulty functions resulting from shorts caused by spot defects in conductive layers of IC layout. The aim of this methodology is realistic representation of physical defects in fault models. The list of defects, identified faulty functions, defect coverage table, conditional defect probabilities, and effectiveness and optimal sequence of test patterns are the main output data of probabilistic-based faults characterisation. The description of such characterisation and experimental data obtained for industrial standard cell library in 0.8 mum CMOS technology are presented. Special software tool named FIESTA has been developed for the automation of the probabilistic-based fault characterisation. The main destination of this tool is the investigation of gates from Cadence standard cell library. The experimental data obtained during complex gates characterisation are used for the estimation of the physical defects coverage by hierarchical defect Simulation. At the higher level simulation the developed functional fault model was used, at the lower level we used the defect/fault relationships in the form of the defect coverage table and the conditional defect probabilities. Analysis Of the quality of 100% stuck-at fault (SAF) sets in relation to physical CMOS defects in complex gates was performed. The investigation of the correlation between the fault coverages for SAFs and defects of short type for two benchmark circuits was done as well.
Jaan	**Raik**	Fast test pattern generation for sequential circuits using decision diagram represeantations	The paper presents a novel hierarchical approach to test pattern generation for sequential circuits based on an input model of mixed-level decision diagrams. A method that handles, both, data and control parts of the design in a uniform manner is proposed. The method combines deterministic and simulation-based techniques. On the register-transfer level, deterministic path activation is combined with simulation based-techniques used for constraints solving. The gate-level local test patterns for components are randomly generated driven by high-level constraints and partial path activation solutions. Experiments show that high fault coverages for circuits with complex sequential structures can be achieved in a very short time by using this approach.
Aimur	**Raja**	n.a.	n.a.
Ingmar	**Randvee**	n.a.	n.a.
Toomas	**Rang**	The basic parameters of diffusion welded Al Schottky contacts to p- and n-SiC	Aluminium Schottky contacts to n- and p-type SiC were fabricated by diffusion welding. Forward current-voltage measurements were made in a temperature range of 300divided by773degreesK. The basic Schottky parameters, such as saturation current (J(S)), barrier height (Phi(B)), the ideality factor (eta), the effective Richardson's constant (A**) and the series on-resistance (R-sp) were obtained from U-I curves at different temperatures. The comparative analysis of temperature variations of these parameters is presented.
Toomas	**Rang**	Numerical study of current crowding phenomenon in complementary 4H-SiC JBS rectifiers	A new type of power semiconductor device - the Junction Barrier Schottky (JBS) diode-has been introduced recently [1]. Our earlier investigations (e.g. [2, 3]) on current crowding effect at Schottky interfaces due to barrier height differences created an idea to investigate the temperature influence on current crowding phenomenon in complementary JBS diodes. The reason for such investigations results from the structure (cross section) of JBS diode, which has three different regions for the current flow through the device under upper metal contact. The MEDICI software package for numerical simulations has been used [4].The current distribution along the p- and n-4H-SiC structures under different temperatures, epitaxial layer concentrations and barrier heights (work function) conditions have been investigated and the results are presented. The clear differences in current suppressing behavior around the areas, where the arbitrary pn-junction reaches the upper contact of the structures near the edge of Schottky interface can be seen only in some cases. Our

			simulations show also the weak sides of the p-epilayer SiC JBS, where the temperature influence changes the normal behavior of the device and rearranges the current distribution under higher temperature and barrier height values.
Toomas	**Rang**	Diffusion-welded Al contacts to p-type SiC	The first experimental results on Diffusion Welding (DW) applied to p-type 6H- and 4H-SiC are described. Using the extrapolation method and available measurement apparatus the specific series on-state resistance and current-voltage characteristics of Schottky contacts in comparison with the n-type Schottky contacts were obtained.
Toomas	**Rang**	Some comparative properties of diffusion-welded contacts to 6H and 4H silicon carbide	The results of experimental investigations of diffusion welded large area Al/SiC contacts are presented. The specific contact resistance is determined for Al/6H- and 4H-SiC. The particular importance of inflatness and non-parallelism for diffusion welding process is shown. The influence of imperfections and structural defects of SiC structures on reverse characteristics is discussed.
Toomas	**Rang**	Formation of large area Al contacts on 6H- and 4H-SiC substrates	The results of experimental investigations of diffusion welded (bonded) large area Al/SiC contacts are presented. The novel data on adhesion of Al to 4H- and 6H-SiC are proposed. The specific contact resistance is determined for Al-6H-SiC contacts. The V-I characteristics for Al-4H-SiC Schottky contacts are measured.
Toomas	**Rang**	Correction	n.a.
Toomas	**Rang**	One-dimensional numerical-simulation of complementary power Schottky structures	n.a.
Toomas	**Rang**	Carrier impact ionization rates and their temperature-dependence in silicon	n.a.
Toomas	**Rang**	Computer-aided numerical modeling of powerful Schottky diodes	n.a.
Toomas	**Rang**	Temperature-dependence of the exponent in the equation of avalanche multiplication factors	n.a.
Toomas	**Rang**	Simple relationship between the breakdown voltage, concentration, and junction depth for diffused PN junctions	n.a.
Toomas	**Rang**	Computer-aided examination of the I2L current source and of the behavior of the I2L flip-flop used in static memory cells	n.a.

Toomas	**Rang**	The DC modeling of the I2L gate with the non-linear circuit analysis program tranz-tran	n.a.
Toomas	**Rang**	Computer-aided examination of I2L structures	n.a.
Priit	**Raspel**	n.a.	n.a.
Karin	**Rava**	n.a.	n.a.
Andri	**Riid**	n.a.	n.a.
Tiit	**Riismaa**	Description and optimization of the structure of hierarchical systems	An approach is suggested for the description and optimization of the structure of a hierarchical system. This approach is based on the multistep aggregation of the flows. It enables one to consider the problem of optimization of the structure of various hierarchical systems (queuing system, sorting and search system, resource allocation system) from a unified point of view.
Tarmo	**Robal**	n.a.	n.a.
Mart	**Rohtla**	n.a.	n.a.
Ants	**Ronk**	Analysis and reproduction of a signal's periodic components by means of an extended block-adaptive Fourier analyzer	This paper presents some results of developing a signal analyzer for performing spectral analysis and simultaneous reproduction/filtering of the input signal's periodic components of different (in general, not harmonically related) frequencies and waveforms/spectra. The proposed analyzer accomplishes this task by applying adaptive recursive Fourier analysis.
Ants	**Ronk**	Design concepts of instruments for vector parameter-identification	The concepts for design of phase-sensitive measuring instruments, based on two-phase synchronous detection, are proposed in this paper. The main idea of the design is to utilize the advantages of both analog and digital signal processing methods via combining the principles of synchronous detection and averaging with the principles of integrating analog-to-digital and functional digital-to-analog conversion.
Meelis	**Roos**	Efficient long-term validation of digital signatures	Digitally signed documents (e.g. contracts) would quickly lose their validity if the signing keys were revoked or the signature scheme was broken. The conventional validation techniques have been designed just for ephemeral use of signatures and are impractical for long-term validation. We present a new scheme that: (1) provides fast revocation while giving no extra power to on-line service providers; (2) supports long-term validation; (3) is lightweight and scalable.
Tiit	**Roosmaa**	n.a.	n.a.
Mart	**Roost**	n.a.	n.a.
Andres	**Rähni**	n.a.	n.a.
Ennu	**Rüstern**	On the robust stability of discrete-time systems	A sufficient stability condition for monic Schur polynomials is obtained via the so-called reflection coefficients of polynomials and the discrete version of Kharitonov's weak theorem. The discrete Kharitonov theorem defines only (n - 1)-dimensional stable hyperrectangle for n-degree monic polynomials. By the use of a linear Schur invariant transformation we put stable line segments through vertices of this hyperrectangle and find an n-dimensional stable polytope with all vertices on the stability boundary.

Märt	**Saarepera**	Improving the availability of time-stamping services	We discuss the availability questions that arise when digital time stamps are used for preserving the evidentiary value of electronic documents. We analyze the time-stamping protocols known to date and point out some weaknesses that have not been addressed so far in scientific literature. Without addressing and solving them, any advantage of the linkage-based protocols over the hash-and-sign time-stamping would be questionable. We present several new techniques and protocols for improving the availability of both the hash-and-sign and the linkage-based time-stamping services. We introduce fault-tolerant linking as a new concept to neutralize fault-sensitivity as the main weakness of linkage-based time-stamping.
Märt	**Saarepera**	Implementation of quasi delay-insensitive Boolean function blocks	The problem of self-timed implementation of Boolean functions is explained. The notions of combinational delay-insensitive code and delay-insensitive function are defined: giving precise conditions under which memoryless self-timed implementation of Boolean functions is feasible. Examples of combinational delay-insensitive code and delay-insensitive function are given. Generic design style, using standard CAD library, for constructing quasi delay-insensitive self-timed function blocks is suggested. Our design style is compared to other self-timed function block design styles.
Eduard	**Schults**	n.a.	n.a.
Asko	**Seeba**	Analyzing pair-programmer's satisfaction with the method, the result, and the partner	This paper gives an overview of a programmer satisfaction survey in pair-programming experiment. The experiment took place at Institute of Computer Science, University of Tartu (UT), Estonia. The paper includes the problem statement, description of the questionnaire, and the survey results.
Olga	**Sokratova**	Reduction relations for monoid semirings	In this paper we study rewriting techniques for monoid semirings. Based on disjoint and non-disjoint representations of the elements of monoid semirings we define two different reduction relations. We prove that in both cases the reduction relation describes the congruence that is induced by the underlying set of equations, and we study the termination and confluence properties of the reduction relations. (C) 2003 Elsevier Ltd. All rights reserved.
Olga	**Sokratova**	On congruences of automata defined by directed graphs	We consider automata defined by graph algebras of directed graphs, characterize all congruences on these automata, and give a complete description of all automata of this type satisfying three properties for congruences introduced and considered in the literature by analogy with classical semisimplicity conditions that play important roles in structure theory.
Olga	**Sokratova**	Projective semimodules	In this paper we represent a projective semimodule as a retract of a direct sum of its countably generated projective retracts with zero intersection. A characterization by means of congruences is also given.
Olga	**Sokratova**	Two algorithms for languages recognized by graph algebras	In this paper we give an algorithmic description of all regular languages recognized by graph algebras of directed graphs. A description of the analogous class of regular languages for the case of undirected graphs is obtained as a corollary.
Olga	**Sokratova**	On semimodules over commutative, additively idempotent semirings	n.a.
Olga	**Sokratova**	The Mal'cev Lemma and rewriting on semirings	We present a connection between congruences on a free monoid and its monoid semiring using the analog of the Mal'cev Lemma. (C) 2001 Elsevier Science B.V. All rights reserved.
Olga	**Sokratova**	Syntactic semigroups and graph algebras	We describe all directed graphs with graph algebras isomorphic to syntactic semigroups of languages.
Viljo	**Soo**	Arrayed primer extension (APEX) for mutation detection using gene specific DNA chips	n.a.

