# 58th European Study Group
# Mathematics with Industry

**Wednesday January 31, 2007**

The experience of a number of Study Groups learns that a number of people visits the Study Group on Monday to only hear about the projects; they will not participate in the teams. With a packed room on Monday, the organisation hopes of course that the decrease on Tuesday and later on in the week is minimal – and they can be satisfied: all teams have a reasonable core, and during the day, the discussions are vivid and stimulating. Tuesday is quite often a day for divergence – different approaches are suggested, the teams split up, some people sit alone and work quietly on their own approach.

But quite soon, Wednesday is nearing – and the organisation has organised a meeting in the afternoon where a comprehensive story should be told by each team: what is the status, what type of approaches are used, what are the stumble stones.

**KLM – Optimising the reserve strategy of cabin crew**



*Part of the team for the KLM challenge – Heidi de Ridder (KLM) is explaining details why certain solutions may be mathematically correct but will result in too much discomfort.*

The KLM team is located in the basement of the Math building. Around a large table, they are discussing about the problem, partly in Dutch, partly in something that resembles Russian. KLM – Heidi de Ridder – assists the team by explaining a number of important side conditions. It turns out that the mathematical formulation (model!) is quite difficult, let alone the optimisation of it. Discomfort can occur on a detailed / flight-attendant level, and to express this in a cost function is not easy. The group is not too big; it is convenient to investigate a number of directions while being able to discuss the overall approach and results at certain instances of the day. But the team has still a long way to go – a week is short!

◄



*The rest of the KLM-team.*

**Innogrow – Optimising a closed greenhouse**



*The Innogrow team has some senior experts on board; Jaap Molenaar has recently exchanged Eindhoven with Wageningen – does he have enough 'green fingers' to get a grip on this challenges.*

The Innogrow team is located in the Minnaert building – this turned out to be a disadvantage in the beginning, since we all left for the Math building directly after hearing the problems on Monday afternoon and returning to this building did not appeal to everyone. Eventually, a few teams were too big, and people were persuaded to change 'problem'. But the Innogrow team has now a convenient size as well, and the problem is attractive enough to receive professional attention from a reporter from the Dutch newspaper NRC.

The team has focused on the utility model; given a reference year, can we compute – on an hourly basis – the optimal use of energy sources. At the moment this still is a

linear programming problem, but the discussion has a few topics: can we work this out not only for a few weeks, but also for a complete year, and isn't there some non-linearity in the problem? The modeling of the heat pump may be too simple, and experience shows that these details may be the difference between profit or loss.



*A colleague reporter for the NRC is interviewing one of the team-members.*

## ASML – Rastering a chip layout
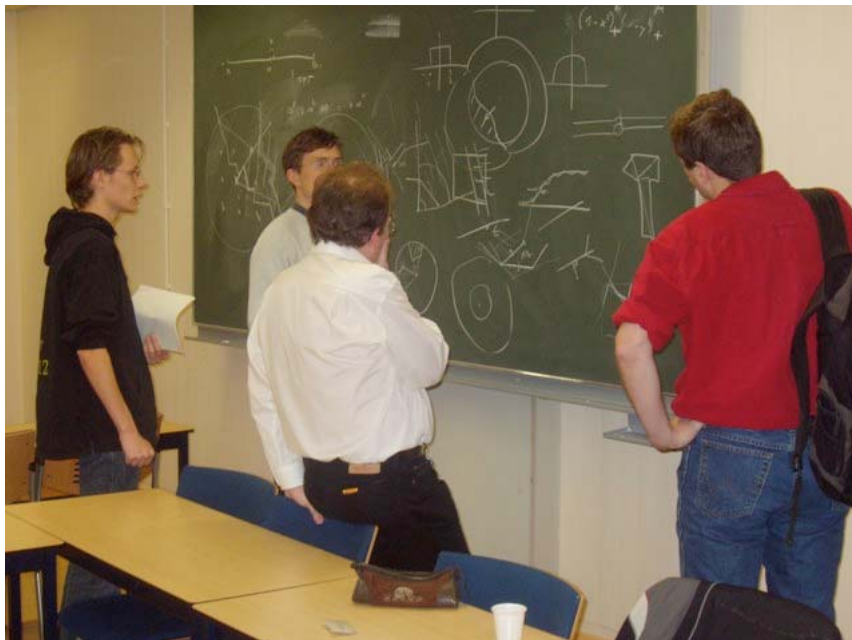


*The ASML team – or part of it – has chosen a well-known position: staring at a blackboard, with a piece of chalk in your hand, chewing on something genius…*

Also the ASML team has some Study Group die-hards on board. The team is not too big, and is also located in the basement – no windows! This group is ready to do some serious computations. The modeling phase has been relatively straightforward, and it now requires creativity and computational engineering to get a reduction of the number of flops. There is no room for asymptotic expressions like 'this method is N

