DCAMM - The Danish Centre for Applied Mathematics and Mechanics

DCAMM is founded

According to legend, DCAMM was created on 27 October 1969 as an act of defiance. The alma mater of DCAMM – the Technical University of Denmark (DTU) – wished to amalgamate research groups into larger institutes. According to the new constitution of August 1969, DTU would in future house two types of research groups: either laboratories headed by a professor, or larger institutes with several professors. The laboratories were to be self-governing entities, while central academic DTU councils would assert more influence over the institutes. Perhaps unsurprisingly, some DTU faculty members preferred the small labs. In 1969, the scientists Frithiof Niordson from Solid Mechanics, Frank Engelund from the Hydraulic Laboratory, Erik Hansen from Applied Mathematical Physics and Kristian Refslund from Fluid Mechanics established the DCAMM network to demonstrate that these mergers were unnecessary; DTU staff could collaborate without belonging to the same administrative entity. The statutes of DCAMM, the Danish Centre for Applied Mathematics and Mechanics, were signed on 4 May 1970. The DCAMM group was of course not a random assembly, as its members had clear methodological similarities.

The founders decided that DCAMM was to be managed by a scientific council, made up of representatives from the cooperating research groups. A chairman would represent the group to the outside world, and DCAMM was defined as an informal framework for internationally oriented scientific collaboration between staff members. But what its founders may not have considered was that DCAMM possessed the potential to go national. Today, in 2019, the network has members from Aalborg University, Aarhus University, University of Southern Denmark and DTU.

Frithiof Niordson played a pivotal role in the creation of DCAMM. He wished to promote relations between Danish and foreign scientists, and the idea that small DTU research groups could strengthen each other was inspired by his international experiences. Frithiof Niordson was born in South Africa in 1922. He studied engineering in Stockholm, but moved on to Brown University, where he studied under William Prager, a professor of Applied Mathematics. The dynamic atmosphere at Brown demonstrated to him the power of a strong

identity and an international outlook. Niordson was also very active in international circles and served as secretary-general of IUTAM (the International Union of Theoretical and Applied Mechanics) from 1968 -1976; DCAMM was really a small-scale copy of this organization. Niordson was familiar with the international scene and he used this to strengthen DTU. In 1976 Niordson became president of IUTAM.

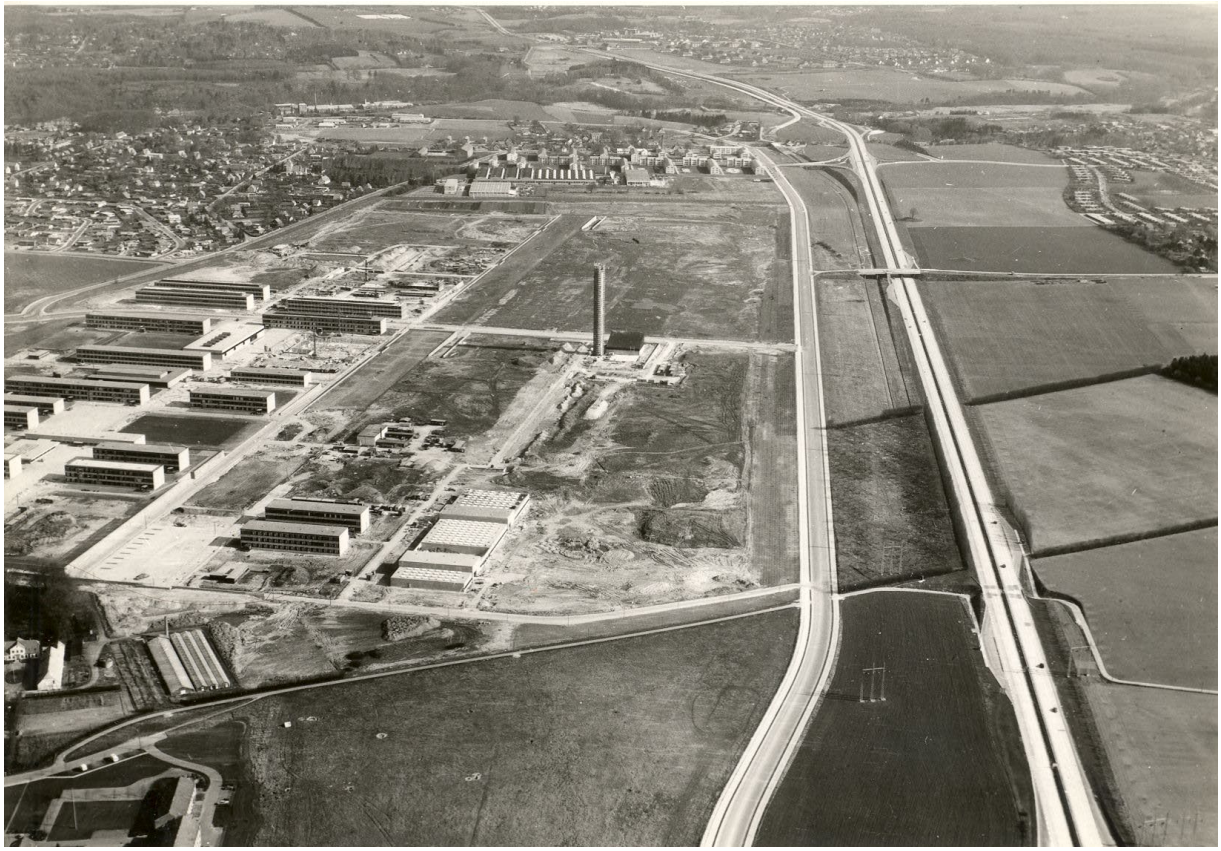
Perhaps Frithiof Niordson also knew that affiliation was key for scientists. Up-and-coming researchers needed the backing of a strong organization in order to make themselves heard on the world stage. The small labs at DTU did not provide an identity, and so had to stand united to make up a critical mass. This identity issue became central in the long life of the DCAMM network, which was truly remarkable in the changing world of university research. It became a well-known and recognized brand in international circles. It could be argued that DCAMM was established merely as an empty shell surrounding the results achieved in the research groups, but in 2019 DCAMM is celebrating its 50th anniversary, and the network is still going strong. This raises the question of what DCAMM actually achieved, and how this fits into the wider picture of technical and engineering science. It is worth taking a closer look at the life of DCAMM, and this text will highlight some of the stories from its first 50 years.

