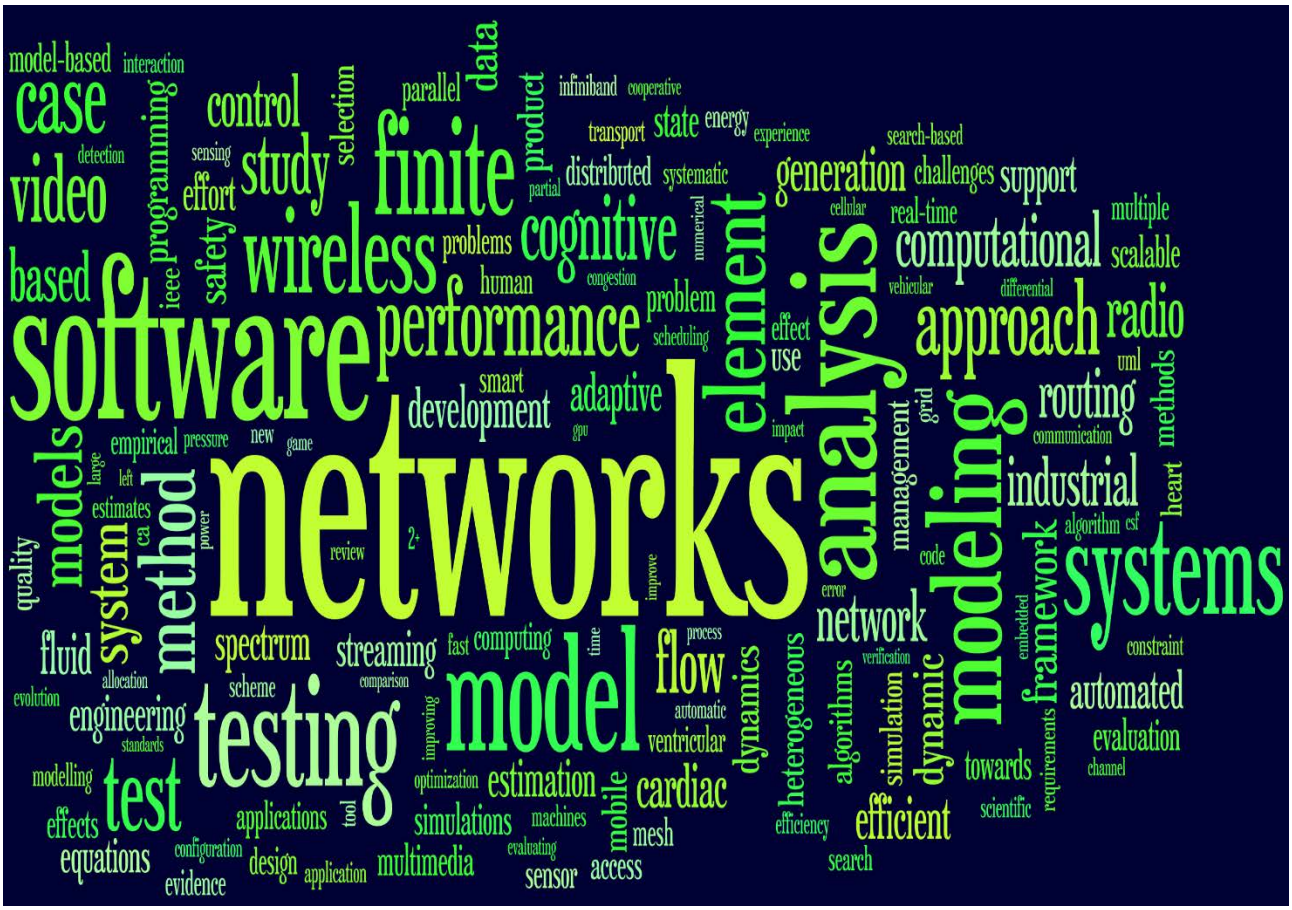

Simula Research Laboratory

Publication analysis 2009-2015

Dag W. Aksnes

Working Paper 2016:4

NIFU

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Preface

This report presents a bibliometric analysis of Simula Research Laboratory and is a background report for the forthcoming evaluation of the institute. The report, which has been commissioned by Simula, is written by Research Professor Dag W. Aksnes at the Nordic Institute for Studies in Innovation, Research and Education (NIFU).

Oslo, 12.04.16

Sveinung Skule
Director

Susanne L. Sundnes
Head of Research

Contents

Main findings

- The analysis shows that Simula has contributed to approximately 1,060 publications in approved publication channels during the time-period 2009-2015. The three Simula research areas are relatively equal in size/total publication volume. The number of publications are approximately 400 publications for Communication System, 370 for Scientific Computing and 300 for Software Engineering.

- The proportion of publications in the most prestigious publication channels (level 2) is 25 percent in the period 2012-2014. With this, Simula ranks as number two of six Norwegian departments selected for the analysis.

- Overall, Simula performs very well in terms of scientific impact measured through citations. The WoS-indexed publications obtain a citation index of 139, which means that the articles have been cited 39 % more than the field normalised world average. The citation index is highest for the Communication System research area (164), and then follows Software Engineering with a citation index of 134, while the Scientific Computing has an index value of 118.

- The extent of international collaboration measured through co-authorship is very high. Of the WoS indexed articles, 69 % had co-authors from other countries. This is clearly above the national (Norwegian) average, which is 55-60 % during the period.

1 Introduction, data & methods

The purpose of the present analysis is to give an overview of the publication output of Simula Research Laboratory. The publication analysis covers the time-period 2009-2015. Simula is organised in three research areas and analyses are carried out for each of the research areas, in addition to analyses at an overall level. A variety of different indicators of the publication output have been included such as publication volume, publication type, citation indicators and scientific collaboration based on co-authorship.

In contrast to most other research institutes in Norway, Simula does not apply the national publication database, CRIStin, for registering of the publication output. Instead, all publications and other types of research output are registered in an in-house database. This database is applied in the present study. The database is assumed to have an almost complete coverage of the scientific publication output of the Simula employees. In addition, it includes data on other kinds of research output, such as lectures, talks, and reports. The coverage of the latter output dimension is, however, less systematic and is paid scant attention in the present report. It should be noted that works carried out by the Simula employees before they became affiliated with the institute, is not included in the database, at least this is the general principle. Within the scope of the present analysis, we have not been able to verify each publication and the validity of the bibliographic data. Probably, some mistakes may occur in the registered data, for example concerning publication type and publication year. Thus, these aspects should be taken into account when interpreting the results.

From Simula we received an extract from the database as a csv-file. A first analysis was carried out in 2014, covering the publications from the period 2009-2013. This analysis has now been updated with publication data from the years 2014 and 2015. In addition, new analyses have been added the previous analysis. As a part of the process, the publication data received have been further processed by NIFU. This includes deletion of duplicates, reclassifications, standardisation of journal names, inclusion of Web of Science IDs, and publication channel levels (see below).

It should be noted that as a consequence of the reclassification carried out as part of the project, the figures in the report may differ slightly from the ones that would appear when using the database directly. For example, the distinction between non-refereed and refereed proceedings papers has not been applied in the project (although there only is a minor number of non-refereed proceedings papers registered). Instead, these papers have been reclassified according to publication channels. Moreover, a some extra publications may have been added the database after the data were extracted from the database.

2 Overall analysis

Figure 1 shows the number of Simula publications/records by publication type and year. All types of publications and other research output are included in the figure. There has been an increase in the overall volume, particularly the two most recent years, 2014 and 2015. The largest category is the one for “miscellaneous” contributions (lectures, talks etc.). If this category is excluded, the total publication output has varied from 155 (2010) to 238 (2015) during the time-period. There was a decline from 2009 to 2010. Then the output volume was fairly stable during the period 2010-2013, with a significant increase from 2013 to 2014.

Figure 1. Number of publications/records by publication type and year. Simula total 2009-2015.