Krista	**Strandson**	Directives in Estonian information dialogues	The paper gives an overview of a typology of dialogue acts we use for annotating Estonian spoken dialogues. Our dialogue corpus includes calls for information and to travel agencies (114 annotated dialogues). Directives (request, proposal, offer) and possible reactions are considered in the paper. Our further aim is to develop a dialogue system that will interact with the user in natural language following the norms and rules of human-human communication.
Aleksander	**Sudnitsõn**	n.a.	n.a.
Andres	**Taklaja**	Transmission of a Gaussian-beam through a circular aperture - comments	n.a.
Tõnu	**Tamme**	n.a.	n.a.
Kalle	**Tammemäe**	Evaluating fault emulation on FPGA	We present an evaluation of accelerating fault simulation by hardware emulation on FPGA, Fault simulation is an important subtask in test pattern generation and it is frequently used throughout the test generation process. In order to evaluate possible simulation speed possibilities, we made a feasibility study of using reconfigurable hardware by emulating circuit under analysis together with fault insertion structures on FPGA. Experiments showed that it is beneficial to use emulation for circuits/methods that require large numbers of test vectors, e.g., sequential circuits and/or genetic algorithms.
Kalle	**Tammemäe**	Automatic FSM synthesis for low-power mixed synchronous/asynchronous implementation	Power consumption in a synchronous FSM (Finite-State Machine) can be reduced by partitioning it into a number of coupled sub-FSMs where only the part that is involved in a state transition is clocked. Automatic synthesis of a partitioned FSM includes a partitioning algorithm and sub-FSM synthesis to an implementation architecture. In this paper, we first introduce an implementation architecture for partitioned FSMs that uses gated-clock technique for disabling idle parts of the circuits and asynchronous controllers for communication between the sub-FSMs. We then describe a new transformation procedure for the sub-FSM. The FSM synthesis how has been automated in a prototype tool that accepts an FSM specification. The tool generates synthesizable RT-level VHDL code with identical cycle-to-cycle input/output behavior in accordance with the specification. An average power reduction of 45% has been obtained for a set standard FSM benchmarks.
Tanel	**Tammet**	Chain resolution for the semantic web	We investigate the applicability of classical resolution-based theorem proving methods for the Semantic Web. We consider several well-known search strategies, propose a general schema for applying resolution provers and propose a new search strategy "chain resolution" tailored for large ontologies. Chain resolution is an extension of the standard resolution algorithm. The main idea of the extension is to treat binary clauses of the general form A(x) V B(x) with a special chain resolution mechanism, which is different from standard resolution used otherwise. Chain resolution significantly reduces the size of the search space for problems containing a large number of simple implications, typically arising from taxonomies. Finally we present a compilation-based schema for practical application of resolution-based methods as inference engines for Semantic Web queries.
Tanel	**Tammet**	Combining an inference engine with databases: A rule server	Complex Semantic Web applications require easy-to-use tools for data and rule storage along with query mechanisms. We describe a prototype server software RLS which is used similarly to the ordinary usage of SQL RDBMS software in application programming. The server combines first-order theorem provers with several query and rule language layers for application development in the Semantic Web context.
Tanel	**Tammet**	Optimized encodings of fragments of type theory in first-order logic	The paper presents sound and complete translations of several fragments of Martin-Lofs monomorphic type theory to first-order predicate calculus. The translations are optimized for the purpose of automated theorem proving in the mentioned fragments. The implementation of the theorem prover Gandalf and several experimental results are described.

Tanel	**Tammet**	Gandalf	We give a brief overview of the first-order classical logic component in the Gandalf family of resolution-based automated theorem provers for classical and intuitionistic logics. The main strength of the described version is a sophisticated algorithm for nonunit subsumption.
Tanel	**Tammet**	Optimized encodings of fragments of type theory in first order logic	The paper presents sound and complete translations of several fragments of Martin-Lof's monomorphic type theory to first order predicate calculus. The translations are optimised for the purpose of automated theorem proving in the mentioned fragments. The implementation of the theorem prover Gandalf and several experimental results are described.
Tanel	**Tammet**	Completeness of resolution for definite answers	We investigate the problem of finding a computable witness for the existential quantifier in a formula of the classical first-order predicate logic. The A-resolution calculus which is essentially the same as the program derivation algorithm A of C.-L.Chang, R.C.-T.Lee and R.Waldinger is used for finding a definite substitution t for an existentially bound variable y in some formula F, such that F{t/y} is provable. The term t is built of the function and predicate symbols in F, plus Boolean functions and a case splitting function if, defined in the standard way: if (True, x, y) = x and if (False, x, y) = y. We prove that the A-resolution calculus is complete in the following sense: if such a definite substitution exists, then the A-calculus derives a clause giving such a substitution. The result is strengthened by allowing the usage of liftable criteria R of a certain type, prohibiting the derivation of the substitution terms t for which R(t) fails. This enables us to specify, for example, that the substitution t must be in some special signature or must be type-correct, without losing completeness. We will also consider ordering restrictions for the A-calculus.
Tanel	**Tammet**	Completeness of resolution for definite answers with case analysis	We investigate the problem of finding a computable witness for the existential quantifier in a formula of the classical first-order predicate logic. The A-resolution calculus based on the program derivation algorithm A of C-L. Chang, R. C-T. Lee and R. Waldinger (a subsystem of the Manna-Waldinger calculus) is used for finding a definite substitution t for an existentially bound variable y in some formula F, such that F{t/y} is provable. The term t is built of the function and predicate symbols in F, plus Boolean functions and a case splitting function if, defined in the standard way: if (True, x, y) = x and if (False, x, y) = y. We prove that the A-resolution calculus is complete, i.e. if such a definite substitution exists, then the A-calculus derives a clause giving such a substitution. The result is strengthened by allowing the usage of liftable criterias R of a certain type, prohibiting the derivation of the substitution terms t for which R(t) fails. This enables us to specify, for example, that the substitution t must be in some special signature or must be type-correct, without losing completeness.
Tanel	**Tammet**	Proof strategies in linear logic	Linear logic, introduced by J.-Y. Girard, is a refinement of classical logic providing means for controlling the allocation of "resources". It has aroused considerable interest from both proof theorists and computer scientists. In this paper we investigate methods for automated theorem proving in propositional linear logic. Both the "bottom-up" (tableaux) and "top-down" (resolution) proof strategies are analyzed. Various modifications of sequent rules and efficient search strategies are presented along with the experiments performed with the implemented theorem provers.
Tanel	**Tammet**	Using resolution for deciding solvable classes and building finite-models	The paper consists of two parts. In the first part we briefly describe the resolution strategy devised by N.Zamov which decides a number of solvable classes, including Maslov's Class K (this class contains most well-known decidable classes like Godel's Class, Skolem's Class, Monadic Class). We give a strategy close to Zamov's, deciding a a wide class with functional symbols. A short description of our theorem-prover implementing the decision strategies is given. The second part presents the main result of the paper: a new, resolution-based method for showing the existence of finite models and an algorithm for building such models for several solvable classes. For small formulas our method often generates considerably smaller models than known methods of B. Dreben and W.D.Goldfarb, although it doesn't improve the known upper bounds on the size of the

models. The work described here has been guided by G.Mints. We would also like to thank N.Zamov for helpful discussions.

Tanel	**Tammet**	The resolution program, able to decide some solvable classes	n.a.
Harry	**Tani**	n.a.	n.a.
Arvi	**Tavast**	n.a.	n.a.
Ander	**Tenno**	A method for battery impedance analysis	A model-based method is proposed for the impedance-spectra analysis of valve-regulated lead-acid batteries. The electrochemical and double-layer processes are analyzed in a wide range of frequencies based on current, voltage, and temperature measurements. Both slow and fast dynamics of the positive and negative electrodes are evaluated. The method is shown to be accurate, enabling the detection of differences in capacity or other parameters even in slightly differing batteries. An exact relation between battery impedance and the electrochemical cell model is established giving useful information on the contribution of different elements and processes on the impedance. The proposed method is computationally effective due to the special analytical formulation developed for impedance analysis. In addition to the basic processes, the method also allows analysis of the fast-rate discharge and overcharge processes.
Ander	**Tenno**	Evaluation of VRLA battery under overcharging: model for battery testing	Theoretical cell model is applied for evaluation of valve-regulated lead-acid batteries under discharge, recharge and overcharge conditions. The previously presented models are improved by introducing a new formula for electrode morphology, applying charging factor to state-of-charge, electrode porosity and acid concentration as well as considering the recombination of oxygen as mass-transport limited evolution process. Also, a new model is proposed for the ohmic resistance of a battery. The modified cell model is calibrated using experimental data. Results show that high prediction accuracy can be obtained for the full discharge-recharge cycle including deep discharge and overcharge. The modified cell model is applied for evaluation of the gas formation processes using externally measured current, voltage and temperature of a battery.
Ander	**Tenno**	Charge-discharge behaviour of VRLA batteries: model calibration and application for state estimation and failure detection	The dynamic behaviour of batteries can be predicted using theoretical cell model for basic processes. In this paper, this model is calibrated for two ty es of valve regulated lead acid (VRLA) batteries, and is applied for viewing unobservable processes in battery by observable processes. It is shown that unobservable parameters like overpotential, reaction rate, porosity, acid concentration, and other parameters of electrode can be evaluated by total current, terminal voltage and temperature of surrounding atmosphere of battery. The calibrated model is applied to distinguish between outwardly equal batteries with different backup time and cut-off time. It is shown that difference in morphology of electrodes, thickness of electrodes and quantity of electrolyte in separator are the main distinguishing parameters between batteries. These parameters can be tested online by current-voltage measurements using fast calculation method proposed in this paper.

