Mathematics as a Cultural and as a Productive Force

- The Mathematical Centre founded February 11, 1946 -

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As of so many institutions entering their forties, the founding of the Mathematical Centre can only be properly understood within the context of post-war optimism. Optimism however does not account for its existence up to this day. The foundation of the Centre envisaged putting mathematics to the service of society. It meant the birth of the idea of a new societal role for mathematics, and apparently the time was right for it.

Key ideas of post-war optimism in the Netherlands were *breakthrough* and *reconstruction*: breakthrough of a new pattern of social and political values, reconstruction in the sense of rebuilding and restructuring society along more rational lines. The drum was beaten for the idea of reconstruction to counter what was conceived as a situation of cultural and economic distress.

The fact that mathematicians claimed their part in overcoming what they felt was a cultural and economic lag, certainly meant a great turn. Indeed, what then might be the contribution that mathematics had to offer to this reconstruction of society? Both D. van Dantzig and J.G. van der Corput, two of the founding fathers of the Mathematical Centre, had their ideas on this point. Mathematics in their view is a cultural force, 'a primordial asset of civilization', and simultaneously a productive force. The latter idea, mathematics in direct service of economic welfare, is a memorable breakthrough. This breakthrough is primarily due (in the Netherlands) to van Dantzig. We will show that van Dantzig took radical consequences of this new view on mathematics. A topologist at the outset, he specialized in mathematical statistics from 1939 and made a major contribution to the development of mathematical modelling in the Netherlands. In fact van der Corput stated in 1946 that, where the Mathematical Centre stands on the two pillars of pure mathematics and application-orientedness, this combination was van Dantzig's idea in the first place [2].

At the time the combination of pure research with consultation was internationally unique. In the same period around 1950 a number of Computation Centres, Statistical and Econometric Institutes were founded in several countries. Also the systematic funding of pure research was an international trend, exemplified by the NSF in the US 1945.

Towards a science policy

In 1945 the stimulation of science in the Netherlands was taken up at great pace. Not only scientists but also the government launched initiatives. G. van der Leeuw, Minister of Education, Arts and Sciences, took a crucial role. Taking the first steps towards what was to become in 1950 ZWO, the Netherlands Organization for the Advancement of Pure Research, he found immediate support with the Prime-Minister Schermerhorn. Inviting the members to the committee studying the possibilities for a ZWO to be founded Schermerhorn writes: March 1946 'As you undoubtedly will know, the Government intends to stimulate and support on unprecedented scale fundamental scientific research in the Netherlands both in the field of science and in the humanities. The final goal of such research will be that the results benefit the welfare of Dutch society' [21, pp. 6,7].

Reconstruction indeed, and, more than that, restructuring: new goals and new directions were set for *pure* scientific research. Both scientists and policy makers held great expectations of pure science. We have to keep in mind here that TNO, the Organization for Applied Scientific Research, had already been founded in 1930.

The new development on the side of pure science was that groups of scientists ascribed direct societal interest to their abstract activities and that they tried to organize this interest. A new feature on the other side is that policy makers recognized this importance of pure science and drew the consequences of a governmental role. From 1945 onwards the first elements of a science policy can be discerned.

In 1949 on the occasion of the parliamental debate on the definitive establishment of ZWO the Minister of Education, Arts and Sciences, Th. Rutten, quotes the founders (1945) of the US National Science Foundation, stating that: 'Today no nation is stronger than its scientific resources' [21 p. 26].

Groningen reconstruction ideals

Van der Leeuw, a Groningen professor of theology, stressed in 1945 the equal importance of the humanities and the natural sciences [21 p. 3]. According to his views the sciences had to play a role in economic and in spiritual welfare in order to counter distress. Van der Leeuw and van der Corput - cofounder of the Mathematical Centre - were among the authors of a manifesto *The Renewal of the University* [20] published immediately after the liberation in 1945. This manifesto also calls for a fundamental restructuring of the universities, not just a rebuilding.

