THE FUNCTION OF MATHEMATICS IN MODERN SOCIETY AND ITS CONSEQUENCE FOR THE TEACHING OF MATHEMATICS

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THE FUNCTION OF MATHEMATICS IN MODERN SOCIETY AND ITS CONSEQUENCE FOR THE TEACHING OF MATHEMATICS [1]

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CONTENTS

1. SOCIETY'S GROWING DEMAND FOR MATHEMATICS.

The degree to which mathematics are applied to other sciences and to non-scientific social activities is rapidly increasing, in particular during the last decades: any convenient mathematical model for it would have to have positive derivatives, at least of the first and second order.

Firstly the number of fields to which mathematics are applied increases. To the classical fields: astronomy and geodesy,

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[1] Report presented by the author on bequest of the National Committee of the ICMJ in the Netherlands before section VII of the International Congress of Mathematicians, on September 8, 1954 in Amsterdam.

mechanics, physics, technical and actuarial sciences, later biology, economy and psychology have been added, at first in the form of biometry, econometry and psychometry, mostly using statistical methods. More recently such methods are more and more applied to industrial planning, to medicine, biochemistry, physiology and pharmacology, to sociology, cryptology, etc.

Also philosophy and even linguistics (mechanical translation), get slowly interested in applying mathematical and symbolic logical and semantical methods. It is a curious fact that, although often a first initiative was taken by mathematicians, it is on the whole not due to mathematical propaganda and advertising, but rather to genuine autonomous demand from the side of the workers in these different fields, which feel more and more helpless if they cannot handle the mathematical methods themselves. Only a few domains have abandoned the use of mathematics, in particular music and the pictorial arts (perspective). Whether to their advantage or not, more competent judges may decide. Among the fields which have hardly begun to make use of mathematical and logical methods occurs, surprisingly, the teaching of mathematics.

Also the number and the variety of applications of mathematics have greatly increased. Extensive new branches have been created which are wholly or mainly based on mathematical methods. As such we mention, leaving aside the classical fields of physics and astronomy[1]: Design of experiments, in particular the analysis of variance, at first mainly used in agriculture, later also in many other fields; Renewal theory in mathematical population theory; Theory of risk and net retain in insurance; Symbolic logic and semantics; Biomathematics; Factor analysis in psychology, etc.; Quality control; Mathematical theory of communication; Information theory and cybernetics; Econometric decision theory, based on the theory of strategic games, in particular linear programming; Periodogram-analysis and time series theory; Theory of statistical decision functions, etc.

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[1] Neither this nor any other of the further lists has any pretention of completeness.

Although we might not claim that the new theories in all cases yield a practical output equivalent to their mathematical difficulty, the judgment of the workers in these fields considers them on the whole as beneficial to their particular domain.

All this requires a re-orientation of the teaching of mathematics, in particular in secondary schools, towards which the present enquiry of CIEM may be considered as a decisive step.

2. Pure and applied mathematics.

Until a few decades ago applied mathematics was considered by the majority of mathematicians as second rank mathematics, notwithstanding the fact that almost all mathematicians till Laplace and Gauss, and since that time e.g. Riemann and Poincaré derived some of their most important results from the applications. This opinion expresses itself already in the word " pure " which is a (positive) " appraisal " according to Charles Morris' terminology, and is probably related to the then preponderant idealistic philosophy, mostly from German origin. It overrates greatly some special features of socalled " pure " mathematics, which, apart from a few branches like number theory and topology, almost all originated humbly from old applications (e.g. the theory of—in particular partial—differential equations and integral equations; Bessel-, Legendre-, and most other special functions). Applied mathematics seems to be like wine: it becomes pure just in course of time. With regard to mathematical rigour and generality modern applied mathematics need not be a second to the pure brand. In fact, mathematical rigour is often overdone in modern applications. A scientific theory then becomes a counterpart to the king's palace in the story of Aladdin's lamp: if a problem belongs to a scientific theory containing many points of considerable doubt and rough approximations, then to give a perfectly rigorous proof of existence of its solution in the mathematical part, is like building up one window of the palace wholly out of diamonds and rubies, whilst leaving all other ones made from plain glass.