Another remarkable feature of DCAMM is the enthusiasm that leading scientists show for the venerable society. Every DCAMM member who was asked to contribute to this account jumped at the chance. This was somewhat surprising, as many expressed the view that in the knowledge circulating processes of DCAMM, they felt that they had given more to DCAMM than they had received. But they had clearly also gained something from DCAMM; the network significantly strengthened the visibility of mechanical science in Denmark and the identity of Danish mechanical science internationally. University staff found that the DCAMM framework provided gravity, and quality in research became its trademark. This is hardly surprising, as the DCAMM founders had the ambitious goal to strengthen the research profile of DTU, and throughout its fifty-year existence the DCAMM council has worked to promote the quality of research at Danish universities.

The timing was also fortuitous. By the 1960s, DTU had become a strong institution and possessed the means to conduct research. DTU offered possibilities for scientists, and research was beginning to take on a key role in the growing institution. Engineering science became further strengthened with the opening of Aalborg University Centre in 1974. A generally positive attitude towards science and technology in Danish society also benefitted the Danish research institutions. In the 50s and 60s, western nations experienced growth, optimism and great material changes. With atomic power stations promising endless free energy, there was a general perception in the west that science and technology would pave the way to a better world – a modern world.

A place in history

In the 1960s, DTU gradually moved out of central Copenhagen to occupy a new campus – a former airfield in Kongens Lyngby north of Copenhagen, which came to be known as 'Sletten'. The move was a long and costly process, and the formation of DCAMM happened at the Copenhagen campus. The technical disciplines were expected to expand, and society was expected to invest in this development – which some might say was long overdue. The college, formerly known as the polytechnic school, had very humble beginnings in 1829 and struggled to find its place in the world. It was under the government of the University of Copenhagen, and there was no university chair for technical disciplines. However, supporters of polytechnics were greatly assisted by developments abroad. Around 1900, engineering and the technical sciences in general really came into their own as academic disciplines, with a culture, particular norms and a community on the transnational level. The ideals and practices of these disciplines resembled those of science, and just as in any other branch of science, practitioners were required to publish their findings in peer-reviewed journals and speak at conferences. Their methodology dictated the use of scientific theory, such as physical, mathematical or chemical theory, to construct models that could predict the behaviour of the material world. Special institutions, university chairs and educational systems were in place. As a consequence of these developments, the Technical University of Denmark officially changed its status to that of a research institution in 1929.



View of the DTU campus in Kongens Lyngby in 1965. History of Technology DTU.

Why did this happen? Denmark aspired to be a modern society with industry and an advanced infrastructure. Science and technology were seen as essential to fulfil this ambition, so Denmark needed engineers and technical academic institutions. The big build-up of Europe and the USA offered new opportunities for the scientifically and technically educated. Institutions for engineering and the technical sciences became an essential part of what defined a modern nation. Moreover, expanding and maintaining this modern society gave rise to complexity, and the massive structures, new materials, high energy and material consumption, and electricity and communications networks brought challenges. Human-made technological systems started to ask humans questions. The growth of science, combined with the growing complexity of the technological networks of the modern world, led to deeper questions and hence fragmentation in the technical sciences. DTU started out as a polytechnic school, emphasizing the *poly* of a common knowledge base, but over time the institution has developed in the direction of narrower but more deeply specialized disciplines.

The new, specialized disciplines developed different cultures, norms and practices, which led to further fragmentation. A key feature of these new disciplines was their connection to peers abroad.

Connections across disciplines – and cake

In 1935, the medical doctor and biologist Ludwik Fleck wrote that "Whatever is known has always seemed systematic, proven, applicable, and evident to the knower. Every alien system of knowledge has likewise seemed contradictory, unproven, inapplicable, fanciful, or mystical."

Within the deeply specialized disciplines, the multidisciplinary connections that would be needed in order to solve the complex issues of the modern world did not form easily. There was a clear danger that experts would dig themselves into a hole. Even scientists who shared a common methodology might not encounter each other's work. DCAMM was created to overcome the traditional barriers of technical academia. When DCAMM was established, DTU was divided into five individual councils: civil engineering, electrical engineering, mechanical engineering, chemistry and general science. The DCAMM group combined groups from mechanical engineering, civil engineering and mathematics, and the network combined the topics of fluid and solid mechanics with theoretical mathematical physics. As early as 1970, DCAMM gained a new member: the DTU department of Loaded Structural Research, which strengthened its links with civil engineering. This department shared the methodology of modelling on the basis of classical mechanics and mathematics. DCAMM members began to inform each other about their research projects at seminars at DTU. The first seminars attracted a crowd of around 25 persons, and the regular seminars gradually became an important local activity. With Frithiof Niordson enlisting all scientific staff in the Solid

Mechanics group, DCAMM now had a proper membership uptake and could form a fair-sized audience. Talks lasted no more than 45 minutes, and the organizers would cut off speakers who did not finish on time. This ensured that staff could return to work as planned and would not have to fear seminars dragging on. Many staff members at DTU appreciated the opportunity to meet people in a new constellation. For those who belonged to small research bodies, DCAMM offered its members new inspiration as well as an oasis from the intensity and tension of working in tight-knit groups. The seminars were as much about social networking as sharing knowledge. As more and more Danish research environments joined DCAMM, the new members also started offering seminars, and these were advertised broadly. This led to an increased awareness of research activities across institutions and groups in different locations. Many members report that they have always made an effort to attend the local seminars, and greatly appreciate these gatherings. On the other hand, the organizers have often felt that keeping up attendance was a struggle. In a world of ever-narrowing scientific disciplines, creating room for interdisciplinary activities can be an uphill battle. The organizers have prioritized serving cake at the seminars; one might argue that this shows that scientists are only human, after all. But although this is true, the cake functions as more than just a treat – it is also part of a format, which again underpins the identity aspects.

The number of seminars and the enthusiasm they have inspired has varied over the years. At times there were fewer talks by members of staff, and the seminars were mainly given by guests. The scientific council could not rest on its laurels, but had to work to keep the seminars series active. DCAMM also organized receptions to keep people mingling. But the network did more than just foster local and national connections and awareness; they also gave DCAMM a wider reach.

