

Opening Session



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Opening Session

Keld Jørgensen, Royal Danish Brass

Your Excellencies. Good morning.

We have the pleasure of being the musical frame of this opening session and we started with a truly festival piece, a piece written by Henry VIII of England. It is called – and this could be the *bon mot* of this event – “Pastime with good company” and we continue with another royal piece, a Danish piece written by an Englishman, John Dowland, to the Danish king Christian the Fourth. The title is “The King of Denmark’s Galliard”.

Ingvill Stedøy, Mistress of ceremonies

God morgen, velkommen til København. Good morning and welcome to Copenhagen and the 10th International Congress of Mathematical Education.

It was the Royal Danish Brass that welcomed you with this great music. I myself am Ingvill Merete Stedøy, I am a member of the Nordic Contact Committee. Since this is a Nordic event we have been working for almost five years in the Nordic countries and now we are finally here. I am the scientific director of the Norwegian Center for Mathematics Education. I represent Norway in the NCC and this morning I am going to be your mistress of ceremonies. First I want to introduce to you Mogens Niss. He is the chair of the International Programme Committee and a professor at Roskilde University, Denmark.

Mogens Niss, Chair of the International Programme Committee

Dear Minister, dear ICMI Executive, dear Mayor, dear Dean, dear colleagues and friends.

Almost five years of planning have passed since the Nordic countries were first asked, in July 1999, whether we would consider to host ICME-10 in 2004. Today, this very morning, the bugles will sound to mark the opening of the 10th International Congress on Mathematical Education, here at the Technical University of Denmark, DTU.

In my capacity as the Chair of the International Programme Committee, it is my immense pleasure and honour to welcome you all to our Congress in Lyngby, Copenhagen, Denmark, the Nordic countries, as we call them at these latitudes, to enjoy – we hope – the fruits of all our efforts.

An ICME is not only a conference, focusing on themes or topics; it is a *congress*, addressing the entire community of all those in the world who perceive themselves as mathematics educators, whether as teachers, developers, curriculum authorities, administrators, researchers in mathematics education or in mathematics as such, or combinations of several of these materialisations of the profession of mathematics educator.



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A congress is obliged to provide new experiences, new knowledge, insights, and food for thought, and above all opportunities for new contacts, to everyone present, regardless of her or his particular position and fields of interest. This calls for a rich, challenging, multi-faceted, and fascinating scientific programme.

The International Programme Committee has done its utmost and worked hard to establish a programme with these characteristics. We have deliberately attempted to compose the scientific programme as a mixture of 'classical' and 'novel' elements as is reflected in the overall time-table for the congress.

Classical elements include plenary and regular lectures and posters. Furthermore we have kept the dual structure of activity groups - the Topic Study Groups and the Discussion Groups - while emphasising in our briefs to the Organising Teams that the former are designed to be focused sub-conferences based on presentations, whereas the latter should really be what the title suggests, groups for focused discussion and not for presentations.

Novel elements include the five Survey Teams, each of which have worked for several years on the community's behalf to survey a field, a topic, or a *problématique*. A plenary interview session and a plenary debate on a truly controversial issue are new as well. The same is true for the Thematic Afternoon, in which the entire congress will concentrate on just five themes, albeit broad and overarching ones.

The Workshops and the Sharing Experiences Groups, too, are new inventions, at least if we keep the ICME-10 notion of a workshop in mind. The same is true with poster round tables where poster presenters are given an opportunity to have their posters discussed together with a few others in small groups, led and moderated by an experienced mathematics educator. And on top of all that, we have also organised a Mathematical Circus demonstrating to the general public, should that be needed, that mathematics offers lots of opportunities for entertainment and fun.

It goes without saying that we hope that these new initiatives, most of which are of a somewhat experimental nature, will be met with your approval. In fact we would very much like to have your opinion on the scientific programme, not because we in the Nordic countries are planning to host yet another ICME, but because we want to assist our successors in organising still better congresses. In your congress bag you will find a questionnaire on the programme. Would you please be so kind as to fill it in - it's anonymous - and return it to us at the end of the congress?