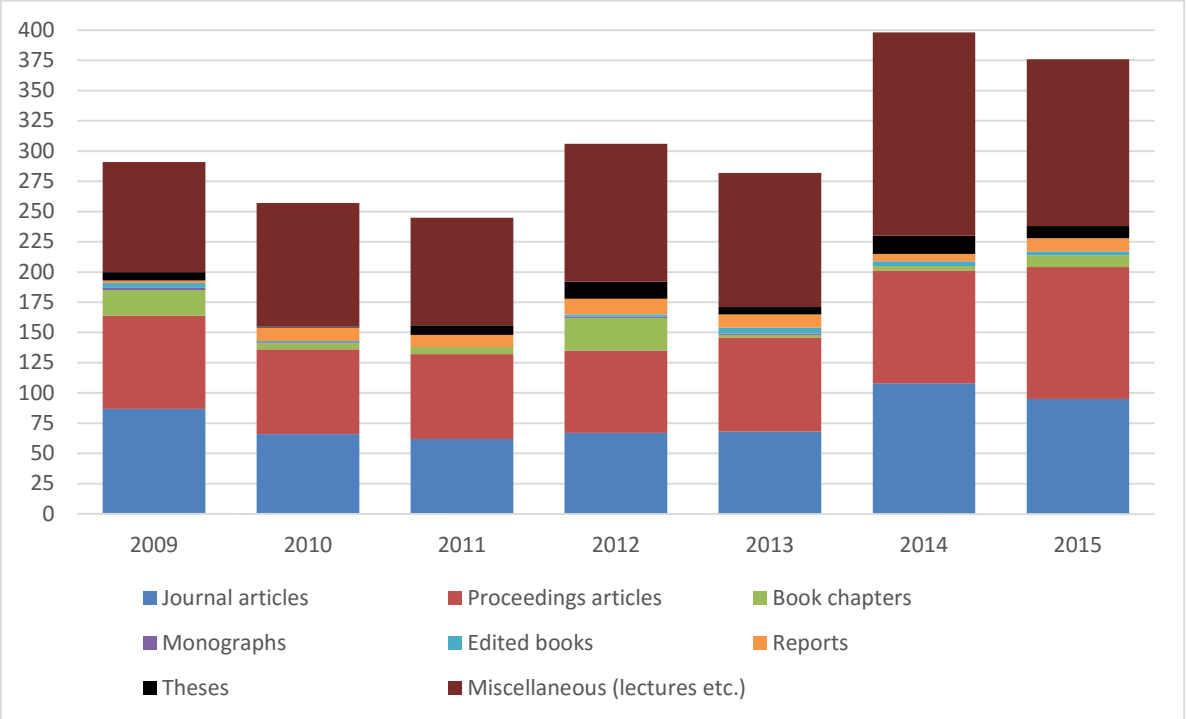
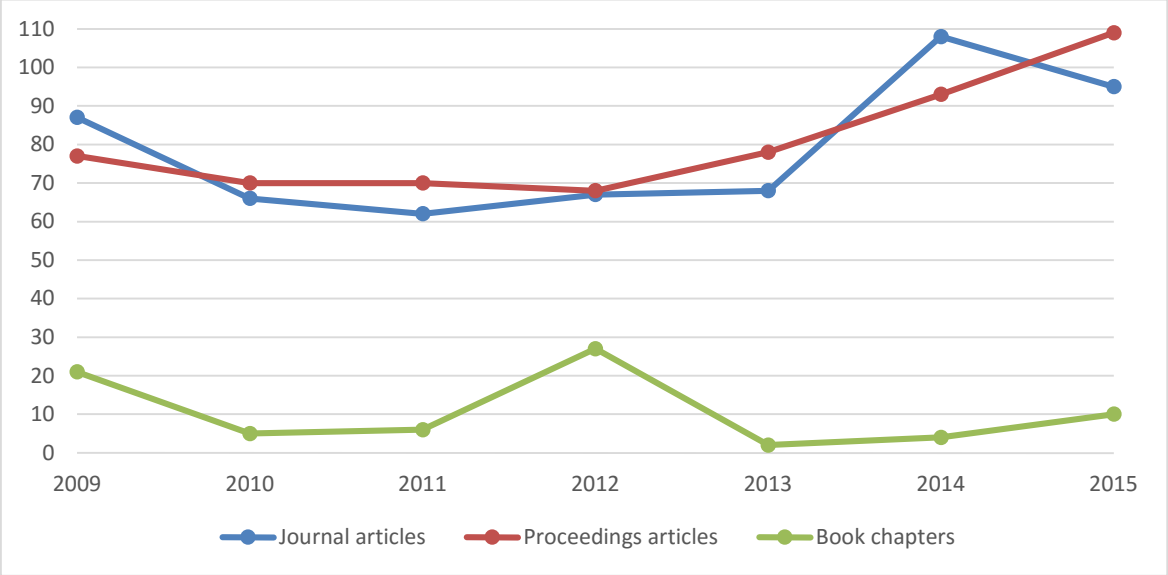


Figure 2 shows the publication output of Simula for the three largest publication types: journal articles, proceedings papers, and book chapters. As can be seen, publishing in journals and proceedings has

an almost equal distribution at Simula. For both publication types, the number decreased from 2009 to 2010, but increased significantly from 2013 to 2014/2015. In 2015, 95 journal articles were published and 109 proceedings articles. The number of articles in books is significantly lower and shows annual variations. In 2015, 10 book-chapters were published.

Figure 2. Number of publications by publication type (journal articles, proceedings papers, and book chapters) and year. Simula total 2009-2015.



The publication patterns differ significantly across Simula research areas. This is shown in Figure 3. The research area Scientific Computing has by far the largest number of contributions in the category “miscellaneous”. Thus, this suggests that the research area has the most outreach activity, although it should be taken into consideration that the data quality for this category is less good, and not all contributions may have been indexed in the database.

In the remaining analyses of the report, we have not included the contributions in the “miscellaneous” category. From figure 3, it is apparent that when this category is excluded the three research areas are relatively equal in size/total publication volume. The research areas Communication Systems and Scientific Computing have approximately 480 publications during the period, while Software Engineering has almost 400.

Figure 3. Number of publications/records by publication type and research area (total 2009-2015).

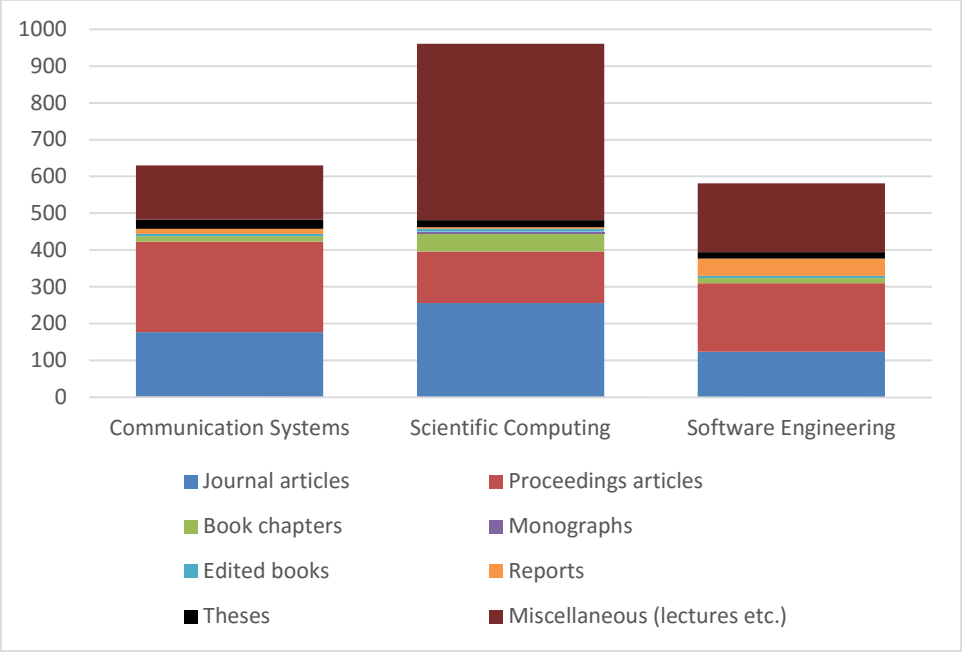


Figure 4 shows the relative distribution of the different publication types by research areas. Scientific Computing has a publication profile where journal publishing is more important than what is the case for the two other research areas. Approximately half of the publication output of the two latter research areas are proceedings articles. Altogether, journal articles and proceedings articles dominate the publication output of all research areas, accounting for 78-88 percent of the publication volume. Thus, there are relatively few publications in the other categories: book chapters, monographs (single books with one or more authors), edited books, reports, and theses. The exceptions are Scientific Computing with 49 book chapters and Software Engineering with 47 reports during the period.

Figure 4. Proportion of publications by publication type and research area (total 2009-2015).