3. Postwar development in the Netherlands.

Before the last war the development of " pure " mathematics was mainly centered in the mathematical departments of the universities, the Technical University at Delft and the Royal Academy of Sciences, and in the " Wiskundig Genootschap " (Mathematical Society), whereas " applied " mathematics was mainly developed in some other departments of these institutions, in the agricultural school at Wageningen, in some governmental or semi-governmental institutions like the Central Bureau of Statistics (C.B.S.), the National Aeronautic Laboratory (N.L.L.) and the Royal Meteorological Institute (K.N.M.I.), and in the laboratories of some big industries like Philips (Eindhoven) and the Shell Laboratories. There were some links between " pure " and " applied ", but only a few.

Since the war the recent development in other countries sketched briefly above, has had a considerable response in the Netherlands also. Several initiatives were taken just after the liberation of our country (which occurred at the very last moment only, on May 5th, 1945), although some of them came only slowly into effect, partly because we had been cut off from almost all scientific activity during the latter part of the German occupation, and could not obtain foreign literature till about 1946-1947 or even later.

In the first place the number of professorships in mathematics was increased by roughly 50%, and they were made more effective by the appointment of lecturers, instructors and assistants. Also the universities created some (mostly minor) positions for the instruction in mathematical education for future teachers. All this, however, is not characteristic for mathematics alone.

Further, shortly after the war, a new chair in the " Theory of Collective Phenomena " (mathematical statistics), one for (mathematical) logic, two special professorships in the actuarial sciences and one in applied mathematics, were founded at the University of Amsterdam. Later also professorships for statistics at the University of Groningen, the " Free University " at Amsterdam and the Technical University at Delft, a chair for mathematical economy and econometry at the University of Amsterdam, and a second professorship in the same field at the Economic School at Rotterdam came into being, whereas the Technical University at Delft recently devoted one of its mathematical chairs completely to applied mathematics with the intention of creating a new kind of instruction, viz. of " mathematical engineers ". Also some of the chairs of mathematics in the universities are partly devoted to applied mathematics and new ones are being or going to be created.

Moreover, we mention a few new institutions like the governmental Central Planning Office, the department for (computational and statistical) elaboration of observational results of the (governmental) Organization for Applied Scientific Research (T.N.O.), the Quality Service for the Industry and the Mathematical Centre.

Finally some societies were founded which are closely related to mathematics, like the Society for Statistics (which has a special section for mathematical statistics, and which amalgamated later with an older and less mathematically minded statistical society), the Society for Logic and Philosophy of Science and the Benelux Region of the Biometric Society.

Also several research—and discussiongroups came into being. We mention those on

Asymptotic expansions;
Computing methods and machines;
Communication and information theory;
Biophysics and Cybernetics;
Econometry;
Application of Statistics in Industry;
Standardization of statistical terms and symbols;
Statistical extreme value problems (in connection with the flood prevention);
Storm surges on the North Sea (ditto);
Teaching of mathematics;
Renewal of education.

The Mathematical Centre, mentioned above, was founded in February 1946, on the initiative and according to the plans of three " pure " mathematicians. Its purpose was: to further the development of applied as well as pure mathematics in the Netherlands, and, in particular to bridge the gulf between mathematics and its applications by, on the one hand, inducing mathematicians to bring forward their results in a form easily understandable by " appliers " with scanty mathematical training, and, on the other hand, teaching such " appliers " the special mathematical results and techniques they have need of. Its leading principle may be described as " multilateral cooperation ". From the very beginning the Mathematical Centre enjoyed enthusiastic support from many sides, in particular also from the government. It rapidly gained impetus, in particular since the computation department and the statistical consultation got leaders who in a few years became prominent in their fields. It is a foundation, independent of the universities, supported by the government (through its organizations for Pure and for Applied Scientific Research), the municipality of Amsterdam, and, to a small extent, by some big industries. At present it has a personnel of about 80, some of these half-time graduate students.