One consequence of today's globalised world, largely ruled by the market place, is that individuals tend to be reduced to being consumers rather than responsible and committed citizens. By its very nature, an ICME is a kind of market place, a supermarket or a department store, if you like. This suggests the presence of forces that turn delegates into consumers. Based on my personal acquaintance and friendship with hundreds of mathematics educators, it is my strong hope and expectation that the participants of ICME-10 will not accept to be just consumers shopping around, but will insist on the right to be true citizens of our congress, helping as best they can to ensure coherence



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and continuity of activities, in particular multi-session activities such as Topic Study Groups, Discussion Groups, Workshops and Sharing Experiences Groups.

It is time for me to conclude. I shall do this by extending, on behalf of the International Programme Committee, my sincerest and warmest thanks to all those hundreds of colleagues and friends who, in a pretty decentralised planning organisation, have worked for years, so altruistically – and indeed without the slightest financial remuneration - to organise the scientific programme of ICME-10. My thanks also go to all those of you who will contribute to the scientific programme as speakers, presenters, inventors of small group activities, special meetings and so forth. Last but not least, my thanks go to all the participants who have come here to listen and to learn and to make new friends from different places round the world. After all, mathematics education is a deeply humanistic activity, and our field will greatly benefit from strong international links and networks amongst those who profess it.

I wish everyone all the best for a stimulating, fruitful, and enjoyable ICME-10!

Ingvill Stedøy

Thank you to Mogens. The next person up here will be the chair of the Local Organising Committee, Morten Blomhøj. He is also a professor at Roskilde University in Denmark.

Morten Blomhøj, Chair of the Local Organising Committee

Dear friends and colleagues.

On behalf of the Local Organising Committee it is a great pleasure for me to welcome all of you to ICME-10. A special welcome to the Minister, the Mayor, the Dean and all the special honoured guests of the congress. After more than four years of preparation it is very exciting for us to see the fruits of our work. In close cooperation with the International Programme Committee and the Nordic Contact Committee we have worked to create the logistic frames for a congress enabling the realisation of the multifaceted and highly interactive programme planned by the IPC. It is a unique thing that ICME-10 has been organised in cooperation among five countries, the Nordic countries. This has been a great benefit for the congress but even more importantly, perhaps, the ICME-10 cooperation has fertilised the research *milieus* in the Nordic countries and strengthened the Nordic cooperation within the field of mathematics education. ICME-10 provides multiple opportunities for interaction between mathematics teachers, mathematics education researchers and mathematicians within the framework of the scientific programme, but also for more informal interaction within the framework of the social programme. It is our hope that all of you, contributors and participants, will take advantage of these particular opportunities. Hopefully, you will find, as we do, the campus of the Technical University of Denmark (DTU) an ideal venue for ICME-10 with its many well equipped lecture halls, group rooms for discussion, and nice, green surroundings. The only less ideal aspect of DTU is that this main hall is not large enough to hold all the 2300 ICME-10 participants. However, I am confident - looking down to the technicians - that our solution to this problem, i.e. video transmission,



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will make it possible for all participants sitting in building 116 and 303 to watch and hear what is going on now here in the opening session. So, a special welcome to you, too.

It is no secret that the congress programme and partly also the budget, I am afraid, was planned for some thousands of participants more than the 2300 that have actually registered for ICME-10. It is our hope that this fact can be turned into an advantage for the congress participants and for the scientific outcomes of the congress. A smaller number of participants in the many different parallel sessions will enable us to deepen the discussion and the reflections, hopefully raising the scientific outcomes of the congress. So as a contributor to the scientific programme, please use the extent and level of interaction as the main criterion for success rather than the number of participants attending your activity. And as a participant, please do take the opportunity to discuss with lecturers, presenters and group organisers. I ensure you that they are more than willing to discuss their work and ideas with you.

ICME-10 is a truly international congress with representatives and contributors from more than a hundred countries, and from all parts of the world. Thus it provides an excellent basis for the further development of multi-cultural approaches to mathematics education research. A large number, in fact nearly half of all the participants, are to contribute to the scientific programme in one way or the other. Please help and support contributors to do the best possible job. One way of doing so is to be supportive of contributors and others not having English as their mother tongue. The Local Organising Committee wishes you a fruitful and enjoyable congress.