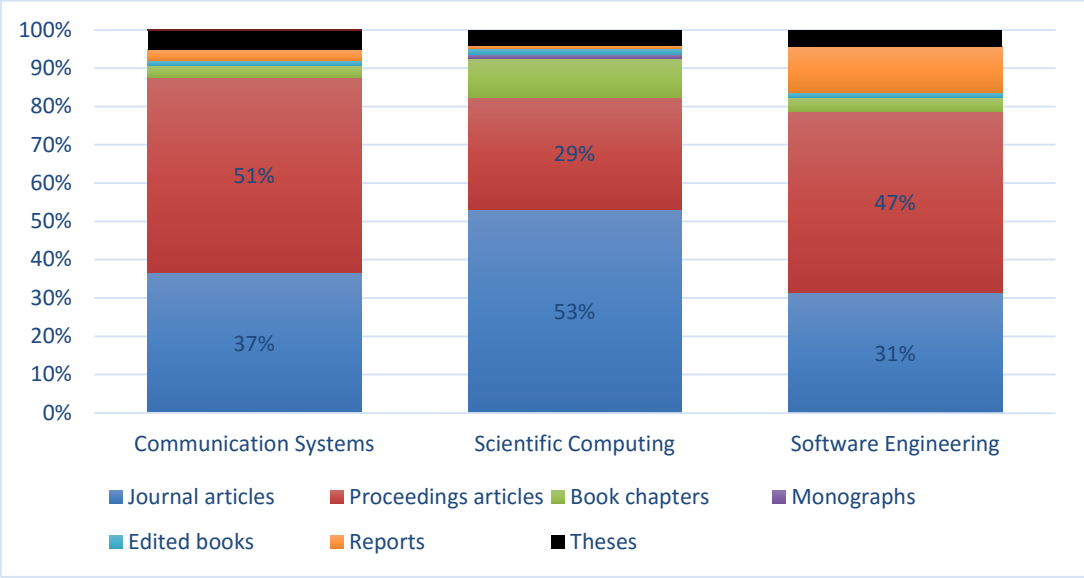
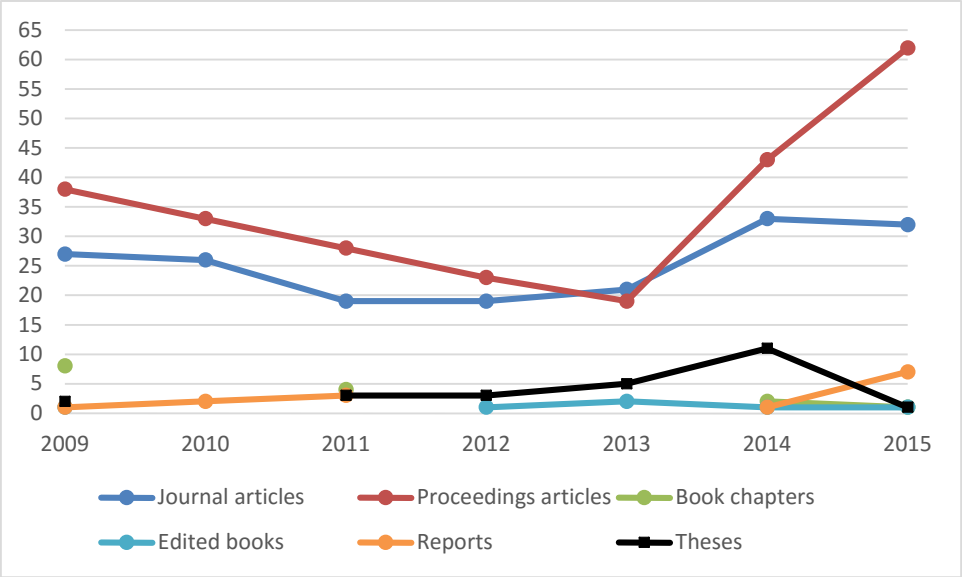


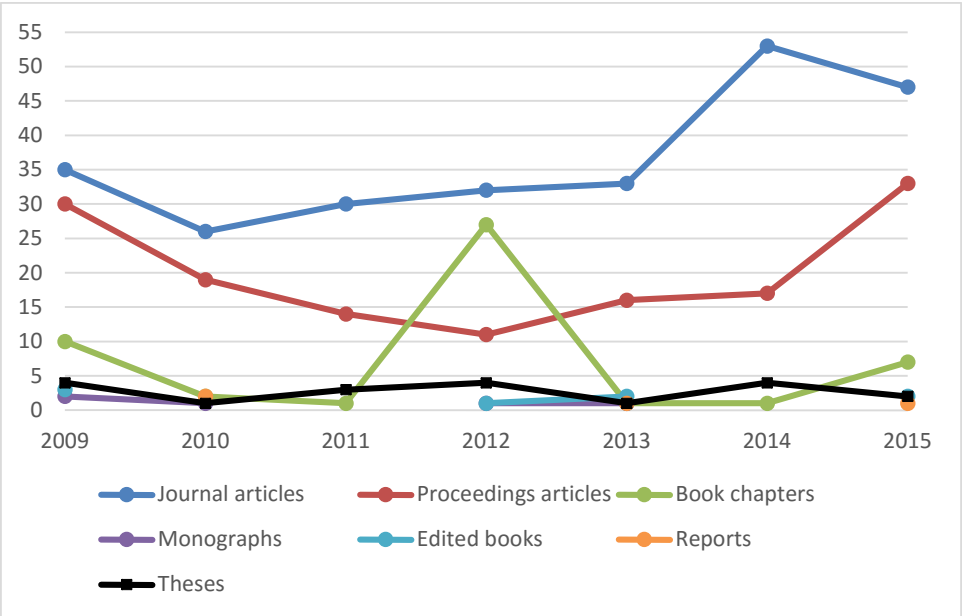
Figure 5a-c shows the number of publications by research areas, publication type and year. For Communication System (Figure 5a), the number of proceedings articles has increased significantly from 2013, and there is also a marked increase in the number of journal articles compared to the period 2011-2013.

Figure 5a. Number of publications by publication type and year. Communication System



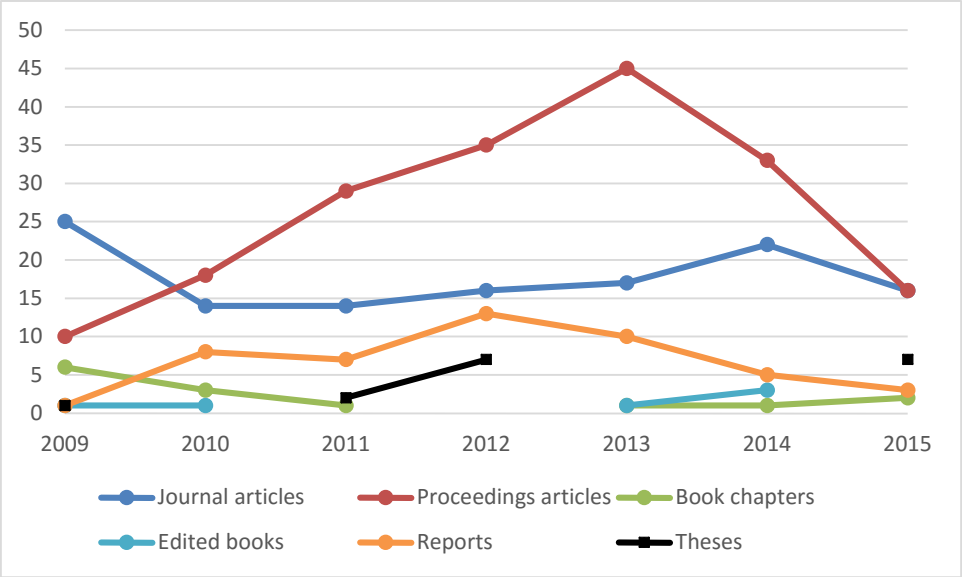
For the Scientific Computing department, the number of journal articles and proceedings articles has increased significantly from 2013 to 2014/2015. In 2015, 47 journal articles were published compared to 25-33 in the 2010-2013 period. The corresponding figures for proceedings papers were 33 and 16-19, respectively.

Figure 5b. Number of publications by publication type and year. Scientific Computing



The publication numbers of the Software Engineering research area, on the other hand, show a declining pattern the two recent years and the number of proceedings papers fell from 45 in 2013 to 16 in 2015. The number of journal articles, however, has been quite stable during the 2010-2015 period.

Figure 5c. Number of publications by publication type and year. Software Engineering



In Norway, publication indicators are included in a performance-based funding system of research institutes, hospitals and higher education institutions. The funding formula for publication activity includes two dimensions. First, articles in journals and series (ISSN-titles), articles in books and books/monographs (ISBN-titles) are given different weights. Moreover, publication outlets are divided into two levels in order to avoid an incentive to productivity only. The outlets given extra weight (level 2) are those defined to be the leading and most selective international journals, series and publishers (limited to about 20 per cent of the publications). In the system, only publications published in journals and by publishing houses classified as scientific/scholarly by the Norwegian Association of Higher Education Institutions (UHR) are included. The national academic councils in each discipline or field of research participate annually in determining and revising the list of approved publication channels. As part of the process, researchers may suggest publication channels for approval and nomination to level 2. These suggestions are reviewed by the national academic councils in each discipline.

