Real Life Mathematics

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I grew up in pure mathematics: after a Ph.D. under the supervision of Laurent Schwartz in 1976, I worked in functional analysis (geometry of Banach spaces, Operator Theory, polynomials). I was appointed as Professor at the University of Lyon (France) in 1979 and, during many years, like most mathematicians, I managed to conciliate research, teaching duties and Ph.D. supervision (altogether, I directed 23 theses).

But, in 1995, I decided to leave my Professor position at the University and to start a company, named "Société de Calcul Mathemátique, SA" (in short, SCM). What this company sells, and how it sells it, is the topic of the present talk.

We have four branches: defense, environment, statistics and operations research. Let me describe, roughly speaking, what each of them does.

— defense is mostly concerned with trajectography. It may be planes, submarines, missiles, or whatever, the topic is the same: find the best route under various constraints; to see as much as one can, to hear as much as one can, not to be seen, not to be heard, and so on.

— environment has a permanent preoccupation. People in this area have some models, usually simple and empirical, and they want to investigate the quality of the model. For instance, you dig a hole, put some waste in it; how much of the waste will come out, 100 km away from the hole, 10 years later? The same concern holds, with other figures, for atmospheric and marine pollutions.

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— statistics is used for data analysis, in many situations. It may be about unemployment, or as a tool, in order to study the robustness of models coming from various situations.

— operations research deals mostly with logistics. Companies want to improve the organization of their stocks, deliveries, the management of their factories and so on.

In all these situations, there is a common factor: what is required from us is mathematical modeling. The problem is never given to us in a language where a mathematical tool, already existent, would be applied. It is always our duty to put the problem in mathematical terms, and this part of the work represents often one half of the total work, because one often has to change the model until we are sure it fits with the client's requests. How do we know? Well, we don't until we have presented preliminary results, and seen how the client reacts upon these results. It is only the final confrontation of our solution with the client's needs which will indicate whether the model was correct or not.

Many young people write to us: they apply for a job at SCM. They write the following way: "I am qualified for a mathematician's job, since I have studied optimization, numerical techniques, this and that software, and so on". That's nice, of course, but this does not meet my concern. My concern is, primarily, to find people who are able and willing to discuss with our clients, trying to understand what they mean and what they want. This requires diplomacy, persistence, sense of contact, and many other human qualities. This is a matter of personality, which is not taught, never at school nor at the university, and which is much harder to acquire than any technical knowledge about, say, the simplex algorithm. Why should I care about specific knowledge in optimization theory? First of all, in most of the cases I can do it myself in five minutes, and if I cannot, I can still ask some former colleagues at the University.

Let me give an example in order to indicate what type of hesitation the client has. Say that he has some delivery to optimize. Usually, what he says is that he wants to reduce the cost. Then there is an obvious mathematical answer: stop the delivery, fire the drivers and sell the trucks: there will be no cost at all! Usually, this is not acceptable, because the client wants (but did not say so) some service to be done. For instance, some goods have to be delivered to various places. OK, still: hire one man with a bicycle, let him take his time. He will deliver everything at proper place within three months. Again, this is not acceptable: it turns out that the work has to be done in a certain delay. What delay? This is unclear. What the client wants is in fact some quality of service, but usually he is unable to describe this quality in quantitative terms.

Once the modeling is made, we have to solve the problem. Since our problem is "real life", it never fits with the existing academic tools, so we have to create our own tools. The primary concern for these new tools is the robustness. Indeed, the data are known only within some range, say 20%, so the model must take this uncertainty into account. Academic tools, instead, put the emphasis upon accuracy and speed of computing, which is totally wrong. Say to the commandant of a nuclear submarine that his escape trajectory will take him 3 hours, 24 minutes and 7 seconds: he will laugh, because this does not make sense, since he does not know exactly where the threat is. And if he laughs, that's a very bad sign, which means you have not understood the problem. Conversely, if you tell him instead: if the threat is in this zone, your escape will take you roughly 2 hours and if the threat is in that zone, it will take 3 hours, that's something he understands because it meets his preoccupation.

Very little exists, taking into account robustness preoccupation, so we have to invent our tools almost all the time. These tools are of high level, but borrow very little from recent academic research. Are these academic theories, such as optimal control, useful at all to us? That's hard to say, but in any case definitely less than what people think. For this reason, usually, when I receive an application, for a job, of someone who presents himself as a strong specialist of some narrow field, I disregard this application, because there is little chance that I can use his knowledge, and there are many chances that the guy wants to put that precise knowledge into operation, no matter whether it is appropriate or not. Conversely, broadness of knowledge, familiarity with real situations, willingness to learn and discover new problems, openness of mind, are the features I consider mostly.

It should be clear by now that we are doing very little numerical mathematics (what people usually call "scientific computing"). The reason is that there is very little demand in this area. Existing software, together with increased speed of the computers, satisfies most needs, so the demand is rather towards better models, more robust, and not in precision or speed of computing.

This, altogether, goes very much against the education given, at

Master or Ph.D. level, to young mathematicians, and goes against the present development of mathematical research, as I have done it myself for more than 16 years. Indeed, what academic mathematicians do, or try to do, is to prove theorems, and they train their students in the same direction.

These theorems usually concern some deep and narrow question, left unanswered by the previous generations, or some arbitrary generalizations of earlier work. The impact of such theories upon real life mathematics is usually extremely small, not to say zero, especially since the solution is put, by means of the publications system, in terms which are understandable only to the specialists of the domain. Those who might need it, by some chance, will never notice.

Most current mathematical research, since the 60's, is devoted to fancy situations: it brings solutions which nobody understands to questions nobody asked. Nevertheless, those who bring these solutions are called "distinguished" by the academic community. This word by itself gives a measure of the social distance: real life mathematics do not require distinguished mathematicians. On the contrary, it requires barbarians: people willing to fight, to conquer, to build, to understand, with no predetermined idea about which tool should be used. We, at SCM, are not yet barbarians, but we are working on this. Of course, it takes some time, due to our earlier education.

In academic life, people have specific ambitions, and customers' satisfaction is not one of these ambitions. They want to be recognized, to obtain some notoriety, to be published and quoted, to get prizes and honors. We, at SCM, live on the service we give to our customers. And we remember what Thomas Grey wrote in 1732 (Elegy in a churchyard):

"The paths of glory lead but to the grave."

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