1. General Remarks.

In March this year I finished 40 years of my work in application of mathematics. I had been prepared for such a work, because I studied at the Technical University of Warsaw with a specialization in air-plane construction just before the war. Light Polish sportsplanes but also Polish fighter-planes were well-known in Europe.

After the war Russians destroyed the whole Polish air-plane industry completely and dissipated all the staff. Some specialists escaped abroad. A two-years older colleague from the Technical University of Warsaw, a very good friend of mine, Henry Milicer, after being in England arrived in 1950 to Australia. I was told he is the best Australian air-plane constructor. Now retired, he still lectures in Melbourne.

Because I did not finish my technical studies, I went in 1946 to Wroclaw, a half-a-million Polish town. There in seven months I finished as an extern the whole university course of mathematics and became a mathematician, never being a university-student of mathematics. Two years later I took a doctors degree.

The mathematical school in Wroclaw was one of the best in Europe. At the Department of Mathematics, the University of Wroclaw, we had 8 professors and over 60 readers, lecturers and tutors. All mathematicians met for a common 2-hours seminar twice a week, without any break. Moreover everybody had 2 or 3 seminars in specialized groups. It was an exacted duty.. Science was prior to teaching. Besides there were teaching-seminars for students. Seminars were considered as the best way of teaching as for students so for the staff.

For about 15 years I were conducting something like a mathematical clinic. I tried to heal engineers, physicians, biologists, economists and other misbelievers for their mathematical ills. It was a good school, because I had to solve unexpected problems in a short time, to recognize problems and to formulate them, when given in an intuitive way. I learned to comprehend languages of different specialists.

In course of time, problems became less and less unexpected, because I had learned to solve them. And I solved hundreds of them. From my to-day's point of view, more than 90% of problems, coming spontaneously to such a mathematical clinic, are standard, i.e., they can be solved by means of well-known standard mathematical methods: differential or integral equations, simplex method, statistical tests etc., but, as a rule, after some specific adjustments and transformations. Only few give inspiration for a new mathematical investigation

In course of time I began to analyse consequences of my clinical help and I was surprised that so many of my solutions were misused. Some of them were sold as somebody's own results. But most of so-called practical problems appeared as elements of dissertations prepared to gain a scientific degree, without any notice that the solution was mine. I know cases when my solution composed the whole of somebody's dissertation, putting aside some non-mathematical background. In such cases self-justifications were standard: first a question to me: could you publish, as a mathematician, your result in a mathematical journal? My answer: No, because I have used well-known methods only. Then: You see, you lose nothing, let me be promoted in my specialization

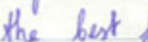
I could tell you much more about crime in science, about international organized groups of swindlers and tinhorns in science, but there is not the time and place for it.

The second period, about 5 years long, was characterized by solving big state problems given by government. For example, I optimalized the distribution of electric power in the whole country, saving a significant part of that power. The result of cooperation with government was: much honour (I was even proposed to be a viceminister for computer-industry), many polite words, no money, no prizes and finally a strong persecution because of my cooperation with some fired ministers.

For the last 10 years in Poland I was working in applications in a quite different and better way. I adopted the following fundamental principle: not to help, not to give services, but to take part as an equal partner in solving problems, from the very beginning. It is a characteristic feature of modern science that the most important problems are being solved by collectives of heterogeneous specialists. I have managed such a cooperation only in some branches of medicine. My trials in economy, agriculture, technics, sociology, philology, psychology, failed. I know why. If somebody were interested I should be ready to speak about it in private talks.

Only cooperating in collectives we are able to recognize the whole of a problem and to construct adequite mathematical models, which is the only way to enjoy an applied mathematician.

The last remark concerns the form of issue of mathematical solutions. If possible, a geometrical form is the best for nonmathematicians because of easier understanding, interpreting and discussing. Hence the importance of graphical methods, among others nomography.

In my first seminar I told you already about my results with nomographic functions. Now I should like to mention a method of constructing nomograms of great exactitude. When dealing with a collinear nomogram of the form  $z = f(x,y)$, we are able sometimes to increase its exactitude by partitioning of scales into bundles of parallel straight-lines, each being the continuation of the previous one . Then the results can be read with 3 decimal places.

To-day I shall not speak about hundreds of problem I solved in a standard way. I have chosen only the funniest ones.

In order to shorten my story, I shall omit most of assumptions, which proper formulating is very time-consuming.

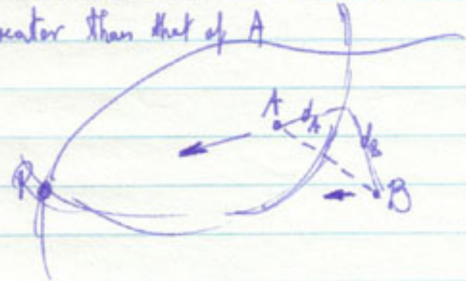
2. Some Results In Computer Science.