In order to compare the research output of Simula with those of other Norwegian departments and institutes, we have classified each publication according to whether or not it is published in a channel included in Norwegian Register for Scientific Journals, Series and Publishers. Type of publications that will not be included in this register include proceeding papers which are not published by a scientific publishing house/scientific society. Other example are unpublished PhD-dissertations, grey literature such as reports, as well as popular science articles. Thus, the system covers publications primarily directed towards the scientific community, but not other types of research disseminations.

Table 1 shows the results of the analysis for the period 2009-2015. As can be seen, almost all articles in journals are published in approved channels. Also, the large majority of the proceedings articles and book chapters are published in approved channels. For the other publication types, there are none publications in approved channels. However, this may also be due to the fact that the publication type is not approved. For example, textbooks, revised books with none or minor changes as well as

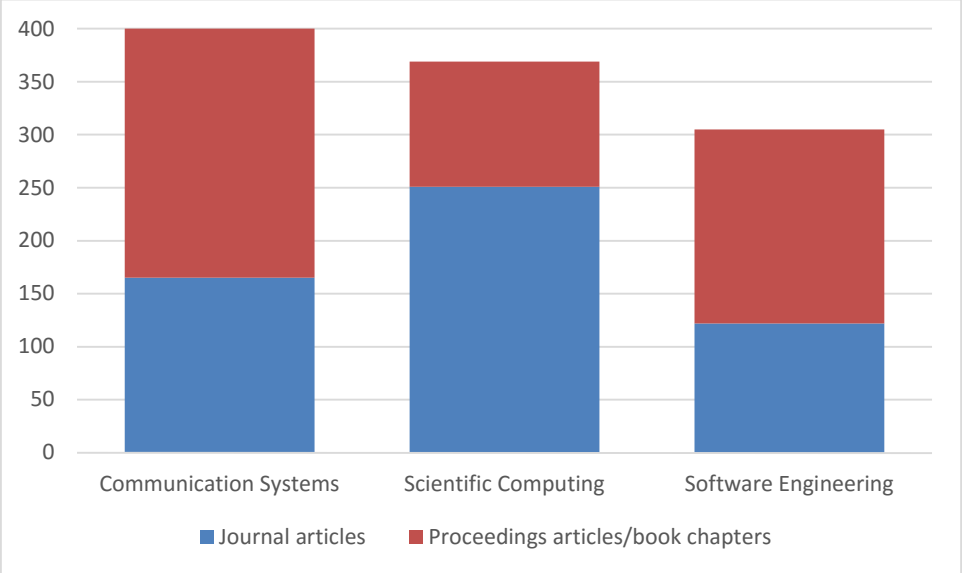
editorial book publications are not approved as publication types in the system. It should also be noted that in the classification, we have not examined each publication in detail, and cases of misclassifications and doubts may occur.

Table 1. Number of records by type, approved and not approved publication channels (according to the Norwegian Register for Scientific Journals, Series and Publishers). Simula total 2009-2015.

	Approved channels	Not approved channels	Total	% in approved channels
Journal articles	534	19	553	97%
Proceedings articles	460	105	565	81%
Book chapters	67	8	75	89%
Monographs	0	5	5	0%
Edited books	0	19	19	0%
Reports	0	64	64	0%
Theses	0	61	61	0%
Miscellaneous (lectures etc.)	0	813	813	0%
Total	1061	1094	2155	

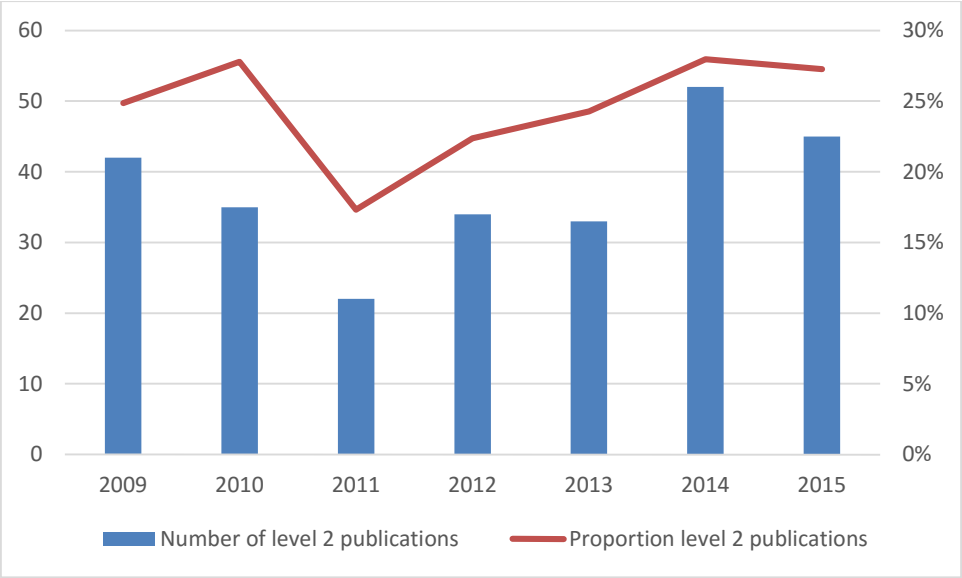
In figure 6, we have for each research area shown the number of articles which has been published in approved channels. The figures are approximately 400 articles for Communication System, 370 for Scientific Computing and 300 for Software Engineering.

Figure 6. Number of approved articles by publication types and research areas (total 2009-2015).



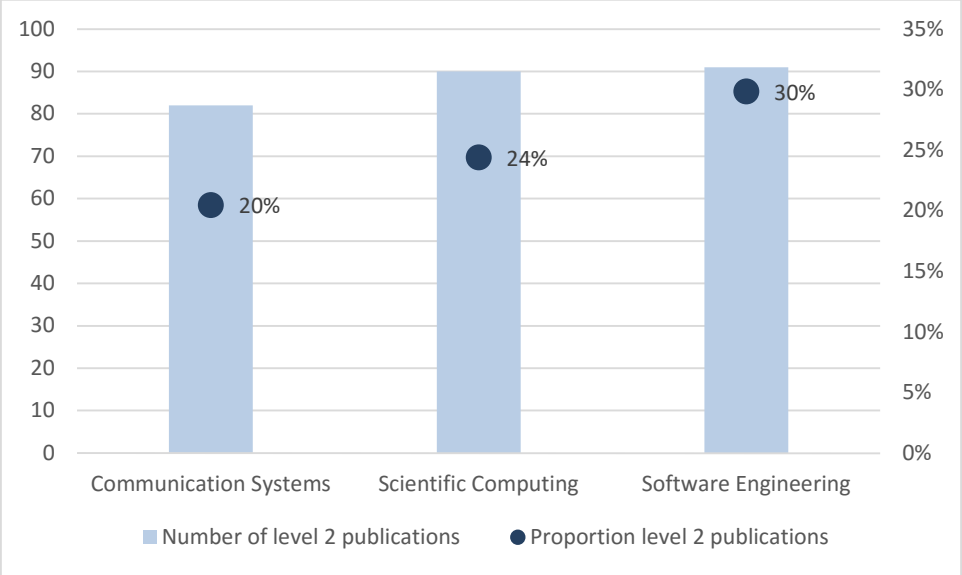
Based on the articles in approved channels, we have calculated the number and proportion of articles in the most prestigious channels, level 2, cf. Figure 7. The annual numbers have been in the range of 30-50 for most of the years in the 2009-2015 period, with the highest numbers in the two most recent years. The proportion of level 2 publications has been increasing since 2011, and amounted to 27 and 29 per cent in 2014 and 2015, respectively. It should be noted that the level 2 publications mainly represent journal articles.

Figure 7. Number and proportion of level 2 publications. Simula total 2009-2015.



The number and proportion of level 2 publications is lowest for the Communication Systems research area and highest for the Software Engineering research area (cf. Figure 2). Based on the premise that level 2 includes the leading and most selective international journals and publishers, high shares here indicate high ambitions when selecting journals for publication and a high quality of the research. On the other hand, it should be noted that in some subfields, particular publication patterns where level 2 publishers are few or less relevant may explain low proportions of level 2 publications. Moreover, as Simula is not part of the performance based-funding system, the institute has no incitement to suggest publication channels for approval and nomination to level 2. This affects the relevance of the indicator. Nevertheless, we have included indicators using the classification system because it is the common standard for measuring publication productivity in Norway.