Jaak	**Tepandi**	Simulation of conflict in an agent world: Access to resources and possibility of termination of the population	The goal of the paper is to create a model for investigating the character of relationships between the freedom and restrictions in the terrorism context, in order to find out how sensitive is the probability of the population survival to small changes in these two parameters. A model for simulating relationships between access to resources and possibility of termination of the population is presented. The model comprises an agent world, its properties, interactions, and a world life cycle algorithm. As the "right" properties and interactions of the model are a question of experimentation, the model is introduced in two steps: a general model and a specific sub-model. Preliminary analysis of results received on a sub-model implementation demonstrate that in certain cases the relationship between the level of access to information and the overall aggressiveness value implying the end of population may has a stepwise character.
Jaak	**Tepandi**	Quality assurance of knowledge-based systems	A number of knowledge-based system quality assurance approaches, techniques and tools have been developed in the last decade. They include general principles of applying verification and validation in knowledge-based system-quality management, static analysis techniques, testing methods, and reliability assessment approaches. The static analysis techniques comprise checking consistency and coherence, verifying completeness, handling redundancy and subsumption, performing walkthroughs, formal reviews, and audits. Among the testing methods, program-based and functional testing are widely used. For reliability assessment, descriptive and modeling approaches have been applied. The paper gives an overview of these topics, and analyses the effectiveness of applying quality assurance methods to knowledge-based systems development.
Jaak	**Tepandi**	A knowledge-based approach to the specification-based program testing	n.a.
Mati	**Tombak**	A compact look-up table structure for low-level binary image processing	Look-up tables are a simple and an efficient means of providing neighborhood transformations in low level image processing architecture; however, they can also form a significant portion of the hardware cost in parallel systems. This paper describes a look-up table structure for low level machine vision applications in which only a restricted set of 3 x 3 neighborhood transformations are necessary and where the size, cost and real-time operation of the processor are additional constraints, The structure is based upon a novel two stage cascaded memory network which acts as the look-up table to implement binary neighborhood transformations, The structure provides sufficient realizations for many low level operations required in machine vision applications, but requires only one-sixth of the gates that would be necessary to provide complete cover. The paper presents a description of the structure, proofs for its realizability and hardware costs based upon simulated designs.
Arvo	**Toomsalu**	n.a.	n.a.
Ants	**Torim**	n.a.	n.a.
Sergei	**Tupailo**	On the intuitionistic strength of monotone inductive definitions	We prove here that the intuitionistic theory T-0\ + UMIDN, or even EETJ\ + UMIDN, of Pi(2)(1) - CA(0). In Section I we give a double-negation translation for Explicit Mathematics has the strength of 2 the classical second-order mu-calculus, which was shown in [Mo02] to have the strength of Pi(2)(1)-CA(0). In Section 2 we interpret the intuitionistic mu-calculus in the theory EETJ\ + UMIDN. The question about the strength of monotone inductive definitions in To was asked by S. Feferman in 1982. and - assuming classical logic - was addressed by M. Rathjen.
Sergei	**Tupailo**	Realization of constructive set theory into explicit mathematics: a lower bound for impredicative Mahlo universe	We define a realizability interpretation of Aczel's Constructive Set Theory CZF into Explicit Mathematics. The final results are that CZF extended by Mahlo principles is realizable in corresponding extensions of T-0, thus providing relative lower bounds for the proof-theoretic strength of the latter.

Sergei	**Tupailo**	Realization of analysts into explicit mathematics	We define a novel interpretation R of second order arithmetic into Explicit Mathematics, As a difference from standard D-interpretation. which was used before and was shown to interpret only subsystems proof-theoretically weaker than To. our interpretation can reach the full strength of To. The A-interpretation is an adaptation of Kleene's recursive realizability. and is applicable only to intuitionistic theories.
Sergei	**Tupailo**	Epsilon substitution method for elementary analysis	We formulate epsilon substitution method for elementary analysis EA (second order arithmetic with comprehension for arithmetical formulas with predicate parameters). Two proofs of its termination are presented. One uses embedding into ramified system of level one and cutelimination for this system. The second proof uses non-effective continuity argument.
Sergei	**Tupailo**	Gentzen-style and Novikov-style cut-elimination	n.a.
Eno	**Tõnisson**	n.a.	n.a.
Maris	**Tõnso**	Linear algebraic tools for discrete-time nonlinear control systems with Mathematica	This paper presents a contribution to the development of symbolic computation tools for discrete-time nonlinear control systems. A set of functions is developed in Mathematica 4.0 on the basis of linear algebraic approach that allows the solution of several modelling, analysis and synthesis problems. In all these problems, a certain sequence of subspaces, associated to a control system and based on the classification of one-forms according to their relative degree, provides the solution.
Maris	**Tõnso**	Transfer equivalence and realization of nonlinear higher order input/output difference equations using Mathematica	This paper presents a contribution to the development of symbolic computation tools for discrete-time nonlinear control systems. A set of functions is developed in Mathematica 3.0 that test if the higher order input/output difference equation is realizable in the classical state-space form, and for simple examples, also find such state equations. The approach relies on a new notion of equivalence of higher order difference equations which yields a minimal (i.e. accessible and observable) realization and generalizes the notion of transfer equivalence to the nonlinear case. The application of the developed functions is demonstrated on three examples obtained via identification.
Enn	**Tõugu**	Concurrent implementation of structurally synthesized programs	Specification for structural synthesis of programs (SSP) contains information needed for introducing concurrency into a synthesized program. We explain how this can be used in a multithreaded computing environment, in particular, in a Java environment. We discuss strategies of coarse-grained multithreaded execution of synthesized programs: composing threads and imposing parallelism on subtasks.
Enn	**Tõugu**	Strategies of structural synthesis of programs and its extensions	Proof search for the structural synthesis of programs (SSP) - a deductive program synthesis method which is suited for compositional programming in large and is in practical use in a number of programming environments is explained. SSP is based on a decidable logical calculus where complexity of the proof search is still PSPACE. This requires paying special attention to the efficiency of search. The practice of application of SSP has given its several modifications and extensions. Besides the general case of SSP and its strategies, we present synthesis with independent, subtasks, a number of heuristics used for speeding up the search and partial deduction in the framework of SSP.

Enn	**Tõugu**	Strateties of structural synthesis of programs and its extensions	Proof search for the structural synthesis of programs (SSP) - a deductive program synthesis method which is suited for compositional programming in large and is in practical use in a number of programming environments is explained. SSP is based on a decidable logical calculus where complexity of the proof search is still PSPACE. This requires paying special attention to the efficiency of search. The practice of application of SSP has given its several modifications and extensions. Besides the general case of SSP and its strategies, we present synthesis with independent subtasks, a number of heuristics used for speeding up the search and partial deduction in the framework of SSP.
Enn	**Tõugu**	Applications of structural synthesis of programs	This is an experience report on the automatic and hidden usage of program synthesis in several application domains. The structural synthesis of programs has been implemented in an object-oriented programming environment NUT and used for development of simulation software, engineering calculations software, implementing a benchmark for safety critical systems and development of highly interactive visual modeling of radar coverage of landscape.
Enn	**Tõugu**	Priz programming system	The structural and fuctioning principles of the PRIZ programming system are considered in the article. The system is an expansion of modular programming systems for the Minsk-32 and ES computers, intended for designing packages and service program unit necessary for the functioning of the packages are described. Basic attention is paid to means for automatically designing algorithms and generation of object programs. A brief description of the expanded Utopist input language that permits semantic models to be constructed and to be used in describing problems is presented.
Enn	**Tõugu**	From visual specifications to executable code	This presentation is based on a particular application that includes object-oriented visual specification of software and its automatic synthesis. The questions discussed here are: extending classes with extra information for program synthesis, a formalism for representing this information and building visual (object-oriented) ontologies.
Enn	**Tõugu**	NUTS: A distributed object-oriented platform with high level communication functions	An extensible object-oriented platform NUTS for distributed computing is described which is based on an object-oriented programming environment NUT which supports automatic synthesis of programs. It is built on top of the Parallel Virtual Machine (PVM), and hides all low-level features of the latter. The language of NUTS is a concurrent object-oriented programming language with coarse-grained parallelism and distributed shared memory communication model implemented on a distributed memory architecture. It differs from other languages of concurrent programming in the following: concurrent processes are represented by packages which are semantically richer entities than objects, inter-process communication is performed in terms of classes, objects, scripts and packages, using the EDA communication model; processes can be arranged into structured collections: grids which enable one to program data-parallel computations on a high level; sequential segments of programs can be synthesized automatically from specifications represented as classes using the program synthesis features of NUT. Examples of usage of generic parallel computing control structures PARDIF and PARARR are given.
Enn	**Tõugu**	Visual programming in NUT	The deep semantics of a scheme is defined as a set of programs derivable from the scheme. A uniform way of representing deep semantics of schemes is introduced based on the usage of a program synthesizer. An implementation of structural synthesis of programs in the NUT system and visual tools built on top of it are described. A visual compositional programming technique based on these tools is demonstrated on a number of examples.

Enn	**Tõugu**	Declarative reflection tools for agent shells	This paper introduces declarative reflection schemata and describes implementation tools for it. The keywords are planning and inference, i.e. a declarative (non-procedural) description of self must exist and be used for making inferences about the future activities of the reflective system and about consequences of these activities. The NUT system is used as a platform for intelligent agents with reflection. NUT processes running in a network are agent shells filled with knowledge in the form of NUT packages. A knowledge-based technique supported by automatic synthesis of programs is used for declarative reflection: a reflection schema with a model of self managed by daemons is implemented using run-time compilation/decompilation of classes and metaprogramming with productions.
Enn	**Tõugu**	Attribute models of design objects	We discuss the usage of deductive systems for representing general design knowledge, and attribute models, which are a kind of constraint networks, for representing implementation knowledge of design objects. This combination of two precisely described (formalized) knowledge systems enables us to represent both kinds of design knowledge and is sufficiently constructive to be used in developing CAD systems.
Enn	**Tõugu**	Large engineering knowledge bases	This paper concerns the development of numerous knowledge bases for engineering applications and integrating them into one knowledge environment applicable in different problem domains. It discusses steps made towards building larger heterogeneous engineering knowledge bases. It analyses the requirements to large knowledge bases, presents their architecture and discusses the content and size of general-purpose engineering knowledge bases.
Enn	**Tõugu**	Higher-order data-flow schemas	This paper describes dataflow schemes which include higher order objects as the input data of processing nodes. It is demonstrated that higher order dataflow can be described by constructive propositional logic. Rules for safe computations on higher order dataflow schemas are presented and their implementation in hardware is discussed.
Enn	**Tõugu**	The programming system PRIZ (Reprinted from J Symbolic Computation, Vol 5, pg 359-375, 1988)	The programming system PRIZ combines conventional programming technique with automatic synthesis of programs from specifications. It enables one to build specifications from descriptions of application domains. They are automatically encoded into propositional calculus and used by the system for the program synthesis. PRIZ is not bound to any particular problem domain, but applicable for synthesis of programs solving problems of a wide class called computational problems. From the theoretical side it has the deductive power of the intuitionistic propositional calculus.
Enn	**Tõugu**	Type-theoretical semantics of some declarative languages	n.a.
Enn	**Tõugu**	Knowledge-based software tools from the USSR	n.a.
Enn	**Tõugu**	Knowledge-based programming environments	This is a survey presented at the International Joint Conference on AI (IJCAI-89) in Detroit on Soviet work in the field of knowledge-based programming. It considers work which started in the 1970s as automatic programming projects with a goal to find new ways of program construction and, particularly, the work on computational models and problem solving. The structural program synthesis and conceptual programming technique developed in this framework were later used in the new generation computer project, START.
Enn	**Tõugu**	3 new-generation software environments	n.a.
Enn	**Tõugu**	Object-oriented programming	This article presents the fundamental notions of object-oriented programming (OOP) and considers formal models for them: automaton models for the behavior of objects, algebraic models of classes, and calculi describing inheritance. Concurrent and distributed implementations of object-oriented systems are discussed.