log N' since, in the words of Mark Peletier: 'N is fixed – it's all about the factors in front of N log N'.
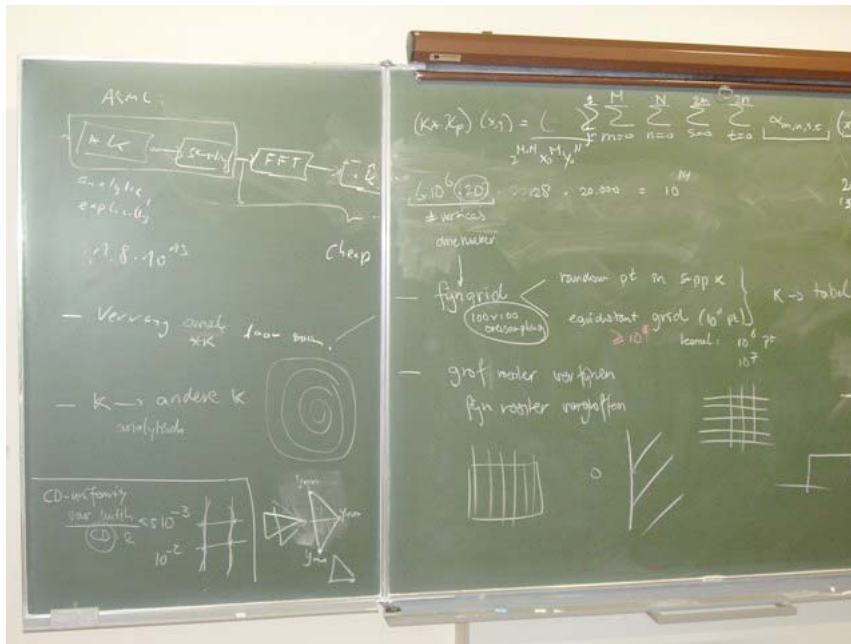

*This looks structured!*


*Everyone is attending the afternoon session – but someone has to do the 'dirty work', or …*

## ING – Improving an option pricing model

The ING team has the advantage of having extensive documentation about the problem. However, this gives the experts the impression that ING has already chewed on this problem for some time – will they be able to solve this in a week? The proof for the Heston model is not easy to grasp, and certainly not easy to generalize. And then a typical suggestion arises: can we change the problem ☺ ? Hmm… But changing the problem is not always identical to 'walking away' – you may get some new inspiration from a problem that you might be able to solve more easily. So the

group has split into three subgroups: some are diving into the literature to grasp some more details, some try to formulate similar looking problems that may be slightly easier to attack first, and finally we have the 'brute force' group, trying to attack the problem with 'computers only' …



*The ING team looks a bit small – but the rest is hiding in the computer room, to use brute force!*



*Just before he leaves a final thought on the blackboard. 'What if …'*

**UMC – Rapid calculation of the radiofrequency pattern in MRI**

The UMC team is definitely the most crowded team of this Study Group – I'm hardly able to squeeze myself into the room and find a place in the back of the room. This group has an agenda – they are at point 1 – b!! Wow, this is looking serious. Different approaches are discussed and compared – is yours really different from mine? Is it 'cheap'? Aren't you overlooking something? It turns out that the group had to start from the very basics – Maxwell's equations, and the interpretation of different symbols and constants – to avoid that everyone is solving his own favorite Maxwell's equation.
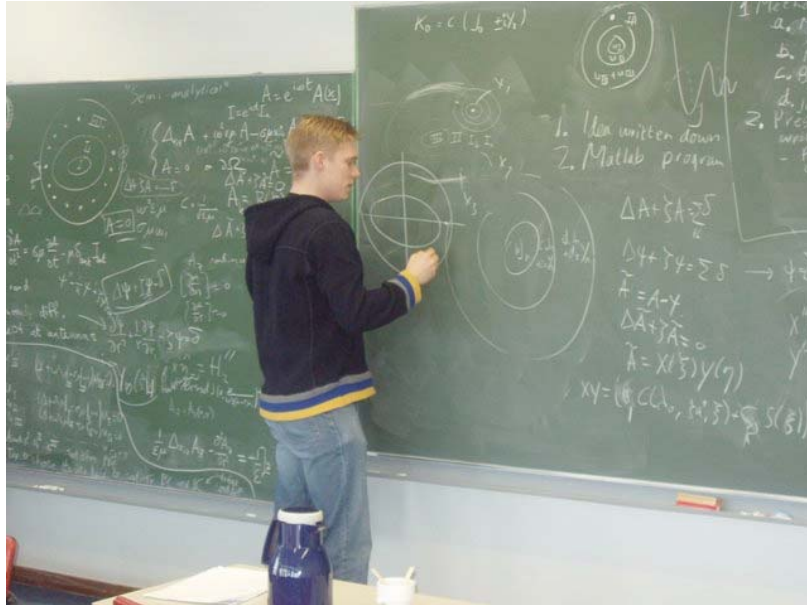


*Definitely the UMC group – circles, ellipses, field equations – we cannot be mistaken!*

The boundary conditions get quite some attention – are you approaching the boundary with a circle, an ellipse, or are you treating the shape of the boundary exact but using a finite number of simple base functions? There is always an error, but is your error bigger than mine??



*They look quiet – but that's just 'keeping up appearances' – a lively discussion within the UMC group!*

**AMC – Optimising the function of artificial heart pumps in humans**

Finally, the AMC team is again located in the Minnaert building. This problem turns out to be a very interesting modeling problem. The modeling of 'everything but the heart' has strong resemblances with a circuit, including potential, resistance, etc. The heart itself is more of a problem – literature is not conclusive about it, and the team starts to doubt one of the references. And then we have numerics: the team has laid its hands on a computer program which does 'everything' (excluding the pump!), but cannot really grasp the messy program lines. So there is not much fun.



*The AMC team, working hard on the models from literature, and some of their own!*



*Let me explain it once more …*

Just before the afternoon session, we have a coffee / tea break, but somehow I get the feeling that most of teams rather like to continue – Friday is nearing …



*Erik Fledderus*