Global outlook

An important objective for DCAMM was to build an international network with representatives of high-quality research. The centre therefore organized various events with international scientists. The first of the long-running series of DCAMM International symposia took place in 1973. Guest lectures were given at this gathering by leading researchers, one of whom was Warner Koiter, Professor of Applied Mechanics at Delft University of Technology in the Netherlands. In 1996 a medal in his name was established, and the first medal was awarded to Koiter himself for his fundamental work on the nonlinear stability of structures. Other foreign guests included Ziegler, Germain, Collatz, Noble, Berndt, Alblas, Olszak and Longuet-Higgins. DCAMM also organized international conferences; in 1977, the GAMM/DCAMM annual meeting of the International Association of Applied Mathematics and Mechanics attracted 500 participants. Another major event was the XIVth 1984 ICTAM, the International Congress of Theoretical and Applied Mechanics, in Kongens Lyngby. This conference more than paid off for DCAMM, as it generated a profit of DKK 180,000, which was placed in a DCAMM trust. In 1992, the Centre brought the symposium of the International

Union of Theoretical and Applied Mechanics to Lyngby to explore Optimal Design with Advanced Materials. DCAMM served as the link to a number of international unions, and paid membership fees to these associations. DCAMM also appointed representatives to these organizations.

The board of DCAMM invited international scientists to become members of the Centre; these scientists often became frequent guests at DTU, and proved to be valuable partners over the years. The Centre also invited international scientists to give presentations at the DCAMM Annual Speaker event. One recurring guest at the Centre is John W. Hutchinson of the School of Engineering and Applied Sciences at Harvard University. Hutchinson works in the area of solid mechanics, and is concerned with engineering materials and structures. Dividing his time between Denmark and the US, this prominent researcher has his own desk at the Department of Mechanical Engineering in the Solid Mechanics section at DTU. International guests from the cooperating departments were often asked to give a talk at a DCAMM seminar.

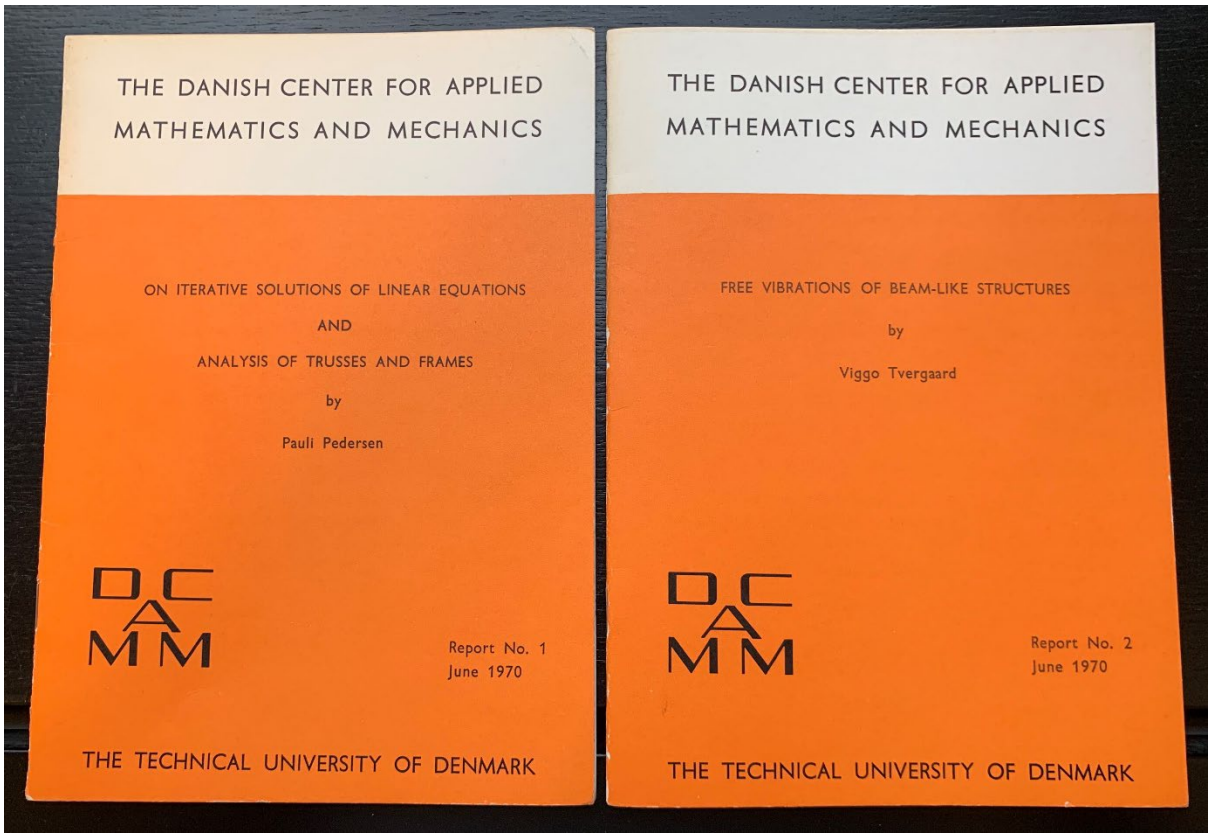
But it was not DCAMM's guests who provided the broadest reach; the distinctive orange DCAMM reports went even further.

The orange DCAMM reports

The report made an impression if it landed on your desk. The orange design of the DCAMM report was striking, and it was meant to be. The design was part of the brand, and the reports were of great importance to DCAMM. The inspiration for the signature orange colour came from the wife of Pauli Pedersen, who as a kindergarten teacher had arts and crafts materials in the family home, one of which was an orange piece of paper.

The DCAMM report series offered members an opportunity to send out preprints of their papers, which were then distributed free of charge to a large group of leading scientists. The author of a report was guaranteed feedback from DCAMM members, and might also receive comments or questions from other readers around the globe. Aspiring scientists were especially happy to see their work published in the orange series: "It was a small stamp of quality. It was just a nice thing to have," says one member about publishing a thesis. The commentary on the preprints provided valuable feedback for authors in parallel with cut-throat world of peer review for a journal. Pauli Pedersen wrote the first report, called "On Iterative Solutions of Linear Equations and Analysis of Trusses and Frames", in June 1970. The same author published the first theses in the orange series under the title "Optimal Layout af Gitterkonstruktioner" in September 1970. The language was Danish, which was the natural choice for a number of reports in the early years, since at the time, the research environment in Denmark was predominantly made up of Danes. Later, English became the preferred language. Viggo Tvergaard authored the second report, which shortly afterwards made its

way into the International Journal of Solids and Structures under the title ”Free Vibrations of Beam-like Structures”. Almost all of the DCAMM reports appeared in recognized international scientific journals. Tvergaard’s PhD research was the second thesis to be published in the thesis series. It is very appropriate that these two people initiated the series, as both Tvergaard and Pedersen were soon to form part of the backbone and mainstay of DCAMM, as well as of research at DTU in general. Many DCAMM reports have been published in their names. In 2013 the department of Mechanical Engineering at DTU celebrated the 70th birthday of Viggo Tvergaard, and the DCAMM brand and website were used to support the event, which attracted leading scientists in material mechanics. This was a typical role for DCAMM: using its strong brand to support activities in the field.