Enn	**Tõugu**	Integration of knowledge	Examines contemporary application of different kinds of knowledge in problem solution. Several calculi for representation of knowledge and methods of their combined use in the NUT and ExpertPRIZ programming systems are described.
Enn	**Tõugu**	Propositional logic programming and the PRIZ system	n.a.
Enn	**Tõugu**	Integration of conceptual and expert knowledge in CAD systems	n.a.
Enn	**Tõugu**	Propositional logic programming	n.a.
Enn	**Tõugu**	The programming system PRIZ	n.a.
Enn	**Tõugu**	Presentation of the engineering models in knowledge bases and personal computerized designing systems	n.a.
Enn	**Tõugu**	Nut - an object-oriented language	n.a.
Enn	**Tõugu**	Semantics of a declarative language	n.a.
Enn	**Tõugu**	Language and example of knowledge-based programming	n.a.
Enn	**Tõugu**	Description semantics in utopist language and automatic program synthesis	n.a.
Enn	**Tõugu**	Computational frames and structural synthesis of programs	n.a.
Enn	**Tõugu**	Justification of the structural synthesis programs	n.a.
Enn	**Tõugu**	The PRIZ system and propositional calculus	n.a.
Enn	**Tõugu**	Completeness of the structural synthesis rules	n.a.
Enn	**Tõugu**	Introduction to data-bases	n.a.
Ermo	**Täks**	n.a.	n.a.
Raimund	**Ubar**	Design error diagnosis with re-synthesis in combinational circuits	A new approach is proposed for removing design errors from digital circuits, which does not use any error model. Based on a diagnostic pre-analysis of the circuit, a subcircuit suspected to be erroneous is extracted. Opposite to other known works, re-synthesis of the subcircuit need not be applied to the whole function of the erroneous internal signal in terms of primary inputs, it may stop at arbitrary nodes inside the circuit. As the subcircuits to be redesigned are kept as small as possible, the speed of the whole procedure of diagnosis and re-synthesis can be significantly increased. A formal algorithm is proposed for the whole procedure. Experimental data show the efficiency of the diagnostic pre-analysis.

Raimund	**Ubar**	Hierarchical test generator for combinational circuits with real defects covverage	This paper deals with the automatic test pattern generation (ATPG) technique at the higher level using a functional fault model and defect-fault relationship in the form of a defect coverage table at the lower level. The paper contributes to test pattern generation (TPG) techniques taking into account physical defect localisation. A new parameter-probabilistic effectiveness of input patterns- has been used in the TPG technique with the goal of increasing real defect coverage. This parameter is based on probabilities of physical defects in digital cells which may occur in real integrated circuits. This improvement has been implemented into the existing DefGen ATPG system for combinational circuits.
Raimund	**Ubar**	Probabilistic analysis of CMOS physical defects in VLSI circuits for test coverage improvement	A new methodology of probabilistic analysis of CMOS physical defects in complex gates for the defect-based test is proposed. It is based on the developed approach for the identification and estimation or the probability of actual faulty functions resulting from shorts caused by spot defects in conductive layers of IC layout. The aim of this methodology is realistic representation of physical defects in fault models. The list of defects, identified faulty functions, defect coverage table, conditional defect probabilities, and effectiveness and optimal sequence of test patterns are the main output data of probabilistic-based faults characterisation. The description of such characterisation and experimental data obtained for industrial standard cell library in 0.8 mum CMOS technology are presented. Special software tool named FIESTA has been developed for the automation of the probabilistic-based fault characterisation. The main destination of this tool is the investigation of gates from Cadence standard cell library. The experimental data obtained during complex gates characterisation are used for the estimation of the physical defects coverage by hierarchical defect Simulation. At the higher level simulation the developed functional fault model was used, at the lower level we used the defect/fault relationships in the form of the defect coverage table and the conditional defect probabilities. Analysis Of the quality of 100% stuck-at fault (SAF) sets in relation to physical CMOS defects in complex gates was performed. The investigation of the correlation between the fault coverages for SAFs and defects of short type for two benchmark circuits was done as well.
Raimund	**Ubar**	Fast test pattern generation for sequential circuits using decision diagram representations	The paper presents a novel hierarchical approach to test pattern generation for sequential circuits based on an input model of mixed-level decision diagrams. A method that handles, both, data and control parts of the design in a uniform manner is proposed. The method combines deterministic and simulation-based techniques. On the register-transfer level, deterministic path activation is combined with simulation based-techniques used for constraints solving. The gate-level local test patterns for components are randomly generated driven by high-level constraints and partial path activation solutions. Experiments show that high fault coverages for circuits with complex sequential structures can be achieved in a very short time by using this approach.
Raimund	**Ubar**	Design error diagnosis in digital circuits with stuck-at fault model	In this paper we describe in detail a new method for the single gate-level design error diagnosis in combinational circuits. Distinctive features of the method are hierarchical approach (the localizing procedure starts at the macro level and finishes at the gate level), use of stuck-at fault model (it is mapped into design error domain only in the end), and design error diagnostic procedure that uses only test patterns generated by conventional gate-level stuck-at fault test pattern generators (ATPG). No special diagnostic tests are used because they are much more time consuming. Binary decision diagrams (BDD) are exploited for representing and localizing stuck-at faults on the higher signal path level. On the basis of detected faulty signal paths, suspected stuck-at faults at gate inputs are calculated, and then mapped into suspected design error(s). This method is enhanced compared to our previous work. It is applicable to redundant circuits and allows using incomplete tests for error diagnosis. Experimental data on ISCAS benchmark circuits shows the advantage of the proposed method compared to the known algorithms of design error diagnosis.

Raimund	**Ubar**	Special issue: Selected papers from the 1997 NORCHIP conference	n.a.
Raimund	**Ubar**	Dynamic analysis of digital circuits with multi-valued simulation	This paper presents a new method for dynamic analysis of digital circuits with multi-valued simulation based on calculation of Boolean derivatives on structural binary decision diagrams (SBDDs) (or structural alternative graphs). A procedure for calculation of the maximum of Boolean derivatives on SBDDs as the basis for multi-valued simulation is described. Algorithms for five- and eight-valued simulation are discussed in detail. The method is applicable for component level representations of digital circuits, whereas components' arbitrary subcircuits (macros) instead of gates are considered. No dedicated model library for representing multi-valued behaviour of components is needed. Instead of dedicated multi-valued models, generic ones in the form of SBDDs are used. Experimental data to demonstrate the advantages of the new approach are provided.
Raimund	**Ubar**	Combinig functional and structural approaches in test generation for digital systems	This article proposes a generalized approach to test generation for digital systems based on combining Functional and structural information of the system in decision diagrams. Decision diagrams are used as a uniform model for describing structures. functions, as well as faults and fault propagation modes in a wide class of digital circuits at different representation levels, For test pattern generation, they provide a general theoretical basis for combining high-level approaches, symbolic techniques, and topological algorithms based on low-level structural descriptions of gate networks. Experimental results are provided for demonstrating the efficiency of using decision diagrams in test generation.
Raimund	**Ubar**	Test synthesis with alternative graphs	Alternative graphs provide an efficient, uniform model describing the structure, functions, and faults in a wide class of digital circuits and for different representation levels. For test pattern generation, they provide a general theoretical basis for combining high-level approaches, symbolic techniques based on binary decision diagrams, and traditional topological algorithms.
Raimund	**Ubar**	Digital Circuit Test Design Using the Alternative Graph Model	n.a.
Raimund	**Ubar**	Detection of Suspected Faults in Combinational-Circuits by Solving Boolean Differential-Equations	n.a.
Andres	**Udal**	High phonon-drag thermoelectric efficiency of SiC at low temperatures	Results confirming the high values of Seebeck coefficient phonon-drag component S-ph in SiC are discussed and the relevant consequences to the thermoelectric figure-of-merit ZT=TS(2)sigma/kappa are studied. The fact that Sph increases at low temperatures as similar toT(-2.4) similarly for low-doped p-6H-SiC, Si and Ge is demonstrated. Materials comparison criterion S(ph)similar tokappa/mum(eff), based on heat conductivity, lattice mobility and carrier effective mass is offered and Sph strength proportions 0.1 : 1: 5: 10 for Ge, Si, SiC and C (diamond) are proposed. Related to that high Tapproximate to500K phonon-drag domination limit is obtained for SiC. It is shown that the proportionality S(ph)similar tokappa, yielding ZTsimilar tokappa; could reverse some concepts accepted in thermoelectric material development. The best-case calculations predict good (>0.1) and excellent (>1) ZT values with steep temperature-dependence similar toT(-3...-4) for low temperatures 50divided by200K if sufficiently high electrical conductivity sigma could be ensured. The last condition may be feasible for n-SiC with relatively shallow donor levels but difficult to achieve in the case of P-SiC with relatively deep acceptor levels.