It has four departments, cooperating closely together, viz. for

Pure mathematics,
Applied mathematics,
Statistics,
Computation,

and a threefold task, namely:

Research,
Education,
Consultation.

The educational task is performed only in such fields and such cases which are not covered already by the universities. It is done by: *a)* organization, preferably in cooperation with other institutions, of colloquia, research and discussion groups, *b)* training mathematical students in consultative work, *c)* courses for non-mathematicians, *d)* methodological statistical instruction of non-mathematical workers by consultation and by methodological sections in statistical reports on concrete problems.

Consultation is done partly on a non-profit cost-price basis, partly (in particular for university laboratories all over the country) free of charge. It comprises often extensive elaboration of observational results, testing of observational evidence, design of experiments, computing, development in pure and applied mathematics, etc.

Research is done in everyone of the four departments, and comprises also design and construction of computing machines.

In order to give an impression of the variety of subjects treated, a list has been added in the appendix of subjects dealt with in consultation during 1953.

4. Flood prevention problems.

On February 1st 1953 the South Western part of the Netherlands, and, to a lesser extent, parts of England and Belgium, were struck by a flood disaster, which exceeded by far any one hitherto observed. It cost in our country over 1750 human lives and far over 10^9 guilders of material losses. On the other hand it gave rise to one of the finest examples of international helpfulness known in history.

In order to find out the best methods for preventing, in asfar as possible, a similar disaster in future, the government immediately appointed a committee, consisting of the most prominent hydraulic engineers, called the " Delta-committee ", because its realm is the delta, formed by the rivers Rhine, Meuse and Scheldt.

The reason why all this is mentioned in this report is the fact that it gave rise to a number of mathematical and physical problems. For solving them the Δ-committee appointed as advisory institutions: the meteorological institute K.N.M.I., the hydrological laboratory of the Technical University at Delft, the (governmental) Central Planning Bureau and the Mathematical Centre.

Parts of the mathematical problems are being solved in different sections of the Ministry of Public Works itself, in the K.N.M.I., the Central Planning Bureau and the Mathematical Centre. Results and plans for further research are exchanged and discussed in two of the working groups mentioned above. The problems fall into three groups:

1. Statistical problems concerning the frequencies of excessively high floods;
2. Econometric decision problems, concerning the optimal height to which dikes must be heightened, taking account of their cost and of the losses caused by breaks;
3. Mathematical physical problems concerning the question, which types of depressions moving over the North Sea are the most dangerous, and which heightening of the sealevel they may cause.

The third group of problems is of the classical type of applied mechanics (partial differential equations with boundary conditions, reducible to integral equations), though showing many complications. The first two groups of problems are not difficult from a purely mathematical point of view, but require a good deal of " practical logic " to avoid many pitfalls into which one might easily step. A survey of results obtained on the second group of problems has been given by the present author before the 8th European meeting of the Econometric Society at Uppsala; one about the first and third group was given before the International Congress of Mathematicians at Amsterdam.

Together they form one of the most important applications of mathematics to large scale government decisions, ranging over a few centuries in time and a few milliards (" billions ") of guilders (or using the standardized physical terminology: giga-guilders), in the Netherlands.

They also form an example of the sometimes insufficiently stressed fact that modern society has a great need, not only of large scale computing, but also of " large scale mathematics ".

5. The social status of mathematicians.

The social position of mathematicians has undergone some change. Before the war a student of mathematics, unless he was exceptionally brilliant, had practically no other professional choice than becoming a teacher in a secondary school, unless he was willing to become an actuarian. The latter prospect was not very attractive for most students—except from a purely remunerative point of view—as the mathematics to be used remained on a rather low level, whereas one had to absorb a good deal of practical economical knowledge, for which no educational base was present. This has been changed now, since the university instruction in actuarial science came into existence, which implies an education in the fundamentals of economics.