The first two DCAMM reports.

The DCAMM reports became a well-known and recognized series. The series editors aimed for early publication of journal-quality basic research, and many contributions were written by leading scientists in their fields. The impact of the series is illustrated by one author, who remembers receiving more reactions to the DCAMM reports than to the later versions published in peer-reviewed journals. Over the years, DCAMM distributed a large numbers of PhD theses as well as papers by scientists at DTU. However, with the rise of the internet, interest in the paper versions of the reports dwindled. The DCAMM reports became available

on the Centre's website, but the number of downloads was low. People would look at the report if it was handed to them, but finding it on a website required more effort from the user. Moreover, the younger members of DCAMM appeared to be losing interest in the publications – they could choose between several online possibilities for preprints. International scientists contacted DCAMM and asked them to stop sending the paper versions of the reports. The DCAMM council deliberated over the situation, and in the end decided against printing more reports; the cost of both printing and postage drew heavily upon the limited resources of the network. However, the free-of-charge printed report was still valued in developing countries, where researchers could not easily gain access to costly online journals.

The demise of the printed reports also meant that an important branding opportunity disappeared. In 2005 DCAMM published its final printed report, which was number 704, and in 2011 the network stopped publishing the reports altogether and subsequently only distributed the PhD theses. By this time, DCAMM had published a total of 746 reports. DCAMM still boasted its well-known logo and trademark orange colour on its stationary and cups, but this was also under attack from DTU design guides and logos. Both the university and the individual departments wanted research groups to boost their own brands. While the small research groups of the early 70s at DTU saw DCAMM as a way to promote themselves, the larger departments could see DCAMM as causing confusion.

Financing and human resources

The discontinuation of the printed orange series helped the DCAMM budget, as the cost of distributing the DCAMM reports was high. From the outset, DCAMM had claimed an annual membership fee which provided DCAMM with the means for its activities. From 1972 the Centre had its own budget, but money was tight. This situation improved after the ICTAM conference in 1984, when, after organizing the conference, DCAMM found itself with a surplus of DKK 180,000 (EUR 25,000). The council decided to leave this sum untouched and to spend only the interest, but this provided the network with the means to support a variety of activities. The network chose for example to support guest speakers from abroad, which was important in building up international connections.

Raising capital from the founding bodies was a key activity for the DCAMM council, which managed to fund several conferences and obtain grants for a research school and fellowships. The council also looked for financing opportunities among private companies, but unfortunately these efforts did not bear much fruit.

Running DCAMM also required manpower. The members of the council bore a substantial part of the workload, and many members emphasize the organizational talents of Pauli Pedersen. DCAMM developed a playbook for the various periodical DCAMM activities,

helping the repeat processes along. But the network still needed administrative support, and so Frithiof Niordson assigned secretarial support to it from Solid Mechanics. The administrative staff, including Gerda Fogt, Robert Zetterlund and Bent Brask Andersen, served as the main driving force behind many activities, and DCAMM owes much of its success to them.

Growth

DCAMM's financial situation was also helped by a growth in its membership. The network was expanding, and it was not just individual members who were joining up; new DTU groups also joined the growing network and became cooperating departments. In 1976 Ocean Engineering joined the network, and Numerical Analysis followed four years later, with Mathematics joining in 1990. Organizational changes and amalgamations at DTU also affected DCAMM. In 1994 the Mathematical Modelling department became part of the network, but Mathematical Modelling now included Applied Mathematical Physics as well as Numerical Analysis. The larger institutes, which DCAMM had tried to avoid, were being established. The mergers were a response to both changes and growth in the technical sciences in general, and in particularly the growth of DTU. At the end of 1994, DTU also changed its name from Danmarks Tekniske Højskole (DTH) to Danmarks Tekniske Universitet (DTU), while Aalborg Universitets Center became Aalborg Universitet. Did this mark a change for these institutions? DCAMM had aimed to raise the bar for technical research and push for further focus on academic research and publishing. They were not alone in this. The adopted title of 'university' was an indicator of change. In debates over a new mission statement for DTU, the central management wished to focus on first-class teaching and research; DTU wished to signal that this university was at the very top. And DTU was not just aiming for the heights; it was also growing in staff and student numbers. The expanding university continued to push for further mergers between smaller research groups. In 2000, the DCAMM cooperating departments of Solid Mechanics, Fluid Mechanics, Ocean Engineering and Structural Research were all caught up in the tide and became part of the department of Mechanical Engineering. It was then only natural for Mechanical Engineering to join DCAMM.

The following year, DCAMM went national; some DCAMM members had moved to Aalborg University, and the departments of Mechanical Engineering and Building Technology in Aalborg joined DCAMM. In 2009, Research Centre Risø in Roskilde became a cooperating department after merging with DTU in 2007. Later, DCAMM was joined by Aarhus University and the University of Southern Denmark. DCAMM was now a nationwide network, and once again it had followed its members out of DTU and into the expanding Danish research structure. In 2019, DTU's cooperating departments within DCAMM are DTU Civil Engineering, DTU Compute, DTU Mechanical Engineering and DTU Wind Energy. Aalborg University is represented by the Department of Civil Engineering, the Department of Mathematical Sciences and the Department of Materials and Production, Aarhus University is represented

by its Department of Engineering, and the University of Southern Denmark by the Department of Technology and Innovation. With this expansion of DCAMM, its activities were now spread across Denmark.

The Technical Faculty at University of Southern Denmark, SDU.