Andres	**Udal**	Modeling of lattice heat conductivity and thermopower in SiC considering the four-phonon scattering process	The lattice heat conductivity in low-doped SiC is studied in the wide temperature range 50/1200 K in order to estimate the strength coefficient a(4P) for 4-phonon scattering processes mechanism for later application in both heat conductivity and Seebeck coefficient models. Heat conductivity calculations confirm the domination of the 4-phonon mechanism and the secondary role of the 3-phonon Umklapp mechanism. The obtained a(4P)approximate to1.5(.)10(-22) s/K-2 gives very satisfactory result in Seebeck coefficient phonon drag component modeling.
Andres	**Udal**	Impact of phonon drag effect on Seebeck coefficient in p-6H-SiC: Experiment and simulation	The temperature dependence of Seebeck coefficient (S) for p-6H-SiC has been obtained. It increases from 2 up to 5.2 mV/K when temperature decreases from 400 down to 240 K. It is shown that phonon drag effect makes critical contribution to the S value. Improved theoretical model involving 4-phonon scattering process has been proposed for the simulation of Seebeck coefficient phonon pail.
Andres	**Udal**	Thermopwer measurements in 4H-SiC and theoretical calculations considering the phonon drag effect	The Seebeck coefficient study in a heavily nitrogen-doped n-type 4H-SiC epilayer in the direction perpendicular to c-axis is presented. The Seebeck coefficient steeply increases from 0.56 mV/K to 1.7 mV/K with decreasing temperature in the range 400-80 R. This behavior is explained by the phonon drag effect. An approach to the theoretical modeling of the phonon drag effect is discussed and simulation of the Seebeck coefficient temperature-dependence is displayed.
Andres	**Udal**	A theoretical study of electron drift mobility anisotropy in n-type 4H- and 6H-SiC	The electron drift mobility ratios in 4H- and 6H-SiC have been calculated accounting for the acoustic phonon and the ionized impurity scattering. A comparison of our theoretical calculations and published experimental data suggest that the acoustic deformation potential tensor of 4H- and 6H-SiC is rather isotropic with a constant E-1 = 10 +/- 0.5 eV for both 4H- and 6H-SiC. A factor, strongly influencing the electron mobility anisotropy is the electron effective mass tensor, which may be rather anisotropic as in case of 6H-SiC.
Andres	**Udal**	Measurement of charge carrier lifetime temperature-dependence in 4H-SiC power diodes	Charge carrier effective lifetimes in 4H-SiC power diode n-bases for wide temperature range -70 divided by +180 degreesC were estimated by reverse recovery charge measurements and parallel simulations. At room temperature lifetime values in the 50 divided by 60ns range were obtained. For lifetime temperature-dependence the power law behaviour tau similar toT(alpha) was confirmed with exponent values alpha approximate to2.0 divided by2.2.
Andres	**Udal**	Corrected accounting of electron-hole scattering in cross-term current equations for Si and SiC	Accounting of electron-hole scattering in so-called cross-term current equations is revised relying on carrier scattering and screening theories by Appel and Dingle used in Kohler's variational principle solution to the coupled electron and hole Boltzmann transport equations. It is shown that the empirically determined electron-hole scattering (EHS) function J(ch) for Si significantly overestimates EHS at carrier concentrations higher than 10(18) cm(-3), causing an artificial minority carrier full-drag effect. The proposed corrected theory-based J(ch) decreases as similar to n(-2/3) at high carrier concentrations and avoids the above mentioned unphysical effect. A set of simple and convenient formulas for use in device simulators is proposed.
Andres	**Udal**	SiC-diodes forward surge current failure mechanisms: Experiment and simulation	As predicted earlier theoretically [1], the usual silicon devices forward surge current failure n(i)(T)-mechanism should be preceded by mu(T)-(i.e. mobility vs temperature) mechanism in silicon carbide devices. The paper presents experimental results to support this theory. In addition, pn-junction voltage drop measurements interpreted by electro-thermal simulations indicate that nondestructive instant temperatures may reach 1600 divided by 1800K in SiC.
Andres	**Udal**	A theoretically accurate mobility model for semiconductor-device drift-diffusion simulation	A novel semiconductor charge carrier mobility model obtained by Kohler's variational method for Boltzmann transport equation solution is presented. Acoustic phonon scattering, ionized impurity scattering, and carrier-carrier scattering are taken into account. Majority electron and hole mobilities in n- and p-type silicon versus impurity and carrier concentration, and temperature are calculated and compared with published experimental data.

Andres	**Udal**	A numerical transient analysis of a bulk-barrier diode	n.a.
Andres	**Udal**	Computer-aided numerical modeling of powerful Schottky diodes	n.a.
Andres	**Udal**	Numerical-analysis of the on-state of diode structures based on direct-gap semiconductors	n.a.
Heli	**Uibo**	n.a.	n.a.
Aivar	**Uisk**	n.a.	n.a.
Tarmo	**Uustalu**	Normalization by evaluation for lambda (-> 2)	We show that the set-theoretic semantics of lambda(-->2)-simply typed lambda calculus with a boolean type but no type variables-is complete by inverting evaluation using decision trees. This leads to an implementation of normalization by evaluation which is witnessed by the source of part of this paper being a literate Haskell script. We show the correctness of our implementation using logical relations.
Tarmo	**Uustalu**	Generalizing substitution	It is well known that, given an endofunctor H on a category C, the initial (A+ H-)-algebras (if existing), i.e., the algebras of (wellfounded) H-terms over different variable supplies A, give rise to a monad with substitution as the extension operation (the free monad induced by the functor H). Moss [17] and Aczel, Adamek, Milius and Velebil [2] have shown that a similar monad, which even enjoys the additional special property of having iterations for all guarded substitution rules (complete iterativeness), arises from the inverses of the final (A+ H-)-coalgebras (if existing), i.e., the algebras of non-wellfounded H-terms. We show that, upon an appropriate generalization of the notion of substitution, the same can more generally be said about the initial T'(A, -)-algebras resp. the inverses of the final T(A, -)coalgebras for any endobifunctor T' on any category C such that the functors T'(-, X) uniformly carry a monad structure.
Tarmo	**Uustalu**	Monad translating inductive and coinductive types	We show that the call-by-name monad translation of simply typed lambda calculus extended with sum and product types extends to special and general inductive and coinductive types so that its crucial property of preserving typings and beta- and commuting reductions is maintained. Specific similar-purpose translations such as CPS translations follow from the general monad translations by specialization for appropriate concrete monads.
Tarmo	**Uustalu**	Generalized iteration and coiteration for higher-order nested datatypes	We solve the problem of extending Bird and Paterson's generalized folds for nested datatypes and its dual to inductive and coinductive constructors of arbitrarily high ranks by appropriately generalizing Mendler-style (co)iteration. Characteristically to Mendler-style schemes of disciplined (co)recursion, the schemes we propose do not rest on notions like positivity or monotonicity of a constructor and facilitate programming in a natural and elegant style close to programming with the customary letrec construct, where the typings of the schemes, however, guarantee termination. For rank 2, a smoothened version of Bird and Paterson's generalized folds and its dual are achieved; for rank 1, the schemes instantiate to Mendler's original (re)formulation of iteration and coiteration. Several examples demonstrate the power of the approach. Strong normalization of our proposed extension of system F-omega of higher-order parametric polymorphism is. proven by a reduction-preserving embedding into pure F-omega.

Tarmo	**Uustalu**	CPS translating inductive and coinductive types	We investigate CPS translatability of typed lambda-calculi with inductive and coinductive types. We show that tenable Plotkin-style call-by-name CPS translations exist for simply typed lambda-calculi with a natural number type and stream types and, more generally, with arbitrary positive inductive and coinductive types. These translations also work in the presence of control operators and generalize for dependently typed calculi where case-like eliminations are only allowed in non-dependent forms. No translation is possible along the same lines for small Sigma-types and sum types with dependent case.
Tarmo	**Uustalu**	Least and greatest fixed points in intuitionistic natural deduction	This paper is a comparative study of a number of (intensional-semantically distinct) least and greatest fixed point operators that natural-deduction proof systems for intuitionistic logics can be extended with in a proof-theoretically defendable way. Eight pairs of such operators are analysed. The exposition is centred around a cube-shaped classification where each node stands for an axiomatization of one pair of operators as logical constants by intended proof and reduction rules and each arc for a proof- and reduction-preserving encoding of one pair in terms of another. The three dimensions of the cube reflect three orthogonal binary options: conventional-style vs. Mendler-style, basic ("[co]iterative") vs. enhanced ("primitive-[co]recuxsive"), simple vs. course-of-value [co]induction. Some of the axiomatizations and encodings are well known; others, however, are novel; the classification into a cube is also new. The differences between the least fixed point operators considered are illustrated on the example of the corresponding natural number types.
Tarmo	**Uustalu**	Combining object-oriented and logic paradigms - a model logic programming approach	In this paper, a number of existing solutions and suggestions towards combining the object-oriented (OO) and logic programming paradigms have been briefly studied and categorized, and a sketch of a new solution has been proposed which tries to capture the essence of OO in terms of modal logic, and which could be implemented as a modal logic programming system. The proposal is based on the belief that two orthogonal dimensions - object hierarchy and time - are involved in OO that in many respects are similar. For the one-dimensional (static) case, three logics - MU, MU', and MU'' - have been designed, each allowing a different variety of inheritance modes. The two-dimensional (dynamic) case has been treated in a logic 2MU and its corresponding variants. Under certain OO-motivated definitions of Horn clause, the resolution calculi of these logics turn out to be complete.
Jüri	**Vain**	Integrating methods for the design of real-time systems	With the aim of designing complex real-time systems, we investigate the integration of conceptual modeling techniques, formal specification, and compositional verification. A constructive transformation is defined from a conceptual meta-model to a real-time specification language. Refinement steps can be verified formally by means of compositional proof rules. The approach is illustrated by the design of a mine pump control system.
Jüri	**Vain**	Real-time specification and modeling with joint actions	The notion of joint actions provides a natural execution model for a specification language, when temporal logic of actions is used for formal reasoning. We extend this basis with scheduling, the role of which is to enforce liveness properties and to introduce real-time properties. This is done in a way that agrees with the partial-order view of computations and can be applied already in the early stages of specification and design. This leads to distinguishing between schedulings that are totally correct, partially correct, or incorrect with respect to liveness properties. A general scheduling policy of durational actions is formulated from which any reasonable scheduling can be obtained by reducing its nondeterminism. When this policy is totally correct for a system and gives the required real-time properties, no special limitations are imposed on the implementation. The approach also leads to a general classification of real-time models according to the permitted interactions between the computational state and real time.