Figure 8. Number and proportion of level 2 publications by research area (total 2009-2015).



The publications are distributed across a large number of different journals, series and publishers. However, the frequency distribution is skewed, and some journals are more important than others are. Tables 2a-c give the publication counts for the most frequently used journals for each research area (based on the period 2009–2015). From the list of journals, one gets an impression of the overall research profile of the research areas.

Table 2a. The most frequently used journals, number of publications 2009–2015.* Communication Systems

Journal	Level	No. articles
IEEE Transactions on Vehicular Technology	2	14
IEEE Network	2	9
IEEE COMMUNICATIONS MAGAZINE	2	8
IEEE Journal on Selected Areas in Communications	2	7
MOBILE NETWORKS & APPLICATIONS	1	6
IEEE Transactions on Smart Grid	1	6
Wireless Communications & Mobile Computing	1	6
IEEE Systems Journal	1	5
IEEE MMTC R-Letter	0	5
IEEE Transactions on Wireless Communications	2	4
IEEE wireless communications	2	4
Multimedia Tools and Applications	1	4
IEEE Transactions on Communications	2	4
IEEE/ACM Transactions on Networking	2	4
Journal of Supercomputing	1	4
ACM Transactions on Multimedia Computing, Communications and Applications	2	4
Computer Networks	2	4
Computer Communications	1	4
IEEE Transactions on Parallel and Distributed Systems	2	3
Wireless personal communications	1	3
International Journal of Multimedia Data Engineering and Management (IJMDEM)	0	3

*) Limited to journals with at least three publications during the time-period.

Table 2b. The most frequently used journals, number of publications 2009–2015.* Software Engineering

Journal	Level	No. articles
Information and Software Technology	2	26
IEEE Transactions on Software Engineering	2	18
Software and Systems Modeling	2	9
Journal of Systems and Software	2	8
ACM Transactions on Software Engineering and Methodology	2	8
Empirical Software Engineering	2	7
IEEE Software	2	5
Software testing, verification & reliability	1	4
Software, Practice & Experience	1	3

*) Limited to journals with at least three publications during the time-period.

Table 2c. The most frequently used journals, number of publications 2009–2015.* Scientific Computing

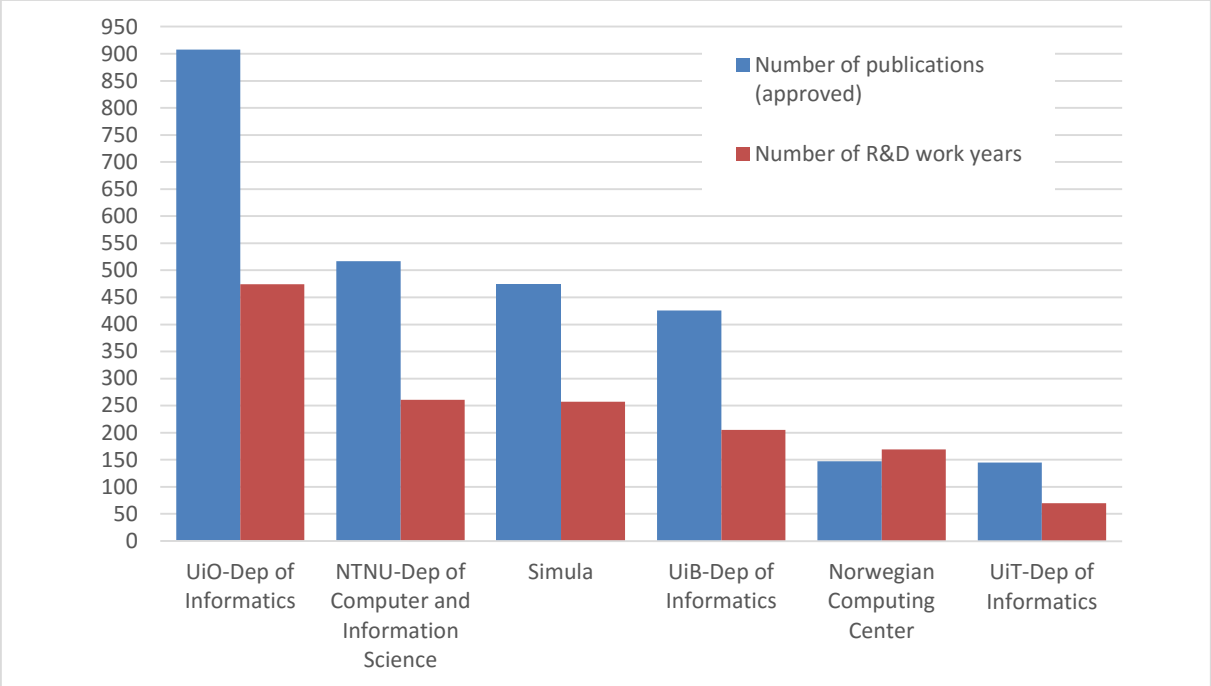
Journal	Level	No. articles
Computer Methods in Applied Mechanics and Engineering	2	11
American Journal of Neuroradiology	1	9
SIAM Journal on Scientific Computing	2	9
International Journal for Numerical Methods in Engineering	2	6
Journal of Biomechanics	2	6
American Journal of Physiology. Heart and Circulatory Physiology	2	6
Numerische Mathematik	2	6
Biomechanics and Modeling in Mechanobiology	1	5
Biophysical Journal	2	5
Journal of Physiology	2	5
Computer Methods in Biomechanics and Biomedical Engineering	1	4
Neuroradiology Journal	1	4
International Journal for Numerical Methods in Biomedical Engineering	1	4
Computational Mechanics	1	4
Mathematical Biosciences	1	4
Computational Science & Discovery	1	4
Frontiers in Physiology	1	4
SIAM Journal on Numerical Analysis	2	3
IEEE Transactions on Biomedical Engineering	1	3
Journal of Biomechanical Engineering	1	3
ACM Transactions on Mathematical Software	2	3
Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences	1	3
Mathematical Biosciences and Engineering	1	3
PLoS Computational Biology	2	3
International Journal of Numerical Analysis & Modeling	1	3
Journal of Computational Science	1	3
Journal of Molecular and Cellular Cardiology	1	3
Communications in Computational Physics	1	3
Advances in Water Resources	1	3

*) Limited to journals with at least three publications during the time-period.

In order to compare the scientific output of Simula with other relevant Norwegian departments, we have collected publication statistics for a few other units. The total number of publications for the three-year period 2012-2014 is shown in Figure 9. As can be seen, Simula ranks as number three in terms of publication volume of the selected units. The Department of Informatics at the University of Oslo (UiO) is by far the largest unit, with a publication volume almost twice as large as Simula. Figure 9 also includes data on number of R&D work years by the selected departments. As expected, The Department of Informatics at UiO is also the largest department in terms of work years. Simula also ranks as the third largest department in terms of R&D work years, with a number marginally below the one of NTNU (Department of Computer and Information Science).

There are differences among the institutes in terms of the degree to which their R&D activities actually result in scientific publications. This is evident by comparing the publication numbers by the number of R&D work years. However, it should also be taken into consideration that the institutes are heterogeneous in terms of their R&D activities. Some institutes have a stronger focus on basic research than others, typically leading them to produce larger numbers of scientific publications. Other have a profile dominated by services and technology development where scientific publishing is less relevant.

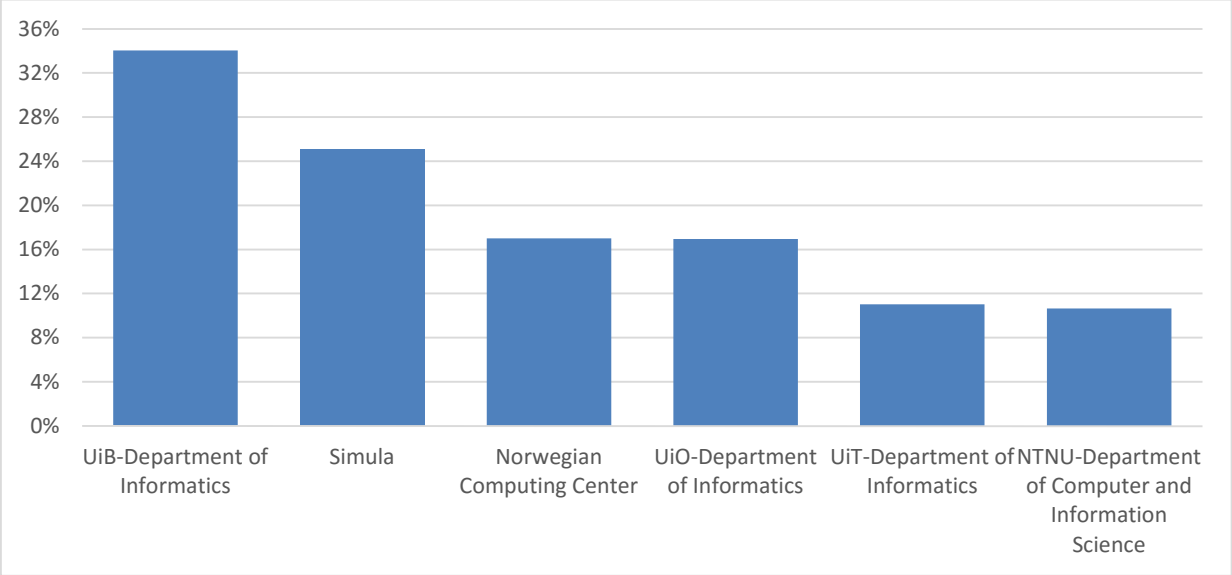
Figure 9. Total number of publications (approved) and total number of R&D work years for selected departments (total 2012-2014).