'A new spirit should create a new academic order' [20, p.4], because 'University stands amidst the "crisis of certainties" ... and ... science as such is not in high esteem' [20, p.6]. The authors held that, particularly in those days, the scientist bears the social responsibility to offer spiritual (and economic) guidance. To this end they proposed a truly academic and social training of students, an active exchange between science and society, between science and industry in particular, and cooperation on a national scale. Science should step outside its specialized and isolated institutes: 'There is great need of a point from which the whole Dutch higher education system can be surveyed and controlled. ... What is needed is a Universitas Neerlandica' [20, p.8].

In minister van der Leeuw's innovative plans science was to put itself at the service of society by taking a leading role:
- firstly by the above mentioned spiritual guidance;
- secondly through closer contacts with society, namely with industry;
- thirdly by cooperative efforts to make science in the Netherlands meet high, i.e. international, standards.

In conformity with this view institutes were created where scientific activity could be built up at greater pace and to a higher level than the reconstruction of the separate universities would allow. The Mathematical Centre was the first such institute to be founded (February 11, 1946). Its regulations perfectly reflect the new science policy:

> 'Article 2: The foundation resides in Amsterdam and pursues the object of stimulating the systematic study of pure and applied mathematics in the Netherlands, in order to increase on the one hand the contribution of these fields of science to the rise of the level of welfare and civilization in the Netherlands, and in order to increase on the other hand the contribution of the Netherlands to the international civilization' [18, p.1].

THE FOUNDING

October 26, 1945, the Minister of Education, Arts and Sciences, G. van der Leeuw, set up the committee for the Coordination of the Higher Education of Mathematics in the Netherlands. The committee was chaired by J.G. van der Corput, the aforementioned professor of mathematics from Groningen, with one of his pupils J.F. Koksma, mathematics professor at the Free University of Amsterdam, as a secretary. Further members were D. van Dantzig, Delft University of Technology mathematics professor; J.A. Schouten who had given up his Delft professorship in 1941 for disappointment in the lack of resistance against the Nazi occupier; the Leiden professor of physics H.A. Kramers and the astronomer, professor M.G.J. Minnaert, from Utrecht.

It was a strong committee in that its members were influential in the Dutch mathematics scene and agreed in new reconstruction-like ideas about university. Moreover it was extremely powerful by its assignment firstly to coordinate in filling up the many vacant chairs of mathematics, and secondly and more importantly, 'to study the possibility and desirability of scientific mathematical activity, and likewise to design the means of establishing closer contacts between pure mathematics and its applications to other fields' [14].

Apparently the minister knew what he was asking for. The response was accordingly quick, in November 1945 the first blueprint was written and on 11 February 1946 the foundation of the Mathematical Centre was a fact, the six members of the Committee themselves acting as its founders. The Centre was supported by the city of Amsterdam and by the Government. Later on it received smaller contributions from various industries.

THE FOUNDERS: TWO IDEAS

A changing view of the societal role of mathematics can be found in so many words in the writings of Van der Corput and Van Dantzig.

To Van der Corput is attributed the ambition to take up the role of prewar Göttingen, centre of mathematical Europe. This ambition is written down on paper only once, in a draft version of a letter to F.A. Vening Meinesz who was at the moment visiting the USA to study their ways of funding pure research. Later on it reads: 'to increase the contribution of the Netherlands to international culture' [18, 14]. In such an ambition mathematics is viewed as merely an asset of civilisation. The contribution to civilization is then made simply by cherishing this asset: by studying mathematics up to a high level.

Van der Corput wanted in fact more than that. Others should be brought into contact with this asset and learn to benefit from it. According to his view mathematicians have a duty towards society to disseminate their knowledge. In 1940 and 1941 in Groningen Van der Corput organized summer schools in mathematics for teachers and others.

The summer school was to become the oldest tradition at the Mathematical Centre, being held annually from 1946 onwards. In those first years the Centre organized courses of continuing education all over the country. Van der

Corput propagated these disseminating activities with a true spirit of mission [5].

> 'The only explanation of why someone chooses to study mathematics is that he gets caught by this science. No one should become a mathematician in search of personal success, but only to contribute to the expansion of a science which is of great importance to mankind. In doing the latter he will be a happy man, because he will enjoy what he does. But he will do this not only for joy, but also for sense of duty, because society sustaining him has a right to demand that he spends his talents to its interest. Hardy may say that it is not all that bad if a few university dons spend their lives on unimportant things, I think it is bad for society.' [3].