Members

The geographical spread and perseverance over time of the DCAMM network was not just due to connections between institutions; it was also a family activity. Eventually, responsibility for DCAMM was passed on to the descendants of Frithiof Niordson and Pauli Pedersen. Christian F. Niordson and Sine Leergaard Wiggers became members of the DCAMM Scientific Council, and DCAMM will celebrate its 50th anniversary with Niels Leergaard Pedersen as chairman. However, DCAMM has also been headed by Ole Sigmund, who is not related to either Niordson or Pedersen.

In the early days, DCAMM's membership numbers were low, but by 1994, the network could count 154 members and a total of eight professors. These numbers rose significantly in the 2000s: in 2008 DCAMM could count 47 professors out of a membership body of 305, while in 2016 DCAMM had 438 members.

The majority of DCAMM members have always been DTU faculty staff, with a smaller uptake from other Danish universities. Scientists from DTU Mechanical Engineering have traditionally been the largest group. In the beginning DCAMM also invited international scholars to join DCAMM, and these scholars were given lifelong membership. DCAMM has now stopped inviting foreign members. DCAMM also has individual members from Danish universities who are not affiliated with the cooperating departments, as well as members from industry. These are known as elected members. The majority of members from industry were at one time PhD students at a cooperating department, and remained in the network after leaving the university environment. The elected members from industry have never been frequent participants at DCAMM activities; they find it difficult to take time off for multidisciplinary activities, but are happy to obtain an overview of cutting-edge research through DCAMM, which represents a way to stay in touch with new results in basic research.

Membership can be applied for and successful applicants are required to be active in research. However elitist the network may appear, no DCAMM council member has any recollection of ever turning down a request for membership.

Science sandbox

Many a PhD student took his or her first feeble steps in the world of university research with the help of the DCAMM followers. In the realm of the network, students were given the chance – or were required – to present their work and obtain feedback from experienced scientists. DCAMM thus provided a scientific sandbox for young scientists, and was pivotal in talent development in Denmark. The network has been very aware of this role and has devoted a lot of attention to this at the biannual DCAMM Internal Symposium. At this event, up-and-coming scientists would not just present their work and progress, but also build up personal networks that could last a lifetime. DCAMM members have often seen these grow into lifelong friendships. A student's thesis could of course also be published in the orange reports series.

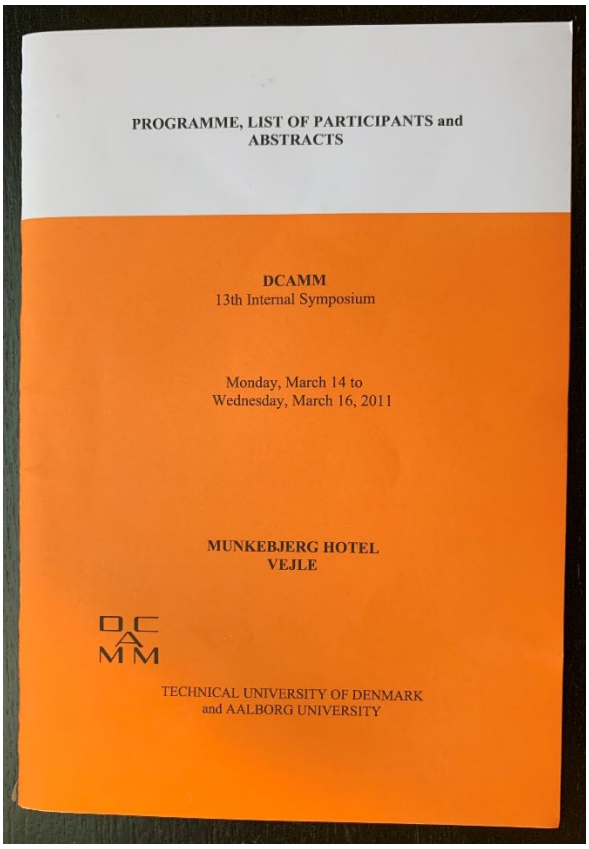
DCAMM also organized and financed the DCAMM Graduate Research School. From 1997 and onwards, a grant from Forskerakademiet made it possible to organize a number of courses. From 2004, the courses were funded by the Danish Agency for Science, Technology and Innovation. This grant also provided PhD fellowships, which gave a huge boost to the PhD study programme. At the 50th anniversary of the network, a number of scientists who started out as PhD students can look back upon research careers within the sphere of DCAMM. As one person says: "We grew up in DCAMM."

However, not all of the PhD students remained within the university world. Many found jobs in industry, and are now important in the circulation of knowledge between fundamental technical science and industry. University scientists publish their findings in papers, hold

lectures, and may collaborate with companies and authorities or provide general communication activities for wider audiences through various media. But a key factor in the circulation of knowledge between academia and society at large is comprised of skilled people who immerse themselves in the daily business of industrial enterprise, public administration and teaching.

DCAMM Internal Symposium

In 1987, in order to foster strong bonds between DCAMM members, the council began the tradition of holding biannual internal symposia. Each symposium was held over several days, and the organizers aimed to get the participants to stay for the duration – for example by choosing venues in places where participants could not simply go home overnight. As Denmark is a rather small country, this required some consideration.



Programme, list of participants and abstracs for the 13th DCAMM internal symposium.

Over the years the symposium has visited many different places almost everywhere in the kingdom, and the organizers have prioritized being close to the sea. At the symposium, members are invited to present their work and discuss it with peers. The organizers aimed to give every participant equal treatment and equal speaking time, but PhD students who had been working less than nine months were only required to bring a poster. At the symposium, much attention was given to young talents. This was not really the intention from the

beginning, but too few university researchers participated in the first event, so the organizers decided to fill the holes in the programme with presentations by PhD students. This was a success, and become a trademark of the symposium.

The symposium was also a social event and a place to meet up with friends. Staying at a venue was believed to foster both social and scientific contacts, but the accommodation had to be financed, and the price of the events caused debate. Departments covered the costs for scientists and PhD students, and wished to keep prices down. Organizing the symposium at a university campus would be cheaper, but DCAMM believed that the intimacy of the event would thereby be disturbed, as scientists would run to and from to deal with the everyday business of university life.

At the symposia the participants each receive a gift adorned with the DCAMM logo.