I finish by paying my sincere respect to all parties who have helped and supported the congress and the organisation. First and foremost I thank all the members of the Local Organising Committee for their work and enthusiasm through the whole process, and special thanks to Elin Emborg, my dear friend and colleague who has worked incredibly hard, being the administrative secretary for both the IPC and the LOC. Also special thanks to our Congress Bureau, Congress Consultants, for their professional and loyal cooperation. Many thanks to the main sponsors, Casio and Texas Instruments, to the Technical University of Denmark for lending us their campus, and to the home institution of Mogens Niss, Elin Emborg and myself, IMFUFA, Roskilde University for supporting the planning process. And to other education and research institutions, foundations and organisations and in particular to the Danish Ministry of Education for a very early and very substantial support. Many thanks also to agencies and bodies from the other Nordic countries. The full list of sponsors can be found at the end of this proceedings. Without this support ICME-10 would not have been possible. Thank you all very much!

Ingvill Stedøy

As you have understood from what the previous speakers have said, this is a Nordic event between Denmark, Finland, Iceland, Norway and Sweden. The next speaker is Gerd Brandell, chair of the Nordic Contact Committee during the five years of the planning of the congress. She is a professor at the Technical University of Lund, Sweden.



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Gerd Brandell, Chair of the Nordic Contact Committee

Dear Minister and invited guests, dear colleagues and friends.

On behalf of the Nordic Contact Committee I wish you very warmly welcome to the 10th ICME. I speak for all five countries involved: Denmark, Finland, Iceland, Norway and my own country, Sweden.

Our countries are neighbours, and we have a long history of close contacts and collaboration in many areas. We feel like brothers and sisters in a family - certainly all five are strong individuals, but we also have many things in common and understand each other well. This also goes for mathematics education; there are many different characteristics for each country. At the same time we have much in common in the teaching and learning of mathematics.

For the first time, ICME has been organised by several countries in cooperation. We hope you will find that this model proves to work well. The role of the Nordic Contact Committee corresponds to that of a national committee, securing necessary support on a regional level for this huge enterprise. As Morten Blomhøj pointed out the committee has been working in close cooperation with the Local Organising Committee. Our common vision for the congress is an efficient organisation and a friendly atmosphere. We feel strongly about the importance of gender balance and have had that in mind during the long process of preparation.

Great visions are fine but the only thing that really counts is the result. Most important for us is that you will all find good opportunities to gain interesting experiences and get new insights during the congress. Hopefully you will also find plenty of time to develop new contacts and get new friends in mathematics education.

A special program for newcomers is launched at this congress, organised by the Nordic Committee with support from the ICMI Executive Committee. We are happy about the overwhelming interest among newcomers to participate, and we sincerely hope it will help those who attend ICME for the first time to find the things of special interest for each one in the rich program, and to grasp the structure and aims of the congress.

As Mogens Niss said it is now five years since we developed the concrete plan to host ICME-10 in Copenhagen. I remember speaking to Gilah Leder – who was at that time a member of the Executive Committee of ICMI. We were talking together at a decisive moment during the process. She told me about the strong impact that the 1984 ICME in Adelaide had on the development of mathematics education as a research area in Australia. Not only the congress in itself but also the efforts to plan and organise the congress created inspiration and energy and offered fruitful experiences for all those involved on the national level.

I am convinced that ICME-10 will help to bring research in mathematics education a big step forward in our countries. Therefore I am happy that ICMI and the Executive Committee decided to let Denmark and the Nordic countries host ICME-10.



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I am pleased to know that many participants from the Nordic countries have found their way to the congress, and that many of them will take active part and contribute in various ways to the program.

I am convinced that I speak for all members of the mathematics education community in the Nordic countries when I, once again, express my warmest welcome to all of you who attend this congress from outside our northern corner of the world. We are happy to see you all here.

I wish to express our special and warm thanks to the ministries of education in all the Nordic countries and to the Nordic Council of Ministers, for their generous financial support.

Thank you!

Ingvill Stedøy

As this congress is taking place in Denmark, it is of course a special thing for the host country and the Danish Ministry of Education. I am now calling upon the Danish Minister of Education, Ulla Tørnæs, to address the audience.

Ulla Tørnæs, Minister of Education, Denmark

It is a great pleasure for me – on behalf of the Danish government – to welcome you and to wish you success with all your activities and work the coming week.

In Denmark we are in a process of adjusting and reforming the entire educational system, from primary through upper secondary school to education at the universities.