Source: Simula, NSD/DBH, NIFU/Nøkkeltalldatabasen. Number of R&D work years refers to number of "UFF-årsverk" (number of work years by scientific personnel (including PhD students)).

The proportion of level 2 publications for the selected units is shown in Figure 10 (average for the 2012-2014 publications). Here Simula ranks as number two of the departments selected for the analysis with a proportion of 25 per cent. Only the Department of Informatics at the University of Bergen (UiB) has a higher proportion. Please note that these figures are based on publication numbers and not on author fractions (which is used in the official Norwegian publication statistics).

Figure 10. Proportion of level 2 publications for selected departments (total 2012-2014).



3 Analysis of WoS-indexed journal articles

In order to assess the citation frequency and collaboration pattern of Simula, we have performed an additional analysis using the Web of Science (WoS) database. The edition of WoS applied, covers the three citation indexes: Science Citation Expanded; Social Sciences Citation Index; and Arts & Humanities Citation Index, but not the two additional indexes of Web of Science: The Conference Proceedings Citation Index, and The Book citation index (the two latter indexes have not been purchased by NIFU and are not available for analyses).

Basically, the WoS-database applied covers articles in international scientific journals. It is important to emphasise that the ICT field is only moderately well covered in this database. This is due to the particular publication pattern of ICT research where proceedings papers play an important role, most of this output will not be covered by the database. For Simula, this means that the citation and collaboration indicators provided in this chapter are based on a limited part of the research output (although probably the most important). This is important to consider when interpreting the results. The issue is further analysed below.

Other databases exist which cover the ICT field better. These databases are however not as well adapted for bibliometric analyses as the WoS-database, and have not been available to us. Citations counts can also be retrieved from Google Scholar which has a much broader coverage of the research literature. Accordingly, the citation counts in absolute numbers would have been much higher if this database had been used. Unfortunately, the data quality is not very good, and it is difficult to distinguish between researchers sharing the same name. Google Scholar has no 'quality' test inherent in the way it collects citations – it simply counts any citation it can identify in a document that appears to be a report, book or journal and only counts the citation for as long as the citing document is visible on the World Wide Web. Therefore, this database has not been applied in the report.

We have identified the citation counts of the Simula journal articles which are indexed in the applied WoS-database. The calculation of citation indicators has been based on aggregated bibliometric statistics at country and field/subfield level. The individual articles and their citation counts represent the basis for the citation indicators. In the citation indicators we have used accumulated citation counts. The edition of WoS applied in the study, covers the period up to and including 2014 (2015-figures were not available at the time the study was carried out). This means that for the articles published in 2010, for example, citations are counted over a 5-year period (2010-2014), while for the articles published in 2012, citations are counted over a 3-year period (or more precisely a 2-3 year period: the year of publication, 2013 and 2014). Citations the publications have received in 2015 and 2016 are not included in the citation counts. Articles from 2014 are not included in the citation analysis, as these have not been available in the literature for a sufficiently long time to be cited. To a

certain extent, this also holds for the 2013 articles. We have, however, included these articles, but it is 'expected' that these articles are uncited or very poorly cited.

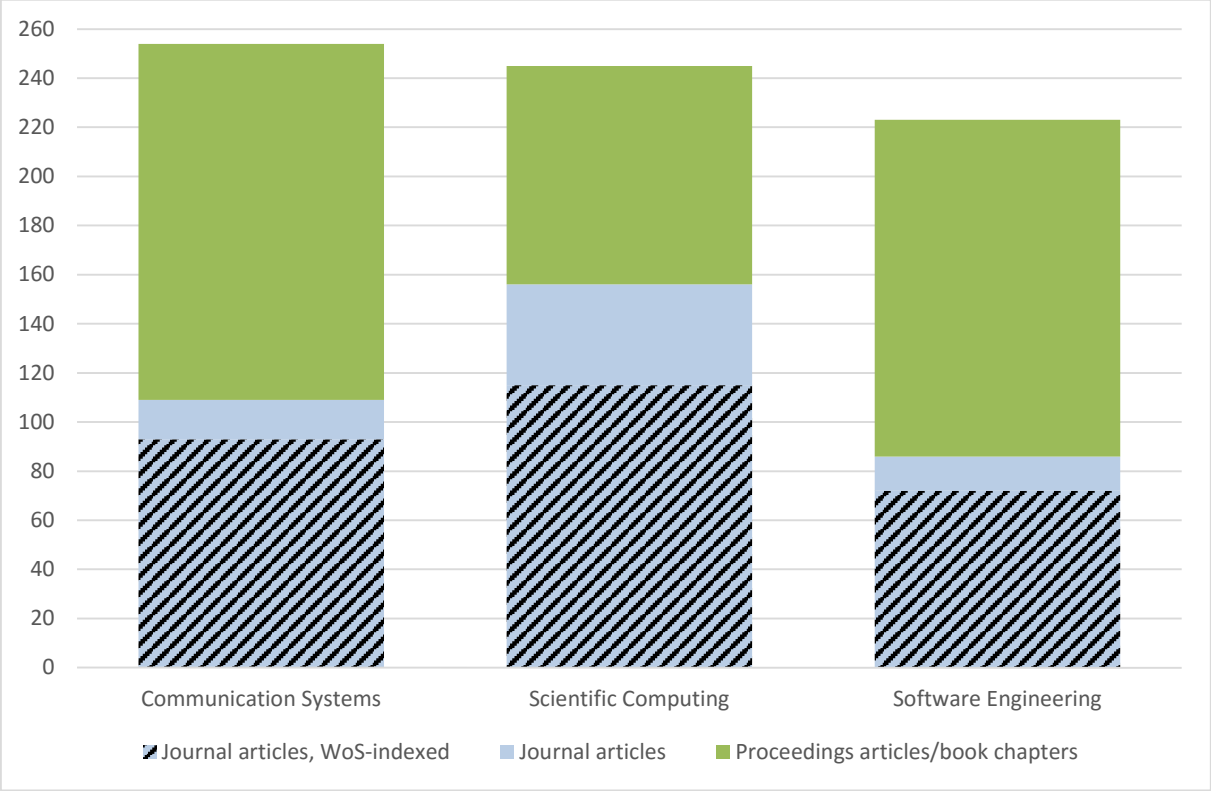
The average citation rate varies a lot between the different scientific disciplines. As a response, various reference standards and normalisation procedures have been developed. The most common is the average citation rates of the field in which the particular papers have been published. In the analysis, we have used the world and Norwegian field averages for comparing the citation counts of Simula. A relative citation index is calculated as the ratio between the average citation rate of Simula's articles and the average subfield citation rate. In this way, the indicator shows whether the Simula articles are cited below or above the world and Norwegian average of the subfields in which the institute is active.

The following guide can be used when interpreting the relative citation index:
Citation index: > 150: Very high citation level.
Citation index: 120-150: High citation level, significant above the world average.
Citation index: 80-120: Average citation level. On a level with the international average of the field (= 100).
Citation index: 50-80: Low citation level.
Citation index: < 50: Very low citation level.

It should be emphasised that the indicators cannot replace an assessment carried out by peers. In the cases where an institute is poorly cited, one has to consider the possibility that the citation indicators in this case do not give a representative picture of the research performance. Citations have highest validity in respect to high index values. But precautions should be taken also here. For example, in some cases one highly cited researcher or one highly cited publication might strongly improve the citation record of a group or even a department. Citations mainly reflect intra-scientific use. In a field like ICT, with strong technological and applied aspects it is important to be aware of this limitation. Practical applications and use of research results will not necessarily be reflected through citation counts.