Moreover, more jobs in applied mathematics, and especially in statistics became available. At present, the study of statistics can be combined with the actuarial one, a combination which is rather attractive to some students.

The increased number of possibilities in industry, together with those in universities (from professorships to assistantships) and in other institutions has, like in other countries, lead to some shortage in manpower in mathematics, also with respect to teachers. This, of course, is also caused by the customary overburdening of teachers by too big classes and too many lessons, and by their payment which until recently was very bad, but has improved considerably since. A further considerable improvement would be obtained if a " sabbatical year " for teachers could be obtained, not, of course, for taking a " busman's holiday ", but with the special purpose that they may from time to time (while retaining, of course, their salaries) revisit a university, in order to renew their knowledge of modern mathematics, to get acquainted with modern applications of mathematics, and to do some scientific work. Such a large scale " teaching of teachers ", however, is still far out of sight, and, anyhow, diminution of classes and teaching-hours is primordial.

6. Traditional teaching of mathematics.

With regard to some critical remarks on the traditional teaching of mathematics in secondary schools, which will be made now, it must be remarked before that they apply to the situation in the Netherlands, but that the author has some strong misgivings that 1° the situation in many other countries is not essentially different, that 2° probably analogous remarks could be made about several other subjects of teaching, and 3° that the teachers in secondary schools are not to be blamed for it, as they usually have had no opportunity, at least since the time of their study, to become acquainted with the many uses of and needs for mathematics in modern life. [1]

The trend of the following remarks is to state that the teaching of mathematics (we shall further omit the words " in secondary schools ") must in several respects be considered as superannuated and badly adapted to modern needs.

This holds in particular for the choice of subjects. These belong in Dutch schools to: Euclidean geometry in the plane and in space, elementary algebra, plane trigonometry, descriptive geometry, and in some schools the elements of analytic geometry in the plane and/or of the calculus. With exception of the two last mentioned these fields are treated to such an extent that, with a few exceptions, neither a modern " producer " nor a " consumer " of mathematics ever meets the larger part of them. So e.g. in plane geometry some of the congruence theorems of triangles (and practically all of those added as exercises), the concurrence of perpendiculars in a triangle and of bisectors, the formulae for the lengths of perpendiculars and medians, the properties of quadrangles inscribed or circumscribed to a circle and of the regular pentagon and decagon are rarely met with in later life. Similar remarks hold for the other branches of mathematics. E.g. in trigonometry the only things one regularly meets later are: the periodicity and addition properties of the

[1] (Added in proof) Recently Dutch teachers' organizations have accepted a renewal plan for the teaching of mathematics, which by removing several superannuated superfluities and introducing elements of statistics, may be considered as an important step in the right direction.

trigonometric functions and their consequences (e.g. duplication and bisection formulae) and the cosine rule and, a few times, the sine law. Similar remarks hold for the other fields. There are, of course, exceptions, where one meets one of the other subjects, but, unless one works in very special fields like geodesics, nautics, astronomy, etc., these are rare. Moreover, most of the subjects which a professional mathematician meets in later life, he meets in a quite different context, in which it is far easier for him to understand them than by way of the elementary treatment (e.g. the formulae for the volume of a sphere, a spherical segment and a spherical sector, which belong to integral calculus rather than to geometry).

Considering on the other hand the needs of a modern " consumer " of mathematics, which vary, of course, over the several branches of sciences one can say that they contain: 1º a clear idea of the testability or non-testability of a statement, 2º a clear idea of the concept of a mathematical model for some part of empirical science, and of the uses which can and which can not be made of it; 3º a good working knowledge of using graphs and algebraic computing, to such a degree that it becomes a natural habit to translate a problem in symbols (this is often not obtained because of the " fear of mathematics ", often raised by the excessive amount of exercises made); 4º the fundamentals of statistics and probability theory; 5º a few elementary methods of testing the most frequently occurring hypotheses (e.g. sign test, rank correlation test, Student's test, Wilcoxon's test); 6º a working knowledge of elementary calculus, etc.