In recent years quite a few countries have carried through similar reforms, or are planning to do so. In almost all primary and secondary education reforms, focus is placed on three specific subjects:

- mother tongue education, for our part Danish
- English, and
- mathematics.

In some sense you can say that there are the two international languages of our time: English and mathematics. At this congress both are in the game.

Reforming raises two main concerns: What to learn and how to learn?

But before trying to find an answer to those two questions, I believe it is just as important that we dare to ask: Why learn? Why is it, that it is so important to learn mathematics?

Putting this question to professionals, the answers you will get fall in three categories:



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Some professionals claim that learning mathematics is important because it advances general analytical competences more than do other subjects. Please forgive me for challenging this statement: you may be right but can you prove it?

I believe that all subjects taught in school could and should sharpen all pupils' and students' abilities to reason, to infer logical implications and to disclose arguments that are valid. One of the greatest Danish mathematicians Harald Bohr once put it this way: "Mathematics may not enable us to learn how to think right, but rather make it clear for us how easy it is to think wrong."

Other professionals stress, that learning mathematics is important because a modern society needs mathematicians of all kinds.

I very much agree and in the process of reform, much attention is drawn to the problem of stimulating the interest in mathematics and natural sciences – from the first years of primary school to the last years of upper secondary school. This is a field where exchanging ideas and experiences of "best practise" are of utmost importance.

We do not expect, nor do we need, all young people to study or work in the field of mathematics. But why then have we decided that all pupils should learn mathematics?

This leads to the third category of answers: Mathematics for all is crucial for the democratic process in a modern society. It gives citizens a better understanding of public matters and debates and helps individuals to form their own opinions.

Therefore it is very important how we teach mathematics in our schools. What sort of mathematical teaching do we need in order to improve the abilities of every individual to become a democratic citizen?

The answer is not a simple one, and some people may argue, that you don't need to be an electronic engineer to operate a television set. However, that is not the issue, because: Mathematical skills at a basic level can furnish you with the self-confidence that it takes to dare to doubt and ask questions, relating to anything from economical policies of the government or propositions of real estate agents.

I believe there is a tendency to give priority to these aspects of teaching mathematics. Therefore we need more research in the didactical problems of teaching mathematics: How do we ensure that "mathematics for all" will really be for all in the end?

If we are to inspire more pupils to take mathematics to heart, and more students to apply for mathematics studies, we need more than politics. There is a Danish saying that you can force a horse to the trough, but you can't force it to drink. We politicians can put mathematics on the agenda and we can drag the pupils to class. But only the teacher can make them learn.



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In the Danish Ministry of Education we are highly aware of the importance of congresses like this, and were happy to have made a considerable donation for the carrying out of the ICME-10.

Some weeks ago three leading professors of mathematics wrote a very interesting essay in one of the Danish national newspapers. The main point, translated into English, was that: "Beauty is a very important and strong incitement in mathematical research. All real mathematicians are chasing beautiful theorems and proofs."

Is it possible that the beauty of mathematics could also be a dynamo in the teaching of mathematics? I leave this for you to answer.

I wish you an inspiring congress and good luck in communicating the beauty of your science.

Ingvill Stedøy

The next person I will call upon is the Dean of Research at the Technical University of Denmark, the host institution of this congress. His name is Kristian Stubkjær.

Kristian Stubkjær, Dean of research, DTU

Ladies and gentlemen, your excellencies.

On behalf of the Technical University of Denmark, DTU, it is a pleasure for me to welcome you and the 10th ICME to our university. We are a technical university and extensive skills in mathematics are a necessity for almost all of our activities. This is reflected by the fact that courses in mathematics account for 15-20% of our teaching load, thus emphasising the importance of mathematics. DTU is a modern university and as of September this year studies at DTU will be structured according to the Bologna declaration, which means a 3+2+3 structure. The new students starting in just two months will meet this study structure which will enable them to move more freely between universities. Here they will be offered a number of specific specialisations at bachelor's level, including one in mathematics and technology, and afterwards, at master's level, we offer a specialisation in applied mathematics. It is an absolute priority for us to offer challenging and stimulating study environments for talented and enthusiastic students. Our teaching, including our teaching in mathematics, is research based. Our professors are continuously exploring new ways to communicate mathematics and to develop new teaching methods in the field. I am sure that the 10th ICME will be important also for further improving the teaching of mathematics here and in other places. I wish you a very successful conference here at DTU. You are very much welcome!