The DCAMM internal symposium has attracted a good following, which may be somewhat surprising as, compared to the sharply-specialized university disciplines, the symposium has always been multidisciplinary. The gathering naturally offered social and narrow disciplinary connections as well as an overview of emerging research topics. But the broader scope of DCAMM activities may also have served as a valuable source of inspiration, as a place where scientists could come into contact with a wide range of views on applied mathematics and

mechanics, and the problems to which these can be applied. Many DCAMM members have collaborated with industry and brought issues from this realm into academia. However, other DCAMM members disagreed with the broad scope of the symposia and preferred more specific conferences. DCAMM has served as a melting pot but has stayed within the boundaries of academia, with the focus on publishing scientists – perhaps more by chance than design. The scientific council has organized special events aimed at industry, but these did not take off and were shelved again.

INTERNAL SYMPOSIA:

1. Sandbjerg Slot, Alssund, 1987, 34 part.

2. Nordsøcentret, Hirtshals, 1989, 53 part.

3. Hotel Fredensborg, Rønne, 1991, 61 part.

4. Gl. Avernæs, Helnæs, 1993, 63 part.

5. Hotel Hvide Hus, Maribo, 1995, 78 part.

6. Hotel Ebeltoft Strand, 1997, 80 part.

7. Hotel Koldingfjord, 1999, 76 part.

8. Örenäs Slott, Sweden, 2001, 81 part.

9. Fjordgården, Ringkøbing, 2003, 69 part.

10. Kobæk Strand, Skælskør, 2005, 66 part.

11. Radisson SAS Hotel, 2007, 79 part.

12. Sørup Herregård, 2009, 107 part.

13. Munkebjerg Hotel, 2011, 113 part.

14. Hotel Nyborg Strand, 2013, 90 part.

15. Hotel Opus, Horsens, 2015, 90 part.

16. Hotel Comwell, Middelfart, 2017, 86 part.

17. Hotel Comwell, Kellers Park, 2019, 101 part.

Group photo from symposium at Nordsøcentret in Hirtshals, 1989.

Transport to symposium in Rønne by plane, 1991.

Transport to Rønne by bus, 1991.

Group photo from symposium outside Hotel Fredensborg in Rønne, 1991.

The romantic setting for the fourth internal symposium in 1993, at Gl. Avernæs hotel in Sydfyn.

Networking in the evening at Gl. Avernæs, 1993.

Networking in the evening at Gl. Avernæs, 1993.

Group photo from symposium at Gl. Avernæs, 1993.

Dinner at symposium in Maribo, 1995.

Poul Scheel Larsen talked about education at the symposium in Ebeltoft, 1997.

Group photo from symposium in Ebeltoft, 1997.

Coffee break at the symposium in Kolding, 1999.

Trip to Koldinghus at symposium in Kolding, 1999.

Participants in the 1999 symposium outside Koldinghus.

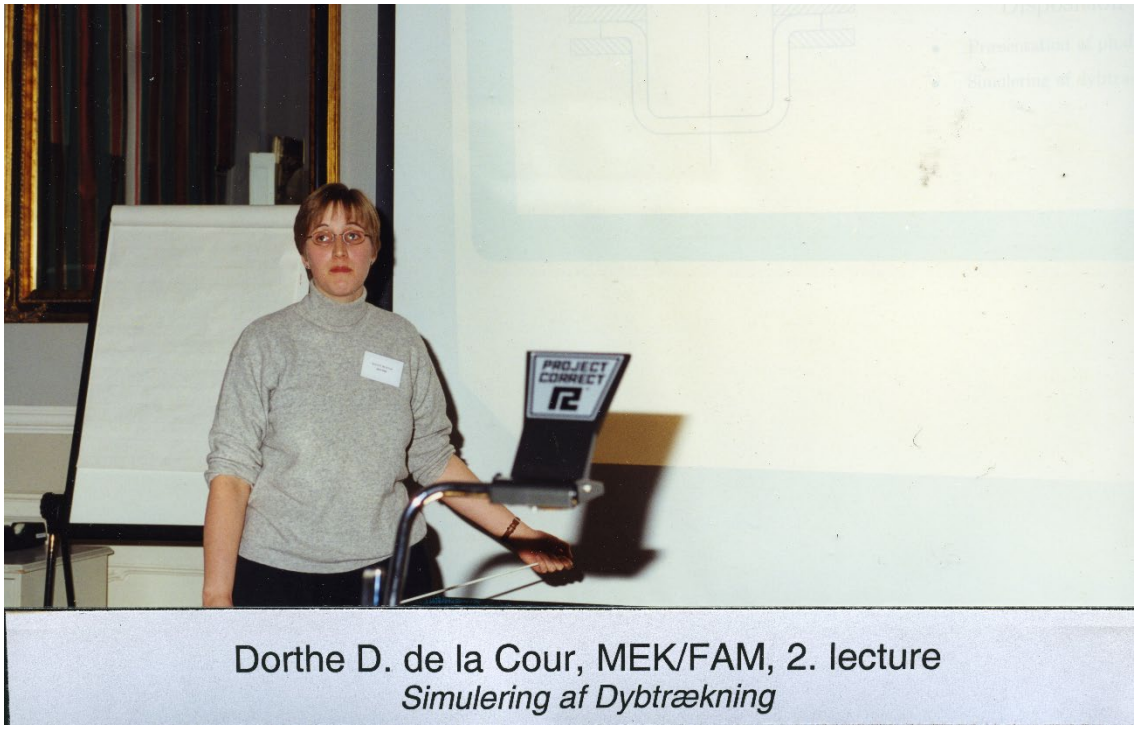
Pauli shares practical information with participants at the symposium in Kolding, 1999.

Lunch buffet at the 1999 symposium in Kolding.

Group photo from the symposium in Kolding, 1999.

Christian Niordson giving a talk at the 2001 symposium at Örenäs Slott, Sweden.

Group photo from the symposium at Örenäs Slott in Glumslöv, 2001.