Poland was one of the first countries, which started a research work in Computer Science. The first seminar was organized at the beginning 1948. I was one of the four scientists, who took part in it and the only mathematician among them. While the others started to work in hardware, I began to develop numerical methods and other problems of software.

Still in 1946 I proved that mankind has made a fatal mistake choosing the decimal system of representing numbers. I proved that the ternary system is the best one, with 3 digits: -1, 0, 1. Computation in this system is much easier than in others. I learned to compute in it and I proved that I can add, multiply, divide big numbers in a surprising simple way, in writing and in mind. Moreover the ternary system is the most natural for computers, because there are three magnetic states and three electric states: +, - and 0. Only because of technological troubles, we have still binary and not ternary computers. I know that some people are trying to solve the technological problems and to construct such a ternary computer, which ought to be better than a binary one.

3. Solution Of Some Pursuit problems.

Let us consider two ships A and B, B hunting A near a coast. Let us assume that the coast-line is sufficiently smooth and the speed of B greater than that of A.



I proved that the best method for A is to turn (at highest speed) to the furthest point of Apolonius'es circle. (Apolonius'es circle is the set of points, for which the ratio of distances from two fixed points is constant). ~~We assume, of course, that the speed of B is greater than the speed of A.~~ The best method for B is to keep (at highest speed) the direction of the straight line passing through A and B. The game is closed, because

$$\max_A \min_B t = \min_B \max_A t$$

when t denotes the time of pursuit. When A and B use optimal method, the Apolonius'es circle does not change and both A and B run at highest speed to the point P.

This and some connected results gave inspiration for further investigations. Among others, Professor Choquet from Sorbonne, Paris, who visited Poland just as I presented the above results, solved a more general problem of pursuit by means of (partial) differential equations of fourth order, where time was the dependent variable. But my results ~~could be~~ were obtained on a quite simple way.

4. A method of measuring the area of plane regions.

Let us have a plain region Q

and let us count the number of lattice points included in Q. In general the lattice may be considered as consisting of equal parallelograms. By multiplying the number of lattice points included, by the area of a single parallelogram we obtain an approximation w for the area a of Q. The error can be estimated by a linear function of the length of the border-line

$$-c_1 l + c_2 < a - w \leq c_3 l + c_4$$

and I found the best values of $c_1, \dots c_4$. I proved that ~~generally~~ the error is minimal when the lattice consists of equilateral triangles. Then

$$-cl + (q-2) < a - w \leq cl + (q-2)$$

where c is a constant:

$$c = 0{,}568575\ldots$$

and q is the number of closed lines forming the border.

For square lattices we have $c = 0{,}582822\ldots$

The method were being used in leather-industry for measuring the area of skins.

5. Dimensional Analysis in sampling inspection of merchandise.

Sampling inspection of merchandise consists in examining a sample drawn from a lot and thus establishing a characteristic of the lot. The theory of sampling inspection is usually based on the theory of probability and mathematical statistics but then it has some disadvantages. I'd like to show you now a funny phenomenological method based on dimensional analysis. I constructed such a method together with Professor Drobot, who escaped from Poland over twenty years ago and was a Professor at the Columbia University in Ohio, USA. Professor Drobot constructed the first mathematical theory of dimensional analysis. Simplifying the problem I can say that his theory is based on a vectorial space but in a multiplicative form. In the method I am just to describe, he was responsible for the theoretical base of problem and I found the following application.

~~Let us denote by square brackets the dimension of a quantity.~~

Let us introduce the following quantities with corresponding dimensions:

Symbol	Quantity	Dimension
N	the size of a lot (the number of pieces)	$[N] = PIECE$
W	value of a lot	$[W] = DOLLAR$
n	the size of a sample	$[n] = piece$
w	value of a sample	$[w] = dollar$
$C = \frac{W}{N}$	price of the lot	$[C] = DOLLAR \cdot PIECE^{-1}$
$c = \frac{w}{n}$	price of the sample	$[c] = dollar \cdot piece^{-1}$
q	conversion coefficient ($C = qc + C_0$)	$[q] = DOLLAR \cdot PIECE^{-1} \cdot dollar^{-1} \cdot piece$
S	dispersion of value of one PIECE in the lot (as an algebraical notion)	$[S] = DOLLAR \cdot PIECE^{-\frac{1}{2}}$
s	dispersion of value of one piece in the sample	$[s] = dollar \cdot piece^{-\frac{1}{2}}$
$K = \frac{B}{n}$	price of the inspection of the sample, B being the inspection costs	$[K] = DOLLAR \cdot piece$

First, let us find the size n of the sample in the form

$$n = \alpha N^{a_1} k^{a_2} s^{a_3} q^{a_4}$$

where α is a constant factor. It follows that

$$[n] = [N]^{a_1} [k]^{a_2} [s]^{a_3} [q]^{a_4}$$

$$a_1 - a_4 = 0 , \quad -a_2 - \tfrac{1}{2} a_3 + a_4 = 1$$
$$a_2 + a_4 = 0 , \quad a_3 - a_1 = 0$$

Hence

$$a_1 = a_3 = a_4 = \frac{2}{3} , \quad a_2 = -\frac{2}{3} .$$

$$n = \alpha \left(\frac{Nqs}{k} \right)^{2/3}$$

In the case $q = 1 \frac{\text{DOLLAR}}{\text{PIECE}} \cdot \frac{\text{piece}}{\text{dollar}}$ this formula in the form

$$n = \left(\frac{Ns}{5k} \right)^{2/3}$$

may be found in mathematical statistics.