Teachers sometimes seem to believe that a subject should not be taught, unless it can be taught in relatively great completeness and in a rigorous way, containing proofs of all statements. The consequence of this opinion, however, is that many scientists are prevented from obtaining a good working knowledge of statistics and differential calculus, if they are not (or not thought to be) capable of grasping the socalled " exact " concept of a limit. It also disagrees with the attitude of all classical mathematicians up to Riemann, for whom it always was more important to find new results and new methods

(" rules ") than to prove them. This reminds of the English school-boy having to learn " Euclid ", and saying to his teacher " Bother the proofs. Tell me the results ! "

Another prevailing opinion holds that the secondary education should restrict itself to " pure " mathematics, without bothering much about the applications. This, however, disregards the fact, mentioned already before, that most of " pure " mathematics is old " applied " mathematics. In particular this holds for school mathematics, with the exception of geometry in its Euclidean form: logarithms were introduced purely as a computational method; the solution of algebraic equations by means of roots is due to the fact that roots (from positive numbers) were originally almost the only onevalued functions one could master (this same fact gave rise later to Galois' theory; from a modern computational point of view it is without the slightest importance whether an equation can be reduced to successive extractions of roots, whereas formerly this was highly relevant); trigonometry was introduced as an expedient for astronomical, nautical and geodesical problems; descriptive geometry was introduced by Monge as a method to avoid the at that time very clumsy computational methods. Descriptive geometry is, by the way, the only subject on the mathematics curriculum which is less than about 300 years old; it is even less than two centuries of age !

In this context the fact should be mentioned that the Educational Institute at the University of Utrecht has successfully initiated an experiment in teaching elementary probability theory and history of mathematics in the highest classes of literary gymnasia, and to abolish the teaching of solid geometry and of broken linear functions in these schools. The experiment will be continued with other school-types also.

7. Desirability of a new orientation of mathematical teaching.

The large extent of obligatory mathematical education for *all* pupils in most schools is usually justified, apart from its applications, by 1° stating that " instruction in mathematics furthers logical thinking ", 2° implying that this is a desirable aim for all pupils, and 3° accepting a hypothesis called the " principle of transfer ", which may be expressed by stating that the faculty of logical thinking, if exercised on special subjects like geometry and algebra only, is automatically " transferred " to applications to other subjects also.

For the sake of argument we shall take here the first statement for granted, by disregarding the vagueness of the term and the objections which could be made against it, but which would lead too far away from the main subject. The second statement undervalues the important difference between deductive and inductive logic, and misjudges the fact that purely deductive logic is only applicable within the context of a mathematical model, and that by purely deductive reasoning no non-trivial empirical statement about observable phenomena can ever be proved or disproved. As to the " principle of transfer ", much has been written about it, but the present author is not aware of serious efforts to test this hypothesis empirically in a way satisfying modern standards of research.

Such an investigation should in any case go into the following remarks, which are based on the personal experience of the author only, and therefore, of course, can not be considered as conclusive.

The attitude of mathematicians towards problems which are rather far from the ordinary mathematical sphere, and which can not be tackled by means of deductive logic, seems not to be very different from that taken by other intellectuals, except that the tendency to avoid them may be somewhat stronger among mathematicians. On the one hand it seems that the mathematician's attitude towards them on the whole is rather intelligent and often based on broad human feeling, and that the more extremistic and in particular the more irrational attitudes are not frequent among them. On the other hand a considerable degree of aloofness from political and philosophical questions can be observed among mathematicians, which might point to a feeling of helplessness towards problems where " logic of partial knowledge " is involved and where data are lacking for making treatment on a rigorous base possible. Among those, however, who do not avoid these questions, one finds, notwithstanding the positive qualities mentioned above, only very rarely that the main features of their mathematical work are maintained in this work also. In particular the main characteristic of mathematicians, viz. to take the utmost precautions against wishful thinking and other forms of self-deception can hardly be said to find its counterpart in the context of other activities of the same mathematicians. Thereby it becomes possible that so many political and religious creeds, each accepting a body of statements, which, if pooled, contains numerous contradictions, so that they certainly can not be true all, nevertheless have among their adherents mathematicians, even of the highest quality, or other scientists which have had an intensive mathematical training. Apparently whatever form of automatic transfer may exist, it is insufficient to break through the emotional and traditional background of such creeds, unless the individual is willing and has been trained (or trained himself) in reasoning as "logically" as possible in cases also where insufficient data together with strong emotions are present. Another instance, pointing in the same direction is the fact that most mathematicians, when discussing the value of mathematics, do not, or hardly, consider the possibility that this need not be always positive, or at least do not try to find all serious arguments which might be brought forward for the alternative possibility.