Ingvill Stedøy

And now the local host of this event, the mayor of Lyngby-Taarbæk municipality will welcome us. I call upon Rolf Aagaard Svendsen.

Rolf Aagaard Svendsen, Mayor of Lyngby-Taarbæk municipality

Thank you very much. Mrs. Minister, ladies and gentlemen, welcome to Lyngby-Taarbæk.

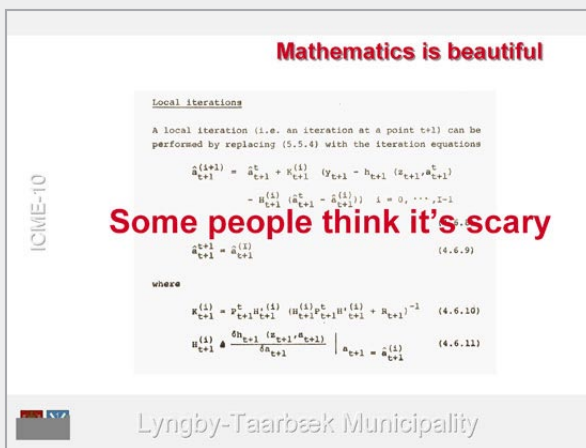


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We are happy to host such an important conference here. I happen to be among those who think that mathematics is beautiful.



What is that? That is the Danish economy. Why is it so beautiful? It is because it is a model. The original is a catastrophe! These drawings I made for a chapter front page in my Ph.D. thesis made here at DTU in 1979. At that time it was true that the model was beautiful and that the Danish economy was a catastrophe. But somehow the economy has converged to the beauty of the model. So we certainly need you to teach future economists to make beautiful models. My Ph.D. thesis was called *Econometric methods and Kalman filtering*. I think it is sold out, but here is a page from the thesis:

Isn't that beautiful? Well, the problem is that most people will find it rather scary. If you haven't broken the code you are not able to see the beauty. So you have an important task to enable people to break the code and see the beauty. To be honest, after all these years it looks a little spooky to me too.



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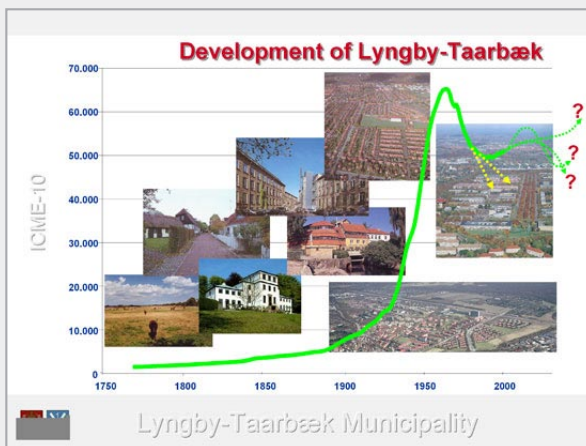
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Because now I am the mayor of Lyngby-Taarbæk municipality, 12,5 km North of Copenhagen, occupying an area of 38,76 km² with 51.500 inhabitants.

You may say that I am the living proof that mathematics can lead to anything. Or for those of you who come from California, you don't need to be a movie star to be a mayor, or a governor. Try with math!

The landscape of the municipality was formed by the ice when it melted 15.000 years ago. Around year 1800 the number of inhabitants was approx. 2.000. They were mostly farmers. There were also three small castles, and some wealthy people had built mansions on the lake sides.



In the next century the population grew, and so did industry in connection to the nine mills along the Mill Stream. They are called the cradle of Danish industry. In the first half of the 20th century, the population growth really took off and farm land was converted to business and residential areas. Then it was decided to move DTU from Copenhagen to Lyngby-Taarbæk. That occupied almost all of the residual areas for housing so the population declined between 1965 and 1991 when it started to slightly grow again. But how will the development be? We need you to teach some people mathema-



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tics so they can make some better forecasts because we were misled by the forecasts of the past.

Lyngby-Taarbæk is a green city. More than 50% consists of parks, forests, open land, lakes and the Mill Stream. And most of this is preserved area. The 51.500 inhabitants live in 25.000 dwellings. We try to keep the residential areas, whether private houses or apartment buildings, green as well.