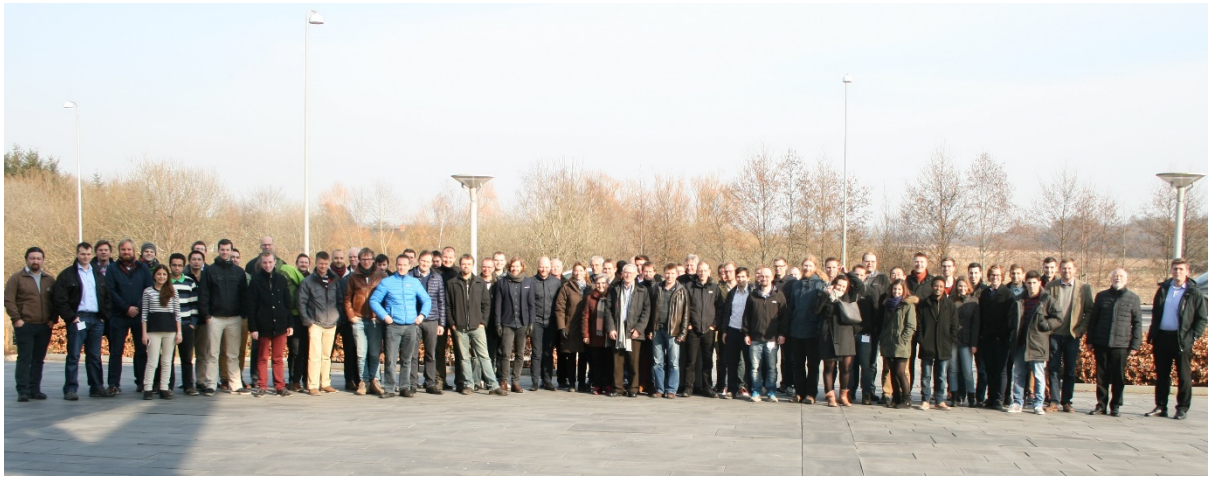
Dorthe D. de la Cour giving a talk at the 2001 symposium at Örenäs Slott, Sweden.

Lunch at the 2001 symposium in Glumslöv.

Group photo from the symposium in Ringkøbing, 2003.

Group photo from the symposium in Vejle, 2011.

Group photo from the symposium in Nyborg, 2013.



Group photo from the symposium in Horsens, 2015.

Group photo from the symposium in Middelfart, 2017.

Group photo from the symposium in Vejle, 2019.

The internal symposia were documented by Robert Zetterlund and filed individually.

Applied Mathematics and Physics in Denmark

At the core of DCAMM is applied mathematics and applied mechanics, and DCAMM has remained true to this throughout the 50 years. The purpose of the research represented by DCAMM is thus not to contribute to fundamental mathematics or physics, but to apply science to problems. Some DCAMM members have attempted to challenge this, feeling that there was too much focus on solids, and wishing to expand the understanding of applied mathematics and physics. Mathematical scientists from various branches were attracted by the term 'applied mathematics', while some felt that this was not for them. A group of cryptologists from the mathematics department also tried to participate, but did not feel at home in DCAMM.

DCAMM stands upon a strong tradition stretching back more than two hundred years, with links to the first polytechnic school, the École Polytechnique in France, where the teaching placed great emphasis on science and mathematics, but economics and public affairs were also seen as important. The French scientists did not treat matters of nature and technical issues differently. These phenomena could all be examined using the same methods, and what we now know as classical physics became central to engineering practices.

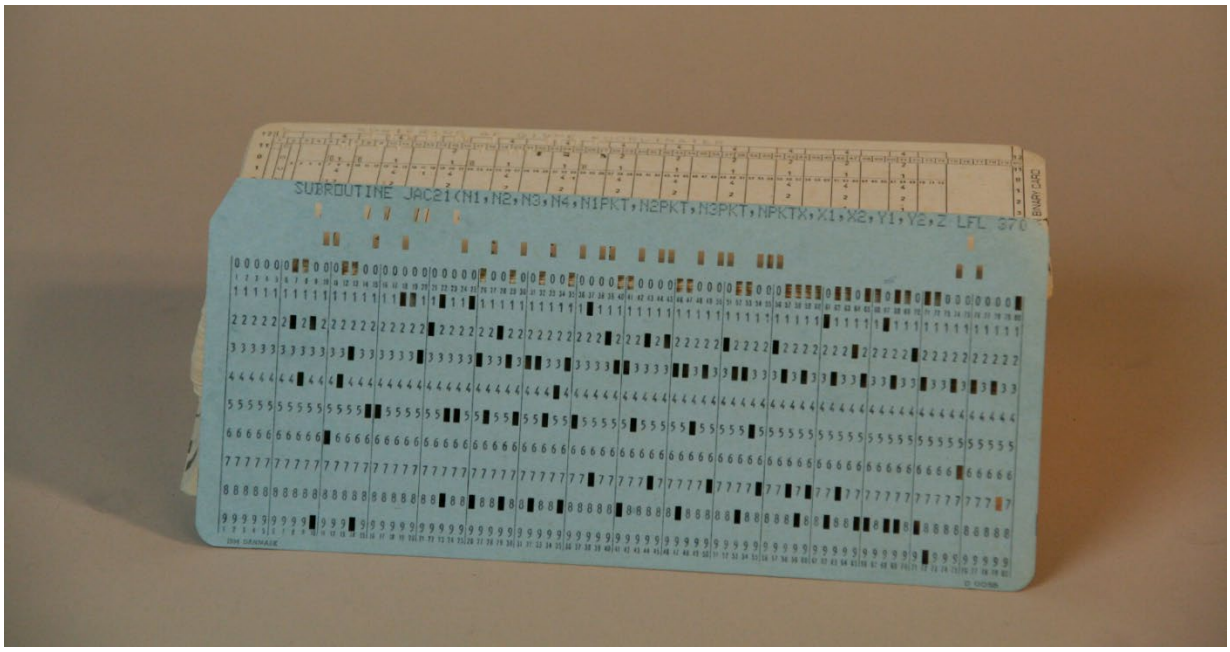
Like many polytechnic schools created on the model of the French École, DTU was partly modelled on the French tradition and with an emphasis on basic science. However, some leading Danish scientists did not favour Newton and mathematics, which meant that Denmark did not participate in the mathematical development of physics until the 1880s. In the late 19th century, however, new ideas about university education began to flourish in Europe. Danish educational institutions were caught up in the wind of change and joined in the mathematical and theoretical trends in both physics and engineering. The laws of nature and mathematics became a stable core, upon which theoretical models dealing with real-life issues could be constructed. Mathematical models also began to appear in the work of Danish engineering companies, new specializations such as materials science and electro-engineering emerged, and existing university chairs were divided into several sub disciplines.

With its systematic rules, mathematics held knowledge together, but it also allowed for transformation. Mathematics could be stretched, reshaped and combined; it could describe phenomena which undergo change – for example over time. Technical and engineering problems are rarely a matter of simple causality, and the models in these areas were often complex and non-linear. But mathematics was also a technology of distance; it allowed scientists to circulate knowledge easily. It could be conveyed in a familiar, standardized form which could be understood far away by people with the right training. It could be printed and published on paper. Mathematics thereby functioned well as a knowledge-sharing practice.