Moreover, although I might not underrate the importance of systematic study of mathematics, and of one of its main characteristics, viz. to separate difficulties and mastering these one after another, one wonders that mathematicians seem not to be able to transfer this characteristic to their educational problems. For, otherwise, how could one understand that mathematical courses do not contain separate parts and groups of exercises for training and testing *separately* the different objectives one has in mind, like acquiring mathematical techniques, theoretical insight, systematizing ability, inventiveness and ability of correct logical reasoning, but that all these elements are mixed up within almost *every* exercise ?

Resuming this argument, we might state that it is at least very doubtful whether training in mathematics, based on deductive logic, leads automatically to an increased capacity of arguing logically in cases where only inductive reasoning is possible, and where often only quite insufficient data, together with strong emotions and/or traditions are present. It seems rather that a special training in the latter direction is necessary. This, however, would make it necessary to revise the " epistemological " basis upon which obligatory mathematical training for *all* students, apart from their respective needs for applications, could be justified. On the other hand this, of course, does not exclude the possibility—which the present author considers as very probable—that deductive and inductive reasoning are sufficiently close in order that teaching of mathematics, provided it will be adapted to the revised needs, may be very useful for the purpose.

Regarding the form of re-orientation of mathematical teaching necessitated by the preceding arguments we might make the following remarks.

1. In the first place is needed: a precise and differentiated formulation of objectives of instruction, using operationally defined terms instead of rather vague terms like " furthering logical thinking ", etc., so that it is possible to test with respect to every pupil, *whether* and/or *in how far* the objective has been reached in his case. The differentiation of objectives should at least entail that *a)* ability to apply special mathematical techniques; *b)* correct ideas about particular theoretical considerations; *c)* systematizing data as well as purposes of an investigation, and following an appropriately chosen orderly line of thought; *d)* inventiveness in overcoming new difficulties, and *e)* correct logical reasoning, either according to the rules of deductive logic (proofs of mathematical statements), or to the less strict rules of inductive or " plausible " inference, can be taught *separately* and tested *separately*.

2. The differentiation of purpose should correspond with a differentiation according to the individual capacities, individual interest, and the professional future of the pupils. Evidently pupils going later to a household-school or getting a job in a

post office or police-HQ, those who go to the university to study law or languages, who go to an engineering school, who are going to study medicine, biology, pharmacology, economy, psychology or social sciences, and those who will become astronomers, physicists, or mathematicians, have quite different needs.

3. This differentiation should be reflected in a differentiation of requirements for the final high school examination, which at present, in the Netherlands, are identical for very large groups of students.

As a final summing up, I believe I may say that we as mathematicians should take care that the mass product we produce, viz. the results of our students, admit a satisfactory quality control, that the results we pretend we can obtain can be subjected to the requirements of testability which the statistician demands from every research worker in biology or medicine, that we are aware of the restricted reliability of our tests (examinations) and admit definite tolerance limits, but also that we know how to balance the "yield", differentiated according to different requirements, against the "cost" in the form of teaching- and learning-hours, and know to treat this as a decision problem.

This seems to me to be a duty of honour for us as mathematicians.