On the relation of mathematics to its fields of application Van der Corput speaks in terms of Cinderella who, from handmaiden, came to be the queen of science. Sometimes she must come down to the kitchen to the aid of her sisters - and now is such a time, Van der Corput states in 1947 - but she must not dwell there because another, a royal task is awaiting her [1,4].

In this view mathematics remains an autonomous force of culture, guiding the other sciences, guiding culture while it can, but not itself affected by this work.

A slightly different view was held by J.A. Schouten. Mathematics and the field of application - theoretical physics in his case - intermittently help and inspire each other. Contact with work outside mathematics is thus an exchange and does not depend on sense of duty, it is simply a vital neccessity for progress within mathematics [17]. In this view mathematics is no longer purely autonomous.

Schouten's view preludes the other idea (due to Van Dantzig) behind the Mathematical Centre: mathematics as a productive force. There must be no misunderstanding about it that Van Dantzig discerned the cultural role of mathematics as well. He was even very explicit about it, calling the mathematical way of thinking a general pattern of clear thought. Mathematical thought would (through so-called *signific analysis*) help clarify vague concepts in our language and mind [8]. Thus mathematics is seen not just as a cultural asset but as a *cultural force.*

More crucial with respect to the history of the Mathematical Centre, however, is Van Dantzig's recognition of mathematics as a *productive force.* He diagnosed the need of mathematicians with a special training in a variety of fields, such as in government, in industries, in insurance companies. As early as 1940 he proposed a curriculum offering such training at the Delft University of Technology. Only in 1958 could professor R. Timman start the program of educating mathematical engineers. Van Dantzig had further plans for a

mathematical service department. 'Equip a team with calculating devices and let them calculate, let them compute in service of others', he is remembered to have exclaimed in 1940 [10].

At the Mathematical Centre these projects were realized. Van Dantzig is considered to be the spiritual father of the institute. His was the idea of combining pure and applied mathematics within one institution. 'Time will come, when many positions in commerce will be claimed by mathematicians, which are today still occupied by lawyers and economists', Van Dantzig predicted in 1947 [16].

The Mathematical Centre sets out to offer mathematicians another professional perspective besides that of becoming a teacher. Orientating courses and seminars in applicable mathematics were set up. Certainly some students and some of the few industrial mathematicians in those days benefitted profesionally from these courses. All of the mathematicians who got jobs at the Centre in these early years however became academic professors of mathematics soon afterwards (cf. [13, appendix]).

The Mathematical Centre did develop active service branches: the Computing Department, the Consultation Division of the Statistical Department and, to a lesser extent, the Department of Applied Mathematics.[1]

New fields were opened for mathematics to prove its usefulness. Besides the traditional application to the physical sciences new opportunities arose in medical and biological science, in social science, and in the fields of organization and policy making. The exploitation of mathematical thought took new directions, which placed mathematics in a new societal role. With its changing role mathematics itself changed accordingly. New branches of mathematical theory were developed and, perhaps most important, mathematicians adopted a new commitment.

Van Dantzig was one of those mathematicians seeking adequate forms of mathematics to meet the expanding use of mathematical thought, and he drew the consequences radically. Being a topologist at the outset he cooperated with J.A. Schouten in geometrical theories for mathematical physics during the thirties. But then starting in 1939 he specialized in probability and mathematical statistics [6]. Not only did he change subject, but he also committed himself to (statistical) consultation, after and during the war (when he was expelled from Delft and had to go in hiding for some time). The consulting statistician bears, according to Van Dantzig, a dual responsibility: first the responsibility of doing mathematics right and second the commitment to deliver an amenable result within due time [9].

At this point the difference in view with Van der Corput is at its greatest. In

1. Surprisingly, operations research only started to play a role at the Mathematical Centre from about 1954; Dutch industry was earlier.