Jüri	**Vain**	Scheduling in real-time models	Interleaving semantics is shown to provide an appropriate basis also for the modeling of real-time properties. Real-time scheduling of interleaved actions is explored, and the crucial properties of such schedulings are analyzed. The motivation of the work is twofold: to make real-time modeling practical already at early stages of specification and design, and to increase the reliability and predictability of reactive real-time systems by improved insensitivity to changes in the underlying real-time assumptions.
Stanislav	**Vassiljev**	TO automation of theorem synthesis	n.a.
Enn	**Velmre**	High phonon-drag thermoelectric efficiency of SiC at low temperatures	Results confirming the high values of Seebeck coefficient phonon-drag component S-ph in SiC are discussed and the relevant consequences to the thermoelectric figure-of-merit ZT=TS(2)sigma/kappa are studied. The fact that Sph increases at low temperatures as similar toT(-2.4) similarly for low-doped p-6H-SiC, Si and Ge is demonstrated. Materials comparison criterion S(ph)similar tokappa/mum(eff), based on heat conductivity, lattice mobility and carrier effective mass is offered and Sph strength proportions 0.1 : 1: 5: 10 for Ge, Si, SiC and C (diamond) are proposed. Related to that high Tapproximate to500K phonon-drag domination limit is obtained for SiC. It is shown that the proportionality S(ph)similar tokappa, yielding ZTsimilar tokappa; could reverse some concepts accepted in thermoelectric material development. The best-case calculations predict good (>0.1) and excellent (>1) ZT values with steep temperature-dependence similar toT(-3...-4) for low temperatures 50divided by200K if sufficiently high electrical conductivity sigma could be ensured. The last condition may be feasible for n-SiC with relatively shallow donor levels but difficult to achieve in the case of P-SiC with relatively deep acceptor levels.
Enn	**Velmre**	Modeling of lattice heat conductivity and thermopower in SiC considering the four-phonon scattering process	The lattice heat conductivity in low-doped SiC is studied in the wide temperature range 50/1200 K in order to estimate the strength coefficient a(4P) for 4-phonon scattering processes mechanism for later application in both heat conductivity and Seebeck coefficient models. Heat conductivity calculations confirm the domination of the 4-phonon mechanism and the secondary role of the 3-phonon Umklapp mechanism. The obtained a(4P)approximate to1.5(.)10(-22) s/K-2 gives very satisfactory result in Seebeck coefficient phonon drag component modeling.
Enn	**Velmre**	Impact of phonon drag effect on Seebeck coefficient in p-6H-SiC: Experiment and simulation	The temperature dependence of Seebeck coefficient (S) for p-6H-SiC has been obtained. It increases from 2 up to 5.2 mV/K when temperature decreases from 400 down to 240 K. It is shown that phonon drag effect makes critical contribution to the S value. Improved theoretical model involving 4-phonon scattering process has been proposed for the simulation of Seebeck coefficient phonon pail.
Enn	**Velmre**	Thermopwer measurements in 4H-SiC and theoretical calculations considering the phonon drag effect	The Seebeck coefficient study in a heavily nitrogen-doped n-type 4H-SiC epilayer in the direction perpendicular to c-axis is presented. The Seebeck coefficient steeply increases from 0.56 mV/K to 1.7 mV/K with decreasing temperature in the range 400-80 R. This behavior is explained by the phonon drag effect. An approach to the theoretical modeling of the phonon drag effect is discussed and simulation of the Seebeck coefficient temperature-dependence is displayed.
Enn	**Velmre**	A theoretical study of electron drift mobility anisotropy in n-type 4H- and 6H-SiC	The electron drift mobility ratios in 4H- and 6H-SiC have been calculated accounting for the acoustic phonon and the ionized impurity scattering. A comparison of our theoretical calculations and published experimental data suggest that the acoustic deformation potential tensor of 4H- and 6H-SiC is rather isotropic with a constant E-1 = 10 +/- 0.5 eV for both 4H- and 6H-SiC. A factor, strongly influencing the electron mobility anisotropy is the electron effective mass tensor, which may be rather anisotropic as in case of 6H-SiC.

Enn	**Velmre**	Measurement of charge carrier lifetime temperature-dependence in 4H-SiC power diodes	Charge carrier effective lifetimes in 4H-SiC power diode n-bases for wide temperature range -70 divided by +180 degreesC were estimated by reverse recovery charge measurements and parallel simulations. At room temperature lifetime values in the 50 divided by 60ns range were obtained. For lifetime temperature-dependence the power law behaviour tau similar toT(alpha) was confirmed with exponent values alpha approximate to2.0 divided by2.2.
Enn	**Velmre**	Corrected accounting of electron-hole scattering in cross-term current equations for Si and SiC	Accounting of electron-hole scattering in so-called cross-term current equations is revised relying on carrier scattering and screening theories by Appel and Dingle used in Kohler's variational principle solution to the coupled electron and hole Boltzmann transport equations. It is shown that the empirically determined electron-hole scattering (EHS) function J(ch) for Si significantly overestimates EHS at carrier concentrations higher than 10(18) cm(-3), causing an artificial minority carrier full-drag effect. The proposed corrected theory-based J(ch) decreases as similar to n(-2/3) at high carrier concentrations and avoids the above mentioned unphysical effect. A set of simple and convenient formulas for use in device simulators is proposed.
Enn	**Velmre**	SiC-diodes forward surge current failure mechanisms: Experiment and simulation	As predicted earlier theoretically [1], the usual silicon devices forward surge current failure n(i)(T)-mechanism should be preceded by mu(T)-(i.e. mobility vs temperature) mechanism in silicon carbide devices. The paper presents experimental results to support this theory. In addition, pn-junction voltage drop measurements interpreted by electro-thermal simulations indicate that nondestructive instant temperatures may reach 1600 divided by 1800K in SiC.
Enn	**Velmre**	A theoretically accurate mobility model for semiconductor-device drift-diffusion simulation	A novel semiconductor charge carrier mobility model obtained by Kohler's variational method for Boltzmann transport equation solution is presented. Acoustic phonon scattering, ionized impurity scattering, and carrier-carrier scattering are taken into account. Majority electron and hole mobilities in n- and p-type silicon versus impurity and carrier concentration, and temperature are calculated and compared with published experimental data.
Enn	**Velmre**	Numerical modeling of non-isothermal transient processes in power semiconductor-devices at the high forward current-density	n.a.
Enn	**Velmre**	Numerical modeling of non-isothermal transient processes in gaas structures	n.a.
Enn	**Velmre**	Numerical modeling of the electrothermal transient process in diode structures based on direct-gap semiconductors	n.a.
Enn	**Velmre**	Numerical modeling of transient processes in gaas diode structures	n.a.
Enn	**Velmre**	Numerical-analysis of the on-state of diode structures based on direct-gap semiconductors	n.a.
Jelena	**Vendelin**	n.a.	n.a.

Varmo	**Vene**	Least and greatest fixed points in intuitionistic natural deduction	This paper is a comparative study of a number of (intensional-semantically distinct) least and greatest fixed point operators that natural-deduction proof systems for intuitionistic logics can be extended with in a proof-theoretically defendable way. Eight pairs of such operators are analysed. The exposition is centred around a cube-shaped classification where each node stands for an axiomatization of one pair of operators as logical constants by intended proof and reduction rules and each arc for a proof- and reduction-preserving encoding of one pair in terms of another. The three dimensions of the cube reflect three orthogonal binary options: conventional-style vs. Mendler-style, basic ("[co]iterative") vs. enhanced ("primitive-[co]recuxsive"), simple vs. course-of-value [co]induction. Some of the axiomatizations and encodings are well known; others, however, are novel; the classification into a cube is also new. The differences between the least fixed point operators considered are illustrated on the example of the corresponding natural number types.
Tarmo	**Veskioja**	n.a.	n.a.
Vladimir	**Viies**	n.a.	n.a.
Jüri	**Vilipõld**	A system for CAD CAM software-development and implementation	n.a.
Anne	**Villems**	n.a.	n.a.
Jan	**Villemson**	Covering the path space: a casebase analysis for mobile robot path planning	This paper presents a theoretical analysis of a casebase used for mobile robot path planning in dynamic environments. Unlike other casebased path planning approaches. we use a grid map to represent the environment that permits the robot to operate in unstructured environments. The objective of the mobile robot is to learn to choose paths that are less risky to follow. Our experiments with real robots have shown the efficiency of our concept. In this paper, we replace a heuristic path planning algorithm of the mobile robot with a seed casebase and prove the upper and lower bounds for the cardinality of the casebase. The proofs indicate that it is realistic to seed the casebase with some solutions to a path-finding problem so that no possible solution differs too much from some path in the casebase. This guarantees that the robot would theoretically find all paths from start to goal. The proof of the upper bound of the casebase cardinality shows that the casebase would in a long run grow too large and all possible solutions cannot be stored. In order to keep only the most efficient solutions the casebase has to be revised at run-time or some other measure of path difference has to be considered.
Jan	**Villemson**	Improving the availability of time-stamping services	We discuss the availability questions that arise when digital time stamps are used for preserving the evidentiary value of electronic documents. We analyze the time-stamping protocols known to date and point out some weaknesses that have not been addressed so far in scientific literature. Without addressing and solving them, any advantage of the linkage-based protocols over the hash-and-sign time-stamping would be questionable. We present several new techniques and protocols for improving the availability of both the hash-and-sign and the linkage-based time-stamping services. We introduce fault-tolerant linking as a new concept to neutralize fault-sensitivity as the main weakness of linkage-based time-stamping.
Jan	**Villemson**	Efficient long-term validation of digital signatures	Digitally signed documents (e.g. contracts) would quickly lose their validity if the signing keys were revoked or the signature scheme was broken. The conventional validation techniques have been designed just for ephemeral use of signatures and are impractical for long-term validation. We present a new scheme that: (1) provides fast revocation while giving no extra power to on-line service providers; (2) supports long-term validation; (3) is lightweight and scalable.

Jan	**Villemson**	Time-stampting with binary linking schemes	We state the basic requirements for time-stamping systems applicable as the necessary support to the legal use of electronic documents. We analyze the main drawbacks of the time-stamping systems proposed to date and present a new system that meets all the stated requirements. We prove that these requirements cannot be significantly tightened.
Jaak	**Vilo**	Expression Profiler: next generation - an online platform for analysis of microarray data	Expression Profiler (EP, http://www.ebi.ac.uk/expressionprofiler) is a web-based platform for microarray gene expression and other functional genomics-related data analysis. The new architecture, Expression Profiler: next generation (EP:NG), modularizes the original design and allows individual analysis-task-related components to be developed by different groups and yet still seamlessly to work together and share the same user interface look and feel. Data analysis components for gene expression data preprocessing, missing value imputation, filtering, clustering methods, visualization, significant gene finding, between group analysis and other statistical components are available from the EBI (European Bioinformatics Institute) web site. The web-based design of Expression Profiler supports data sharing and collaborative analysis in a secure environment. Developed tools are integrated with the microarray gene expression database ArrayExpress and form the exploratory analytical front-end to those data. EP:NG is an open-source project, encouraging broad distribution and further extensions from the scientific community.
Jaak	**Vilo**	ArrayExpress: a public database of gene expression data at EBI	ArrayExpress is a public repository for microarray-based gene expression data, resulting from the implementation of the MACE object model to ensure accurate data structuring and the MIAME standard, which defines the annotation requirements. ArrayExpress accepts data as MAGE-ML files for direct submissions or data from MIAMExpress, the MIAME compliant web-based annotation and submission tool of EBI. A team of curators supports the submission process, providing assistance in data annotation. Data retrieval is performed through a dedicated web interface. Relevant results may be exported to Expression-Profiler, the EBI based expression analysis tool available online (http://www.ebi.ac.uk/arrayexpress).
Jaak	**Vilo**	ArrayExpress - a public repository for microarray gene expression data at the EBI	ArrayExpress is a new public database of microarray gene expression data at the EBI, which is a generic gene expression database designed to hold data from all microarray platforms. ArrayExpress uses the annotation standard Minimum Information About a Microarray Experiment (MIAME) and the associated XML data exchange format Microarray Gene Expression Markup Language (MAGE-ML) and it is designed to store well annotated data in a structured way. The ArrayExpress infrastructure consists of the database itself, data submissions in MAGE-ML format or via an online submission tool MIAMExpress, online database query interface, and the Expression Profiler online analysis tool. ArrayExpress accepts three types of submission, arrays, experiments and protocols, each of these is assigned an accession number. Help on data submission and annotation is provided by the curation team. The database can be queried on parameters such as author, laboratory, organism, experiment or array types. With an increasing number of organisations adopting MAGE-ML standard, the volume of submissions to ArrayExpress is increasing rapidly. The database can be accessed at http://www.ebi.ac.uk/arrayexpress.