However, as the models became more complex and held more and more information together, they also became difficult to handle. Here computers came to help, as mathematics could also be understood by computers. As computing power grew, the use of numerical

analysis became meaningful and many DCAMM members availed of this opportunity. Scientists no longer had to keep models simple – they could expand freely. Researchers in solid and fluid mechanics became computer people.

The research that found a home in DCAMM mainly used physics and mathematics as tools – the aim was not to develop fundamental physics or mathematics. There was a somewhat finalized foundation for the practice. However, some DCAMM members feel that their work is indeed fundamental, but it is fundamental as applied science. One example is topology; here, scientists developed basic methods which others have since applied to develop new materials. One DCAMM member describes the work of an applied scientist as: "either having a problem and then finding the methods to deal with it, or else having the methods and then later encountering a problem".

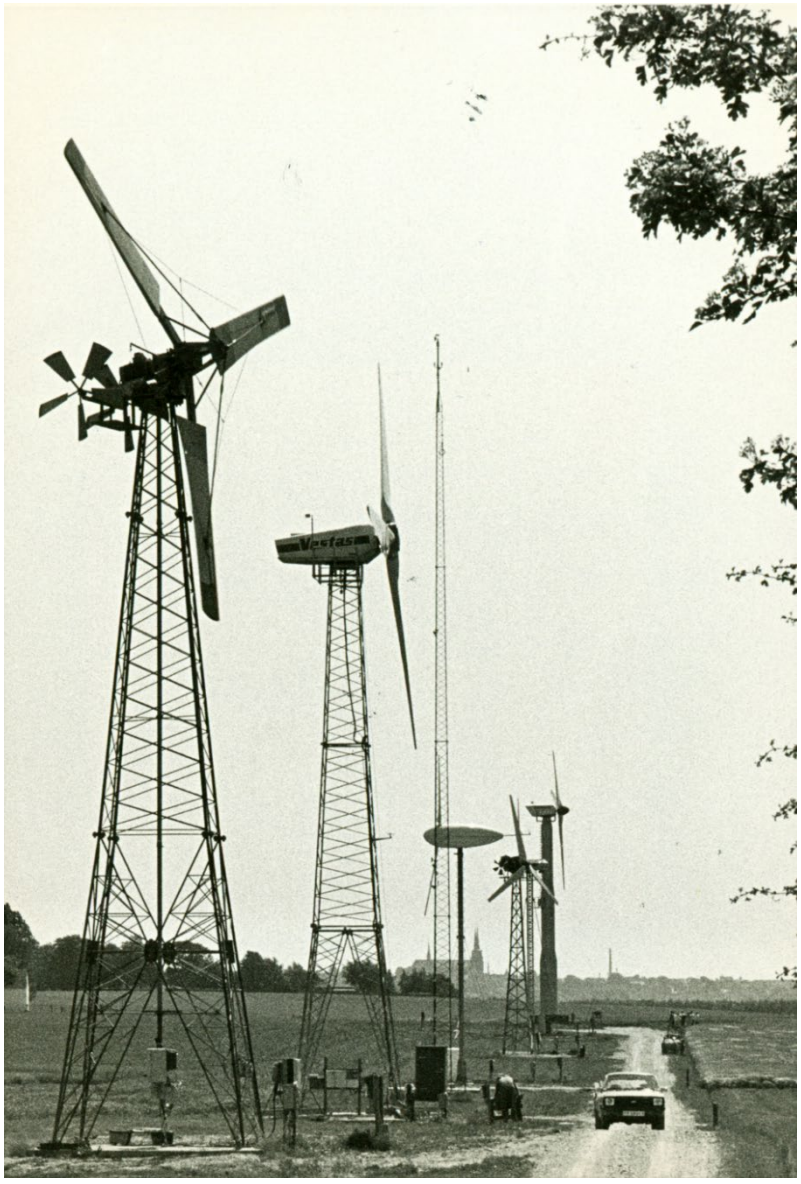


Punch cards had to be brought to a mainframe computer. History of Technology DTU.

DCAMM in a troubled world

When you look at the research themes that DCAMM members have presented and published over the 50 years since the network's establishment, you can observe the development of our modern world. The issues that DCAMM members have addressed have dealt with the issues raised by the big technological systems and structures to the development on a molecular level. They have concerned themselves with many issues of construction, such as breakage, failure and optimization, and have considered how to use computing to model these issues. DCAMM may have been born out of optimism towards growth, but it had to work in a world in which this worldview was being challenged by scepticism. Our modern

world has presented us with new issues, such as our massive energy and material consumption, pollution and climate change. DCAMM members also began to consider these issues, and questions of sustainability became a natural part of almost any engineering work. DCAMM members have for example shown how designing lighter materials with specific properties for a specific usage could be part of the solution. National concerns have also featured prominently among the research topics – a large number of contributions have for example been concerned with coastal challenges and shipping. The energy crisis in the early 70s, together with the Danish ban on nuclear energy, brought new attention to wind energy and hence wind turbines, which is a topic that has featured significantly in DCAMM. Other topics have appeared more rarely, such as biomechanical and electromechanical issues.



Experimental wind turbines at Risø. History of Technology DTU.

A future for DCAMM

DCAMM greatly strengthened mechanical engineering in Denmark and provided scientists with a strong brand. The network was an important signifier in international circles, and became pivotal in talent development. It has continually provided a national arena for multidisciplinary scholars within applied mathematics and mechanics, and has created connections to the wider world. It is also a place to meet up with old friends – and it is still orange. DCAMM is a place for fundamental science in technical academia, and it is free of many of the pressures of departmental life. DCAMM offers opportunities, but makes no demands. The network is not about counting points or requesting funding applications.

But will DCAMM still be meaningful ten years from now? One informant believed that not much would change if DCAMM disappeared. The university departments now have an appropriate size to carry on the activities of the network themselves. Some aspects of the DCAMM work, however, would probably suffer, as the departments would most likely cultivate a more narrow disciplinarity, and some cross-cutting connections would disappear. DCAMM operates on a national level, and the DCAMM symposia are popular. It is a place to obtain an overall perspective and to find inspiration. As one member says, “it would be just such a shame” if DCAMM ceased to exist.

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Based on interviews and archival studies