APPENDIX

Examples of modern problems in different fields where mathematics is applied [1]

A. *Statistical applications in medicine, biology and pharmacology.*

1. An epidemiological investigation of tuberculosis in Indonesia.
2. Biological standardization of insulin by experiments on rabbits.

[1] The examples are taken from problems treated in the Mathematical Centre at Amsterdam.

3. The number of leucocytes and eosinophil leucocytes in blood samples from women during pregnancy, delivery and childbed.
4. Errors in counting the number of eosinophils in blood.
5. Measurements on eggs of black-headed gulls.
6. The augmentation effect of hypophysis-extract and adrenal-extract on the preputial glands of rats.
7. Scheme for diagnosing rheumatism species based on serological tests.
8. Investigation of the nutritive value of food taken by pregnant women.
9. Regeneration of rat-livers.
10. A comparison of the vitamin B_1 content of blood in old and young men.
11. Investigation of the public health of two rural districts in Holland.
12. Medicines for yaws.
13. The thickness of the layer of blubber of whales.
14. The number of times bats awake during the hibernation. Capture and recapture of bats for determining the death rate.
15. The influence of light on the growth of tadpoles.

B. *Statistical application in other fields.*

1. Delays in the landing of aircraft.
2. Experiments on laundry cleaning methods.
3. A design of experiments in steel rolling.
4. The frequency of different types of monosyllabic words in the Dutch language.
5. Frequency of delays in a transport system.
6. Comparison of the performance of different types of instruments for repairing broken threads in a spinning mill.
7. Statistical analysis of psychological tests.

8. Comparison of practical work in elementary physics required for students in various Dutch universities.
9. Regression-analysis of the power absorbed by a ship's propellor.
10. Statistical analysis of an investigation of the so-called " earth rays " and dowsing rods.
11. Statistical work for the Flame Radiation Research Joint Committee.
12. A design for a quality control system for an electrotechnical factory.
13. Sociological research on the flood disaster in the south of the Netherlands in 1953.
14. Statistics of mixing solid particles.
15. The life-term of jet planes.
16. Research on a time-scheme for glassgrinders.

C. *Problems treated by the Computation Department.*

1. The investigation of the shape of a fresh-water body under the dunes near Amsterdam. The investigation was carried out for the benefit of the watersupply of the city.
2. Computation of zeros of polynomials in connection with vibrations in railwaycars.
3. The temperature of gasparticles in a hot-air engine.
4. Calculation of the tides on a river on behalf of the government.
5. Integrals of scattering factors occurring in crystallography.
6. The computation and the expansion of triple integrals originating from the theory of cosmic rays.
7. Design of ships-propellers to prevent cavitation of the propeller-blade.
8. Solution of Schrödinger equations.
9. Computation of the form of ships.
10. Radiation-functions occurring in astrophysics.

11. Wavefronts in connection with soundings for geological exploration.
12. Computation of coefficients in connection with vibrating airfoils.
13. Integrals in connection with temperaturedistribution in the human skin.
14. Redesigning a road-system to ensure easy transport of sugarbeets in a rural district that has been flooded.
15. The upheaval of Fenno Scandia.
16. Fluttercomputations for wings of aircraft.
17. Computation of the production of oil-wells.
18. Design and computation of filters for carrier-wave telephony.
19. Radiation of cobalt bomb in cancer-therapy.
20. Fields of radiotransmitters.
21. Forces occurring in certain molecules.
22. Inversion of matrices of a high rank.
23. Flow in homogeneous porous media in connection with watersupply.
24. Boundary-layer computation for aircraft.

LE ROLE DES MATHÉMATIQUES DANS LA SOCIÉTÉ MODERNE ET SES CONSÉQUENCES POUR L'ENSEIGNEMENT MATHÉMATIQUE

D. VAN DANTZIG, Amsterdam

Résumé

L'auteur décrit le besoin accrû d'après-guerre de mathématiques et de mathématiciens dans le domaine social et industriel. Un exposé plus précis de la situation aux Pays-Bas contient une description des travaux mathématiques faits en vue d'éviter