Now, let us find the price C of the lot. In a similar way we find

$$C = \beta \left(\frac{k q^2 s^2}{N} \right)^{1/3}$$

Let us take notice of the simplicity of the above method.

SYMBOL	QUANTITY	DIMENSION
N	size of the lot	PIECE
n	size of the sample	piece
W	value of the lot	DOLLAR
w	value of the sample	dollar
C	$= \frac{W}{N}$ price of the lot	DOLLAR · PIECE^{-1}
c	$= \frac{w}{n}$ price of the sample	dollar · piece^{-1}
q	conversion coefficient: $C = qc + C_0$	DOLLAR · PIECE^{-1} · dollar^{-1} · piece
S	dispersion of value of one PIECE in the lot (algebraic)	DOLLAR · $\text{PIECE}^{-\frac{1}{2}}$
s	dispersion of value of one piece in the sample (algebraic)	dollar · $\text{piece}^{-\frac{1}{2}}$
k	$= \frac{B}{n}$ price of the inspection of the sample, B being the inspection costs	DOLLAR · piece^{-1}

6. Mathematical Modelling.

I shall constrain myself to some fundamental synthesizing remarks.

We can divide mathematical modelling into deterministic and stochastic, static and dynamical. They differ totally.

Most of important practical problems require dynamical stochastic modelling, which is most complicated and difficult. Especially, many problems could be solved by methods of stochastic control (medical treatment, economy, politics etc.).

The theory of stochastic control is one of most difficult mathematical theories.

There exists a big gap between theory and practise of stochastic control.

The theory of stochastic control is not an adequate method for practical stochastic control, because of permanent lack of data.

Thus we are not able today to model the most important problems.

Mathematicians must concentrate themselves on finding quite new methods adequate to practical stochastic control and operating with minimal number of data.

7. Medical Models.

Medical problems belong to most difficult, because they are dynamical, stochastic with large dispersions and experimental area is very limited, because of humanistic reasons. On the other hand, they belong to most important, because of human health and life.

I have been working in medicine for over 30 years. First 25 years failed totally. I could not get sufficient accuracy of my mathematical models. Finally I have passed the methodological barrier and became able to construct many good medical models. Finding of normal regression was the turning-point, because it improved the accuracy of models in a significant way. But also other tricks have helped here. For example, an adequate method for selection of homogeneous patients.

Finally, I was able to construct medical models with correlation coefficient between real and approximate quantities over 0.95. I was fully satisfied, when, during an international symposium on cardiology, I was able to speak about some diseases only on the basis of my models, my numbers, because my medical knowledge was rather poor, and one of the prominent cardiologists, speaking just after me, told that I have described the problem in such a way that he has nothing to add. Nobody believed me that not my medical education but only my models formed my knowledge.

I should like to show you a typical result, concerning optimal dosage of digitalis for patients suffering chronic congestive heart failure, when the distance between the toxicity limit and the limit of efficiency is very small. Moreover, efficient level for one patient can be toxic for another. Errors in dosage are measured by the number of dead patients. Mortality is about 10%.

The model, I am presenting now, is dynamical, constructed on the basis of a prognosis for the 3-rd day in advance, by method of step-by-step regression. The 6 symptoms were choosen mathematically as the best and they coincide surprisingly with best medical ones.

From medical point of view only pO_2 would be better interpretable than pCO_2, because the first characterizes the amount of oxygen in blood. But physicians agree that pO_2 is very changeable and pCO_2 negatively correlated with pO_2 is more stable and therefore, perhaps, more representative.

I constructed hundreds of medical models. The presented is only one of them, but one of best.

My work in medicine was interrupted by conditions, independent on me, which were created in Poland, and my escape abroad.

I was just going to solve a very important problem: prediction of death for patients with heart failure for some days earlier than practitioners can do it, which means prediction in such a time that a prophylactic treatment ~~is still possible~~ and rescue is still possible. I am able to solve this problem but I have no data.

Shall I find partners in Australia?

THE SPECIFYING OF DIGOXIN (DG) AND LANATOSID C (LA) DOSAGE BASING ON THE PREDICTION OF TOTAL BODY CONCENTRATION OF DIGITALIS

„Normal" correlation coefficient: 0.952
Central correlation coefficient: 0.705