Van der Corput's view the contact with field of application is a rather one-directional affair. Mathematics is not affected. With Van Dantzig this contact is not only an exchange but so much of a mutual influence that the expanding role of mathematics gives rise to a change of commitment in doing mathematics; in particular a commitment to extra-mathematical goals.

What combines the two ideas, mathematics as a productive and as a cultural force, is service. Mathematics was to be put at the service of society. The idea of mathematics for its own sake was definitely left behind.

REALIZATION

What was realized of these ideas of mathematics as a productive and cultural force can only be briefly indicated here. The board of directors consisted of Van der Corput, Van Dantzig, Koksma and Van der Waerden. As a result of 'coordinating higher education in mathematics in the Netherlands' Van der Corput and Van Dantzig had meanwhile acquired chairs at the University of Amsterdam. B.L. Van der Waerden worked at the time with Shell Research in The Hague. With A. van Wijngaarden, the head of the Computing Department, the members of the board remained the only workers at the Centre for the first year of its existence.

The board, in particular the first three Van der Corput, Van Dantzig and Koksma, met with high frequency: at least once every week. Their first task was to prove the existence of the Mathematical Centre as an institution. Apart from their scientific work they fulfilled this task with discernable personal accents. Koksma was the man of the internal organization of the institute. He was the ideal secretary of the board. If service is the common part of the ideas behind the Mathematical Centre, Koksma was service in person. Van Dantzig could be named the 'philosopher' within the board of directors. As we saw, he was the main inventor of the Centre as an institute of pure and serviceable research. His publications [6, ..., 9] show a developing thought on the serviceability of mathematics. Van der Corput was the director-in-chief and the one who stepped most to the foreground in the public and political scene. Basically, however, they worked in close cooperation. As far as proving the existence of their institute is concerned, they spent fine hours in meetings with industry and with centres of applied scientific research. Fine hours, because in

general first reactions to their proposals were sceptical. Industries favoured the initiatives from the part of the mathematicians, but stated to do their own mathematical research or 'to manage without'. All the same contributions were acquired. Shell and Philips had representatives in the Board of Trustees, and a seminar on applicable mathematics was set up. One extreme was a visit of the complete Board of Directors to the meteorological institute, the KNMI, headed by the aforementioned Vening Meinesz, which by misinterpretation wound up as a working visit solving mathematical problems instead of an introductory talk. The other extreme was a rather 'existential' debate with TNO, the Netherlands Organization for Applied Scientific Research, in which financial support asked from TNO was at stake. The Mathematical Centre had to prove its right of existence next to TNO's own statistical department. After an exchange of formal arguments TNO's president had to give in, inundated by Van Dantzig and Van der Corput under a stream of examples of statistical and numerical problems occurring in applied science [16].

Starting slowly in 1947, a stream of computational, statistical (and later operations research) consultation projects built up during the late forties, stabilizing in the fifties. As far as computation is concerned we have to keep in mind that the work was done by hand, by a team of lady calculators handling electromechanical devices. Among the work were calculations of function tables, which no one would think of doing anymore today, but which were at the limits of computational capacity at that time. The Computing Department did build computers but the first machine actually working in service was not completed until 1954. The Computing Department has its own history which is not touched upon here any further.

The Statistical Department handled a growing number of statistical consultations. From 1950 a series of ready made Memoranda, explaining statistical tests, were published and added as appendices to reports. J. Hemelrijk, head of the statistical consultation division from 1948, built up an individual routine and style of consultation.

Mathematical modelling

One part of the developments after 1945 was, as we saw, a change of opinions among mathematicians and a change of expectations in society concerning science in general and concerning mathematics in particular. The broad support for a more application oriented view can be judged from the members of the Board of Advisors of the Mathematical Centre. All professors of mathematics and some from related fields had been invited to participate in the Board of Advisors, actually serving as a recommending committee, and practically all accepted.

A change of opinions, however, is not sufficient to make mathematics in fact serviceable. In order to be engaged in the pursuit of practical purposes, mathematics must first be taken to an adequate serviceable form. Mathematical modelling is such a form. In looking back we can now see that at that time

mathematical modelling was just becoming generally accepted as a common procedure. Mathematical modelling extends the activity of mathematics in a form amenable to practical purposes. Thus mathematics can be engaged directly for economic welfare.