Jaak	**Vilo**	Correlating gene promoters and expression in gene disruption experiments	Motivation: Finding putative transcription factor binding sites in the upstream sequences of similarly expressed genes has recently become a subject of intensive studies. In this paper we investigate how much gene expression regulation can be attributed to the presence of various binding sites in the gene promoters by correlating the binding sites and the changes in gene expression resulting from gene disruptions (e.g. knockouts). Results: We have developed a data analysis method for comparing mRNA measurements of gene disruption experiments with information about gene promoters. The method was applied to a well-known dataset to uncover correlations between known transcription factor binding site motifs in the upstream regions of all S. cerevisiae genes and the gene expression changes in various gene disruption experiments. The possible explanations of the correlations were categorized and analyzed using e.g. expression cascades. Several correlations turned out to be consistent with existing biological knowledge while some new ones suggest themselves for further study.
Jaak	**Vilo**	Building and analysing genome-wide gene disruption networks	Motivation: Microarray experiments comparing expression levels of all genes in yeast for hundreds of mutants allow us to examine properties of gene regulatory networks on a genomic scale. We can investigate questions such as network modularity, connectivity, and look for genes with particular roles in the network structure. Results: We have built genome-wide disruption networks for yeast, using a representation of gene expression data as directed labelled graphs. Nodes represent genes and arcs connect nodes if the disruption of the source gene significantly alters the expression of the target gene. We are interested in features of the resulting disruption networks that are robust over a range of significance cutoffs. The networks show a significant overlap with analogous networks constructed from scientific literature. In disruption networks the number of arcs adjacent to different nodes are distributed roughly according to a power-law, like in many complex systems where the robustness against perturbations is important. The networks are dominated by a single large component and do not have an obvious modular structure. Genes with the highest outdegrees often encode proteins with regulatory functions, whereas genes with the highest indegrees are predominantly involved in metabolism. The local structure of the networks is meaningful, genes involved in the same cellular processes are close together in the network.
Jaak	**Vilo**	A first-generation linkage disequilibrium map of human chromosome 22	DNA sequence variants in specific genes or regions of the human genome are responsible for a variety of phenotypes such as disease risk or variable drug response(1). These variants can be investigated directly, or through their non-random associations with neighbouring markers (called linkage disequilibrium (LD))(2-8). Here we report measurement of LD along the complete sequence of human chromosome 22. Duplicate genotyping and analysis of 1,504 markers in Centre d'Etude du Polymorphisme Humain (CEPH) reference families at a median spacing of 15 kilobases (kb) reveals a highly variable pattern of LD along the chromosome, in which extensive regions of nearly complete LD up to 804 kb in length are interspersed with regions of little or no detectable LD. The LD patterns are replicated in a panel of unrelated UK Caucasians. There is a strong correlation between high LD and low recombination frequency in the extant genetic map, suggesting that historical and contemporary recombination rates are similar. This study demonstrates the feasibility of developing genome-wide maps of LD.

Jaak	**Vilo**	Protein interaction verification and functional annotation by integrated analysis of genome-scale data	Assays capable of determining the properties of thousands of genes in parallel present challenges with regard to accurate data processing and functional annotation. Collections of microarray expression data are applied here to assess the quality of different high-throughput protein interaction data sets. Significant differences are found. Confidence in 973 out of 5342 putative two-hybrid interactions from S. cerevisiae is increased. Besides verification, integration of expression and interaction data is employed to provide functional annotation for over 300 previously uncharacterized genes. The robustness of these approaches is demonstrated by experiments that test the in silico predictions made. This study shows how integration improves the utility of different types of functional genomic data and how well this contributes to functional annotation.
Jaak	**Vilo**	Minimum information about a microarray experiment (MIAME) - toward standards for microarray data	Microarray analysis has become a widely used tool for the generation of gene expression data on a genomic scale. Although many significant results have been derived from microarray studies, one limitation has been the lack of standards for presenting and exchanging such data. Here we present a proposal, the Minimum Information About a Microarray Experiment (MIAME), that describes the minimum information required to ensure that microarray data can be easily interpreted and that results derived from its analysis can be independently verified. The ultimate goal of this work is to establish a standard for recording and reporting microarray-based gene expression data, which will in turn facilitate the establishment of databases and public repositories and enable the development of data analysis tools. With respect to MIAME, we concentrate on defining the content and structure of the necessary information rather than the technical format for capturing it.
Jaak	**Vilo**	Regulatory sequence analysis: application to the interpretation of gene expression	Microarray technologies for measuring mRNA abundances in cells allow monitoring of gene expression levels for tens of thousands of genes in parallel. By measuring expression responses across hundreds of different conditions or timepoints a relatively detailed gene expression map starts to emerge. Using cluster analysis techniques, it is possible to identify genes that are consistently coexpressed under several different conditions or treatments. These sets of coexpressed genes can then be compared to existing knowledge about biochemical or signalling pathways, the function of unknown genes can be hypothesised by comparing them to other genes with characterised function, or from trends in expression profiles in general - why cell needs to transcribe or silence the genes during particular treatment. The regulation of genes on the DNA level is largely guided by particular sequence features, the transcription factor binding sites, and other signals encaptured in DNA. By analyzing the regulatory regions of the DNA of the genes consistently coexpressed, we can discover the potential signals hidden in DNA by computational analysis methods. The prerequisite for this kind of analysis is the existence of genomic DNA sequence, knowledge about gene locations, and experimental gene expression measurements for a variety of conditions. This article surveys some of the analysis methods and studies for such a computational discovery approach for yeast Saccharomyces cerevisiae.
Jaak	**Vilo**	Gene expression data analysis	Microarrays are one of the latest breakthroughs in experimental molecular biology, which allow monitoring of gene expression for tens of thousands of genes in parallel and are already producing huge amounts of valuable data. Analysis and handling of such data is becoming one of the major bottlenecks in the utilization of the technology. The raw microarray data are images, which have to be transformed into gene expression matrices, tables where rows represent genes, columns represent various samples such as tissues or experimental conditions, and numbers in each cell characterize the expression level of the particular gene in the particular sample. These matrices have to be analyzed further if any knowledge about the underlying biological processes is to be extracted. In this paper we concentrate on discussing bioinformatics methods used for such analysis. We briefly discuss supervised and unsupervised data analysis and its applications, such as predicting gene function classes and cancer classification as well as some possible future

			directions.
Jaak	**Vilo**	Gene expression data analysis	Microarrays are one of the latest breakthroughs in experimental molecular biology, which allow monitoring of gene expression for tens of thousands of genes in parallel and are already producing huge amounts of valuable data. Analysis and handling of such data is becoming one of the major bottlenecks in the utilization of the technology, The raw microarray data are images, which have to be transformed into gene expression matrices - tables where rows represent genes, columns represent various samples such as tissues or experimental conditions, and numbers in each cell characterize the expression level of the particular gene in the particular sample. These matrices have to be analyzed further, if any knowledge about the underlying biological processes is to be extracted. In this paper we concentrate on discussing bioinformatics methods used for such analysis. We briefly discuss supervised and unsupervised data analysis and its applications, such as predicting gene function classes and cancer classification. Then we discuss how the gene expression matrix can be used to predict putative regulatory signals in the genome sequences. In conclusion we discuss some possible future directions.
Jaak	**Vilo**	Predicting gene regulatory elements in silico on a genomic scale	We performed a systematic analysis of gene upstream regions in the yeast genome for occurrences of regular expression-type patterns with the goal of identifying potential regulatory elements. To achieve this goal, we have developed a new sequence pattern discovery algorithm that searches exhaustively for a priori unknown regular expression-type patterns that are over-represented in a given set of sequences. We applied the algorithm in two cases, (1) discovery of patterns in the complete set of >6000 sequences taken upstream of the putative yeast genes and (2) discovery of patterns in the regions upstream of the genes with similar expression profiles. In the first case, we looked for patterns that occur more frequently in the gene upstream regions than in the genome overall. In the second case, first we clustered the upstream regions of all the genes by similarity of their expression profiles on the basis of publicly available gene expression data and then looked for sequence patterns that are over-represented in each cluster. In both cases we considered each pattern that occurred at least in some minimum number of sequences, and rated them on the basis of their over-representation. Among the highest rating patterns, most have matches to substrings in known yeast transcription Factor-binding sites. Moreover, several of them are known to be relevant to the expression of the genes from the respective clusters. Experiments on simulated data show that the majority of the discovered patterns are not expected to occur by chance.

Jaak	**Vilo**	Discovering unbounded unions of regular pattern languages from positive examples	The problem of learning unions of certain pattern languages from positive examples is considered. We restrict to the regular patterns, i.e., patterns where each variable symbol can appear only once, and to the substring patterns, which is a subclass of regular patterns of the type x alpha y, where x and y are variables and alpha is a string of constant symbols. We present an algorithm that, given a set of strings, finds a good collection of patterns covering this set. The notion of a 'good covering' is defined as the most probable collection of patterns likely to be present in the examples, assuming a simple probabilistic model, or equivalently using the Minimum Description Length (MDL) principle. Our algorithm is shown to approximate the optimal cover within a logarithmic factor. This extends a similar recent result for the so-called simple patterns. For substring patterns the running time of the algorithm is O(nN), where n is the number and N the total lenght of the sequences.
Jaak	**Vilo**	Implementing attribute grammars by computational models	We describe the implementation of attribute grammars with the knowledge-based system NUT. NUT uses intuitionistic propositional calculus for automatic synthesis of programs [2]. Penjam [3] discussed the connection between two formalisms - computational models, used in NUT system, and attribute grammars. We have developed this relation further. The system we are presenting is the extension of NUT and it allows automatic transformation from AG-representation to equivalent computational model (we call that the language model). NUT can then be used for automatic synthesis of tree-decoration algorithms for both - dynamic and static tree evaluation. For latter the algorithm synthesised is the multi-visit tree decoration algorithm.
Leo	**Võhandu**	A comparative-study of cancer registries in the German-Democratic-Republic and the Estonian-SSR	n.a.
Leo	**Võhandu**	New possibilities of data-analysis	n.a.
Tiina	**Zingel**	n.a.	n.a.
Enn	**Õunapuu**	n.a.	n.a.