Figure 11 shows the number of WoS articles for the Simula research areas. As can be seen, the large majority of the journal articles are indexed in WoS, although the proportion is lower for the Scientific Computing research area (74 % compared to 84 and 85 % for the two other research areas).[1] Compared with the total publication output in journals and books/proceedings (NVI approved), the proportions are much lower: 32 % for Software Engineering, 37 % for Communication Systems and 47 % for Scientific Computing. Thus, the analyses of citations (and collaboration, below) are based on a limited part of the overall research output. Also other units within the ICT field are affected by the coverage problem, and an analysis of WoS-publications still gives interesting information of the scientific performance.

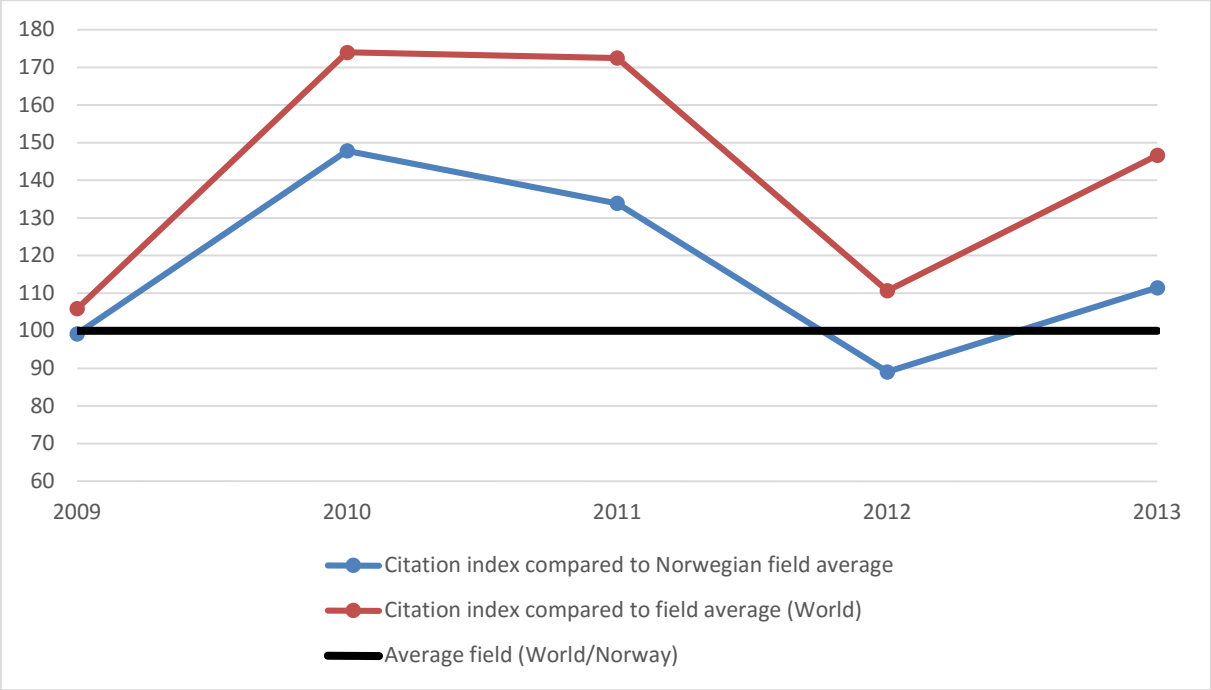
Figure 11. Number of articles (NVI approved) by publication types, and research areas (total 2009-2013).



[1] The main reason is that some journals which Simula employees have published in are not indexed in WoS. In addition, in a few cases, we have not been able to identify the articles in the WoS edition applied in the study, despite the fact that the articles have been published in indexed journals. This may be due to a lack of an indexed Simula author address in the papers.

Figure 12 shows the development of the relative citation index by publication year. In the red line, the citation counts of the Simula publications have been compared with the world average, while the blue line shows similar figures where the Norwegian field average is used as baseline. As can be seen, the annual citation index shows rather large fluctuations during the period, which is not unusual in analyses like this. However, in all years, the publications have been cited above the world average, and in some years considerably above this average. Norwegian ICT research is generally cited above the world average. Therefore, the Simula figures are lower when this average is used as baseline.

Figure 12. Relative citation index* Simula, compared with the field averages for Norway and the world.

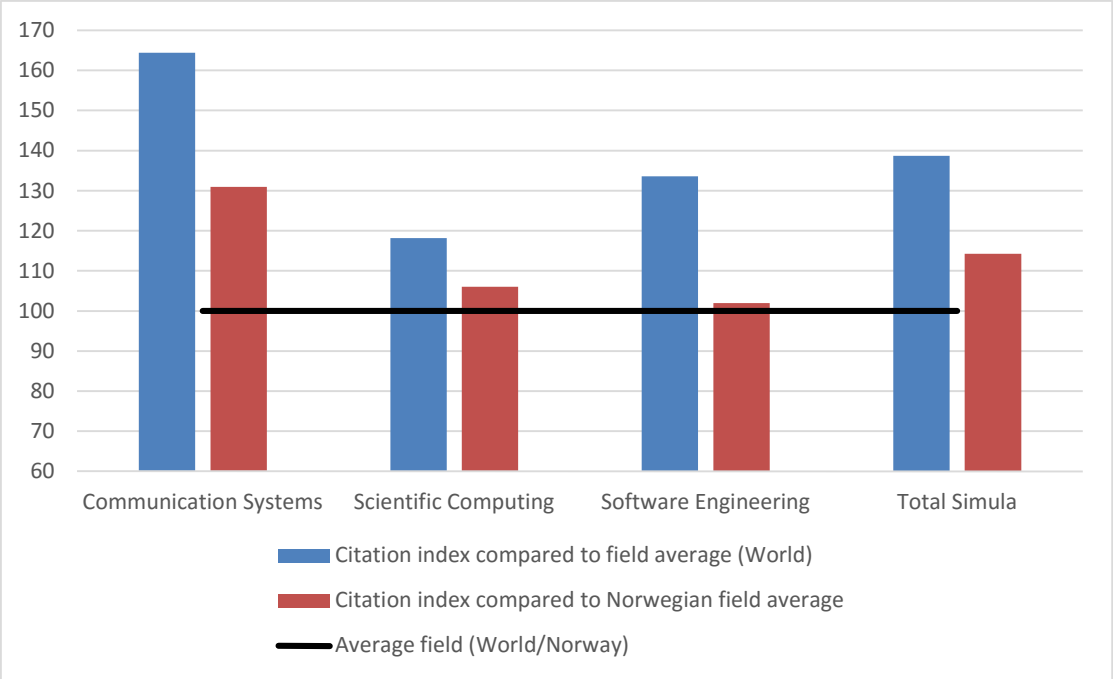


*) Based on annual publication windows and accumulated citations to these publications.

Figure 13 shows the citation index by Simula research area, covering the entire 2009-2013 period. The citation index is highest for the Communication System research area. Compared to the world average, the citation index of the research area is 164, which means that the publications have been cited 64 % more than the field normalised world average. Then follows Software Engineering with a citation index of 134, while the Scientific Computing has 118. Overall, the Simula publications have a citation index of 139, which also is significantly above the world average.

Compared with the field normalised Norwegian average, the citation indexes are lower, as expected. Overall, the Simula publications have been cited 14 % more than this average. The Communication System articles have been cited 31 % more than the comparable Norwegian average, while the two other research areas obtain index values slightly above this average.

Figure 13. Relative citation index* by research areas (2009-2013 publications), compared with the field averages for Norway and the world.