It was again Van Dantzig and later on Timman who propagated this way of making mathematics useful [7,19]. They both describe the procedure of mathematical modelling extensively and offer their views on its scope and limitations. The expression 'mathematical modelling' was apparently not commonly known and accepted in those days. Though 'mathematical model' does occur as an expression with both authors, they do not present it as a keyword. Van Dantzig, following Mannoury, speaks of 'switching on' and 'switching off' the formalism [7,15]. The 'general pattern of clear thinking' which mathematics has to offer, according to Van Dantzig, has a concrete version through mathematical modelling.

Van Dantzig's example was of course mathematical statistics, which he calls a matter of 'testing probability-theoretical models'. Timman's example was applied scientific research: "Technology raises questions and demands an answer to them. Applied mathematics can proceed no other way than attacking such problems by 'third degree' methods in order to acquire the desired results. Consequently applied mathematics must be aware that it should take utmost care in drawing conclusions from results aquired this way" [19, p.15]. Timman worked with the Centre for a short period only, heading the Applied Mathematics Department in 1951-1952. He did however maintain close contacts from 1947 onwards.

Reflecting the context

The Mathematical Centre was founded in 1946 in the societal context of *reconstruction.* The Minister of Education, Arts and Sciences, Van der Leeuw, and the Prime Minister Schermerhorn staked out the policy frames for a new societal role of science. Their ideals of science guiding civilization and producing welfare were reflected for the particular case of mathematics in the background ideas of the Mathematical Centre: mathematics as a cultural force and as a productive force.

The general acceptance of such tendency towards a new societal role of mathematics certainly did mean a breakthrough in the usual sense for the Dutch mathematical community. This change in view was not merely an academic matter. The abstract science of mathematics proved to have in fact something to contribute to reconstruction. In the concrete form of mathematical modelling mathematics was made serviceable to industry and commerce, to society in general. Developing a tradition of mathematical modelling was one of the characteristics of the Mathematical Centre. Thus the postwar context was not only reflected in views concerning the particular case of mathematics but also given concrete form.

Being the reflection of a general cultural and political context the

Mathematical Centre was not unique. Others than the founders of the Centre, and of course others abroad, held similar views on mathematics. Outside the academic scene mathematical modelling was practiced and further developed, particularly in the fields of econometrics, statistics and operations research. Industry and commerce had not been waiting and had some right to be sceptical in the talks with the Centre's Board of Directors.

What is special about the Mathematical Centre is the fact that academic mathematicians were engaged in developing here practice-oriented mathematics, although here as well no uniqueness can be claimed. A singularly beautiful example of academic-commercial cooperation is given by Freudenthal (Utrecht State University) and Sittig (advisor for Applied Statistics, Rotterdam) conducting a large scale statistical enquiry in order to develop a sizing system for clothing [11]. At the Mathematical Centre however the pursuit of serviceable mathematics was systematic and institutionalized. Still in 1959 Hemelrijk claimed worldwide uniqueness for the Mathematical Centre as an institution engaging mathematicians in the combination of pure and application oriented mathematics [12].

In the Netherlands the Mathematical Centre acquired a central position in this field. Today a majority of Dutch academic computer scientists and statisticians count Van Wijngaarden and Van Dantzig respectively as their scientific father, grandfather, or great grandfather... . Indeed at the crossroads of application oriented mathematics and pure scientific research the Centre played an initiating and forerunning role in those early years. Part of this role was taken over when the Universities of Technology established a program for the education of Mathematical Engineers, for the first time at Delft in 1958, initiated by Timman.

When in 1952 Timman was called away from the Mathematical Centre to take a chair of mathematics in Delft he consolidated the attained changes and preluded further development [19, p.16]: 'It is my impression that a large influx of mathematicians with an insight in technology or of engineers with a sound knowledge of mathematical methods will be welcomed with joy in many places. Also in our country the road has been opened for mathematics to a new social function and I hope that the opportunity will be found to make it hold this function with honour'.

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