Appendix 4: Aggregated publication data

Name	Surname	*Institution*	A	C	CPA	G
Margus	**Freudenthal**	Cybernetika	0	0	0	0
Rein	**Haavel**	Cybernetika	0	0	0	0
Kristo	**Heero**	Cybernetika	0	0	0	0
Harry	**Tani**	Cybernetika	0	0	0	0
Aivar	**Uisk**	Cybernetika	0	0	0	0
Kristiina	**Hakk**	IT Kol.	0	0	0	0
Kaido	**Kikkas**	IT Kol.	0	0	0	0
Martin	**Luts**	IT Kol.	0	0	0	0
Andres	**Mulin**	IT Kol.	0	0	0	0
Valdo	**Praust**	IT Kol.	0	0	0	0
Jaanus	**Pöial**	IT Kol.	0	0	0	0
Priit	**Raspel**	IT Kol.	0	0	0	0
Eduard	**Schults**	IT Kol.	0	0	0	0
Arvi	**Tavast**	IT Kol.	0	0	0	0
Tanel	**Alumäe**	Küb. Inst.	0	0	0	0
Arvo	**Eek**	Küb. Inst.	0	0	0	0
Hele-Mai	**Haav**	Küb. Inst.	0	0	0	0
Mait	**Harf**	Küb. Inst.	0	0	0	0
Vahur	**Kotkas**	Küb. Inst.	0	0	0	0
Mati	**Kutser**	Küb. Inst.	0	0	0	0
Marko	**Kääramees**	Küb. Inst.	0	0	0	0
Tanel	**Mullari**	Küb. Inst.	0	0	0	0
Ingmar	**Randvee**	Küb. Inst.	0	0	0	0
Mart	**Rohtla**	Küb. Inst.	0	0	0	0
Margit	**Aarna**	TTÜ	0	0	0	0
Marina	**Brik**	TTÜ	0	0	0	0
Julia	**Derkats**	TTÜ	0	0	0	0
Erki	**Eessaar**	TTÜ	0	0	0	0
Teet	**Evartson**	TTÜ	0	0	0	0
Jelena	**Fomina**	TTÜ	0	0	0	0
Alina	**Gavrijaseva**	TTÜ	0	0	0	0
Boris	**Gordon**	TTÜ	0	0	0	0
Ksenia	**Grigorjeva**	TTÜ	0	0	0	0
Raul	**Isotamm**	TTÜ	0	0	0	0
Eero	**Ivask**	TTÜ	0	0	0	0
Rein	**Jõers**	TTÜ	0	0	0	0
Taivo	**Kangilaski**	TTÜ	0	0	0	0
Toomas	**Kont**	TTÜ	0	0	0	0
Marko	**Koort**	TTÜ	0	0	0	0
Valeri	**Kozevnikov**	TTÜ	0	0	0	0
Valeri	**Kravets**	TTÜ	0	0	0	0
Helena	**Kruus**	TTÜ	0	0	0	0
Alar	**Kuusik**	TTÜ	0	0	0	0
Rein	**Kuusik**	TTÜ	0	0	0	0

Raul	**Land**	TTÜ	0	0	0	0
Paul	**Leis**	TTÜ	0	0	0	0
Harri	**Lensen**	TTÜ	0	0	0	0
Marion	**Lepmets**	TTÜ	0	0	0	0
Viktor	**Leppikson**	TTÜ	0	0	0	0
Raul	**Liivrand**	TTÜ	0	0	0	0
Grete	**Lind**	TTÜ	0	0	0	0
Eerik	**Lossmann**	TTÜ	0	0	0	0
Teodor	**Luczkowski**	TTÜ	0	0	0	0
Urve	**Madar**	TTÜ	0	0	0	0
Peep	**Matverk**	TTÜ	0	0	0	0
Ants	**Meister**	TTÜ	0	0	0	0
Harri	**Mägi**	TTÜ	0	0	0	0
Elmet	**Orasson**	TTÜ	0	0	0	0
Avo	**Ots**	TTÜ	0	0	0	0
Toivo	**Paavle**	TTÜ	0	0	0	0
Mihhail	**Pikkov**	TTÜ	0	0	0	0
Aimur	**Raja**	TTÜ	0	0	0	0
Karin	**Rava**	TTÜ	0	0	0	0
Andri	**Riid**	TTÜ	0	0	0	0
Tarmo	**Robal**	TTÜ	0	0	0	0
Mart	**Roost**	TTÜ	0	0	0	0
Andres	**Rähni**	TTÜ	0	0	0	0
Aleksander	**Sudnitsõn**	TTÜ	0	0	0	0
Arvo	**Toomsalu**	TTÜ	0	0	0	0
Ants	**Torim**	TTÜ	0	0	0	0
Ermo	**Täks**	TTÜ	0	0	0	0
Jelena	**Vendelin**	TTÜ	0	0	0	0
Tarmo	**Veskioja**	TTÜ	0	0	0	0
Vladimir	**Viies**	TTÜ	0	0	0	0
Tiina	**Zingel**	TTÜ	0	0	0	0
Enn	**Õunapuu**	TTÜ	0	0	0	0
Heldur	**Haak**	TTÜ/IT Kol.	0	0	0	0
Juhan-Peep	**Ernits**	TTÜ/Küb. Inst.	0	0	0	0
Ahto	**Kalja**	TTÜ/Küb. Inst.	0	0	0	0
Ain	**Isotamm**	TÜ	0	0	0	0
Kaili	**Müürisepp**	TÜ	0	0	0	0
Härmel	**Nestra**	TÜ	0	0	0	0
Rein	**Prank**	TÜ	0	0	0	0
Tiit	**Roosmaa**	TÜ	0	0	0	0
Tõnu	**Tamme**	TÜ	0	0	0	0
Eno	**Tõnisson**	TÜ	0	0	0	0
Heli	**Uibo**	TÜ	0	0	0	0
Anne	**Villems**	TÜ	0	0	0	0
Sven	**Heiberg**	Cybernetika	1	0	0	1
Uuno	**Puus**	Cybernetika	1	0	0	1
Asko	**Seeba**	Cybernetika	1	0	0	1

Viljo	**Soo**	IT Kol.	1	0	0	1
Einar	**Meister**	Küb. Inst.	1	0	0	1
Tiit	**Riismaa**	Küb. Inst.	1	0	0	1
Irina	**Amitan**	TTÜ	1	0	0	1
Ilmar	**Arro**	TTÜ	1	0	0	1
Igor	**Astrov**	TTÜ	1	0	0	1
Artur	**Jutman**	TTÜ	1	0	0	1
Margus	**Kruus**	TTÜ	1	0	0	1
Vello	**Kukk**	TTÜ	1	0	0	1
Rein	**Paluoja**	TTÜ	1	0	0	1
Ennu	**Rüstern**	TTÜ	1	0	0	1
Andres	**Taklaja**	TTÜ	1	0	0	1
Stanislav	**Vassiljev**	TTÜ	1	0	0	1
Jüri	**Vilipõld**	TTÜ	1	0	0	1
Krista	**Strandson**	TÜ	1	0	0	1
Mati	**Tombak**	TÜ	1	0	0	1
Varmo	**Vene**	TÜ/Küb. Inst.	1	0	0	1
Rein	**Kipper**	Cybernetika	2	0	0	2
Meelis	**Roos**	Cybernetika	1	1	1	2
Toomas	**Lepikult**	IT Kol.	1	1	1	2
Peeter	**Ellervee**	TTÜ	2	0	0	2
Tõnu	**Näks**	TTÜ	1	1	1	2
Kalle	**Tammemäe**	TTÜ	2	0	0	2
Jüri	**Kiho**	TÜ	2	0	0	2
Mare	**Koit**	TÜ	2	0	0	2
Märt	**Saarepera**	Cybernetika	2	1	0,5	3
Maarja	**Kruusmaa**	IT Kol.	3	0	0	3
Kaarel	**Allik**	TTÜ	2	1	0,5	3
Jaak	**Henno**	TTÜ	2	1	0,5	3
Jaak	**Tepandi**	TTÜ	3	0	0	3
Arne	**Ansper**	Cybernetika	2	2	1	4
Sven	**Nõmm**	Küb. Inst.	3	1	0,33	4
Oleg	**Korolkov**	TTÜ	4	0	0	4
Jaan	**Raik**	TTÜ	4	1	0,25	5
Jüri	**Vain**	TTÜ/Küb. Inst.	3	2	0,67	5
Maris	**Tõnso**	Küb. Inst.	2	4	2	6
Olev	**Märtens**	TTÜ	3	3	1	6
Monika	**Oit**	Cybernetika	1	6	6	7
Johan	**Anton**	Küb. Inst.	2	5	2,5	7
Ants	**Ronk**	TTÜ	2	5	2,5	7
Ander	**Tenno**	TTÜ	3	4	1,33	7
Tarmo	**Uustalu**	TTÜ/Küb. Inst.	7	2	0,29	9
Leo	**Võhandu**	TTÜ	2	8	4	10
Olga	**Sokratova**	TÜ	7	4	0,57	11
Raimund	**Ubar**	TTÜ	11	1	0,09	12
Sergei	**Tupailo**	Küb. Inst.	5	8	1,6	13
Martin	**Min**	TTÜ	4	9	2,25	13

Toomas	**Parve**	TTÜ	4	9	2,25	13
Ülo	**Nurges**	TTÜ/Küb. Inst.	5	8	1,6	13
Jan	**Villemson**	TÜ	4	12	3	16
Helle	**Hein**	TÜ	5	13	2,6	18
Leo	**Mõtus**	TTÜ	13	6	0,46	19
Toomas	**Rang**	TTÜ	14	5	0,36	19
Peeter	**Laud**	TÜ	4	15	3,75	19
Ahto	**Buldas**	TTÜ/TÜ	4	17	4,25	21
Jaan	**Penjam**	TTÜ/Küb. Inst.	7	16	2,29	23
Andres	**Udal**	TTÜ	12	14	1,17	26
Enn	**Velmre**	TTÜ	14	11	0,78	25
Leo	**Ainola**	Küb. Inst.	13	19	1,46	32
Tanel	**Tammet**	TTÜ	10	45	4,5	55
Enn	**Tõugu**	Küb. Inst.	33	39	1,18	72
Ülle	**Kotta**	Küb. Inst.	30	80	2,67	110
Hillar	**Aben**	Küb. Inst.	30	88	2,93	118
Jaak	**Vilo**	TÜ	14	734	52,42	748
		TOTAL	**326**	**1202**	**3,69**	**1528**

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