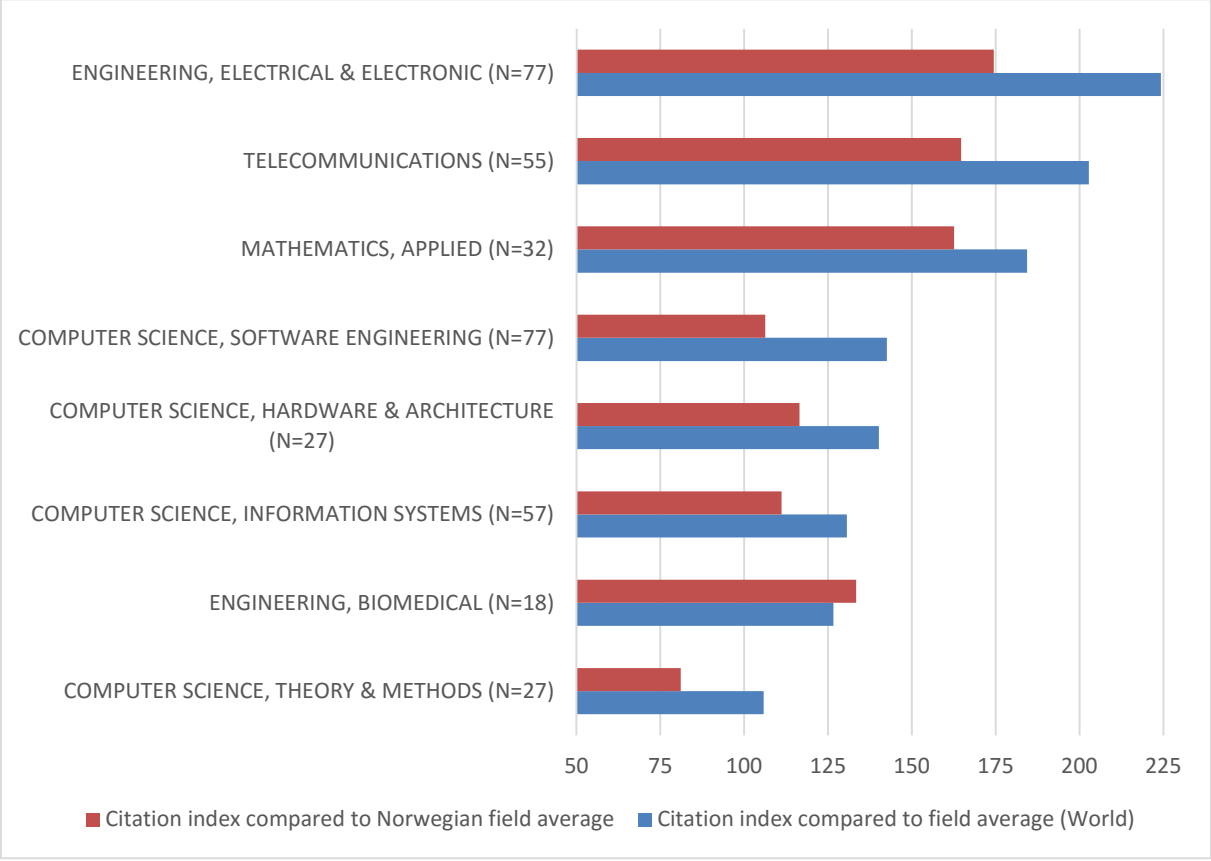
*) Based on annual publication windows and accumulated citations to these publications.

In order to provide further insight into the scientific profile of Simula, we have analysed the distribution of the articles at subfield levels. This is based on the classification system of Thomson Reuters, where the journals have been assigned to different categories according to their content (journal-based research field delineation).

The citation index is highest for the publications classified within the WoS category Electrical & Electronic Engineering. Compared to the world average, the citation index is 224 and 77 of the Simula articles are classified within this subfield. Then follows Telecommunications with a citation index of 203. The citation index is lowest in Computer Science, Theory & Methods with 106.

The figure provides an indication of which areas the Simula research has obtained highest and lowest impact as measured by citation (for an explanation of the content of the different categories see http://ip-science.thomsonreuters.com/mjl/scope/scope_scie/#AA).

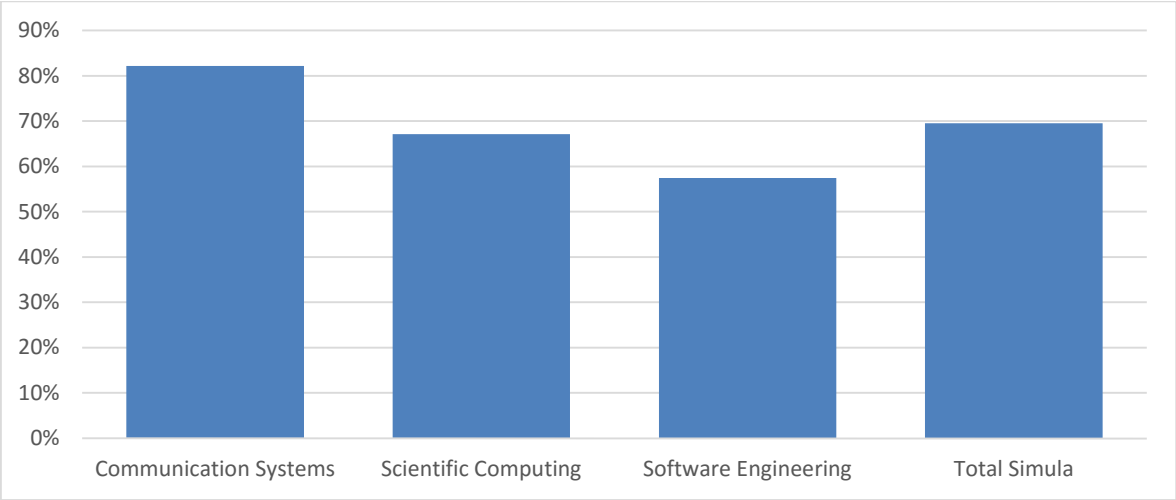
Figure 14. Relative citation index* by WOS categories (Simula total, 2009-2013 publications), compared with the field averages for Norway and the world.



*) Based on annual publication windows and accumulated citations to these publications.

As the WoS-database includes data on the co-authors of the publications, we are able to analyse the collaboration profile of Simula based on co-authorship. In total, 69 % of the Simula articles had co-authors from other countries (total for the 2009-2014 publications). In other words, more than two out of three publications were internationally co-authored (Figure 15). This is significantly above the national (Norwegian) average, which is 55-60 % during the period. The proportion is highest for the Communication System research area (82 %) and lowest for the Software Engineering research area (57 %).

Figure 15. The proportion of international co-authorship by research area, 2009–2014 publications.



Which countries are the most important collaboration partners for the Simula? In order to answer this question we analysed the distribution of co-authorship. Table 3 shows the frequencies of co-authorship for the countries that comprise the institute's main collaboration partners in the period 2009–2014. The USA is the most important collaboration partner, and 23 % of the articles also had co-authors from this nation. Then follows China with 16 %, Canada with 12 % and UK with 11 %.

Table 3. Collaboration by country. Number and proportion of the Simula article production 2009-2014 with co-authors from the respective countries.*

Country	No. articles	Proportion
USA	81	23%
CHINA	57	16%
CANADA	44	12%
UK	39	11%
GERMANY	23	6%
SWEDEN	13	4%
FRANCE	12	3%
LUXEMBOURG	12	3%
SPAIN	10	3%
ITALY	9	3%
NETHERLANDS	8	2%
QATAR	7	2%
AUSTRALIA	6	2%
TAIWAN	6	2%

*) Only countries with more than five collaborative articles are shown in the table.

In Table 4 we have shown which foreign institutions that have the highest number of co-authored articles with Simula. On the top of the list, we find the University of California System with 24 shared articles.

Table 4. Collaboration by foreign institutions. Number and proportion of the Simula article production 2009-2014 with co-authors from the respective institutions.*

Institution	Country	No. collaborative articles
Univ Calif System	USA	24
Carleton Univ	CANADA	15
S China Univ Technol	CHINA	13
Guangdong Univ Technol	CHINA	12
St Francis Xavier Univ	CANADA	11
Univ Luxembourg	LUXEMBOURG	11
Univ Wisconsin System	USA	10
Beihang Univ	CHINA	7
Univ Qatar	QATAR	7
Zhejiang Univ	CHINA	7

*) Only institutions with more than six collaborative articles are shown in the table.

Table 5 shows similar figures, but for Norwegian institutions. As can be seen, a very large number of articles (193) have been co-authored with researchers affiliated with the University of Oslo. In fact, more than half of the Simula articles also have co-authors from this institution. It should be noted, however, that people with dual affiliations (i.e. Simula and University of Oslo, Professor IIs) may list both addresses on the publications. These articles will therefore be identified as involving national collaboration in the analysis. In total, 6 % of the Simula articles have been co-authored with industry.

Table 5. National collaboration by institution/sector. Number and proportion of the Simula article production 2009-2014 with co-authors from the respective institutions.

Institution/sector	**No. collaborative articles**	**Proportion**
University of Oslo	193	55%
Industry	23	6%
Institute sector	18	5%
Norwegian University of Science and Technology	14	4%
Hospitals	10	3%
Telemark University College	8	2%
University of Bergen	7	2%
Arctic University of Norway	7	2%
Norwegian University of Life Sciences	7	2%
Other HE-institutions	6	2%
Total	354	

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