We have 32.000 workplaces, and many companies have chosen to place their headquarters here. The workplaces of course include the DTU but we have also some other educational institutions in the municipality. So we consider ourselves to be a university city.

Our shopping centre is a big mall area with a turnover that equals that of Copenhagen City. So you don't have to go to Copenhagen to buy things to bring home. Shuttle busses to and from the centre will be provided.

And while you are in Lyngby, you are most welcome to take a look at the different sights. We have a medieval church with some characteristic Danish frescos, and you can take a stroll in the well preserved village, *Bondebyen*, nearby. Moreover, you can visit the *Open Air Museum* with old farmhouses from different parts of Denmark.

You can visit the big forest park called the *Deer Garden*. There you will also find *Bakken*, the world's oldest amusement park. You can take a look at the three castles and the mansions. Unfortunately the castles are not open to the public, but you can take a look from the woods.



The mills along the Mill Stream are worth visiting and you can rent a canoe or take a boat trip on the lakes. But please don't forget the mathematics! You are always welcome back. Have a very nice stay!



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Musical interlude by the Royal Danish Brass:

Jeremiah Clarke: Trumpet Voluntary

Keld Jørgensen: Lur Cha-cha

H.S. Paulli: "Retrait" from the ballet Napoli

Ingvill Stedøy

Thank you again to the Royal Danish Brass. Now we have come to the official opening of ICME-10 and I will call upon the President of the International Commission on Mathematical Instruction (ICMI), Hyman Bass, who is a professor at the University of Michigan, Ann Arbor, USA.

Hyman Bass, President of ICMI

Minister Tørnæs, Dean Stubkjær, Mayor Aagard Svendsen, Chairmen Niss and Blomhøj, Dr. Stedøy, guests and participants of the 10th International Congress on Mathematical Education.

As President of the International Commission on Mathematical Instruction, it is my honor and pleasure to welcome you all to this auspicious congress, and to express our collective appreciation of the hard work, imagination, and gracious hospitality of our Nordic hosts.

About the ICME and mathematics education

This Congress vividly reminds me of the complexity of mathematics education, and of how hard it is to globally comprehend.

This contrasts with mathematics, as a discipline. Mathematics has a universal character. Mathematicians throughout the world have a largely shared sense of the nature of their discipline, its central problems, its methods, and of the nature, genesis, and warrants of mathematical knowledge. Mathematicians know each other, and speak a common technical language.

Mathematics education, in contrast, is not simply a discipline, a body of knowledge, a field of scholarly research. It is *partly* that – things one *knows*. But, much more than that, and perhaps more importantly, it comprises things that people *do*, a field, or rather a constellation of fields, of *practice*. Who are the professionals that populate this enterprise? They are, first and foremost, teachers of mathematics, at all levels, from kindergarten through university levels. And they are teacher educators, a diverse community of which many mathematicians are (often unconsciously) members, as well as teacher leaders and professional developers. They are mathematicians, curriculum developers, assessment specialists, school administrators, district and state level supervisors and policy makers. And overlain on all of this are educational researchers who study all aspects of this loosely organized system.

This character of mathematics education was not always so. For most of history, few of the professions I have mentioned, except for teaching, existed. The evolution toward this vast enterprise, that we now inhabit – and here assemble – was long and gradual.



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It was marked by certain transforming events such as the invention of the printing press, the industrial revolution, the emergence of science as a foundation for security and commerce, the digital revolution, and the spread of democratization. These have had certain consistent and cumulative effects on education, and on mathematics education in particular:

- Higher leverage resources for the conservation and transmission of knowledge.
- The need for acquisition of more, and more sophisticated knowledge.
- The need to provide such knowledge to growing numbers of people.
- The challenges of diversities: Of resources and expertise needed for the educational enterprise; of cultural and social contexts; of institutional and curricular organization; of learners and learning styles; of appropriate pedagogical methods; and of the formation of education professionals.

The core of contemporary mathematics education remains what Deborah Ball and David Cohen have called the “instructional triangle,” the interactive dance of the teacher, the students, and the mathematics, in a classroom setting. Scholarly work on mathematics instruction has progressed from an early focus on the mathematical ideas, and how best to render them in the school curriculum, then to a close cognitive study of learners and how they process and assimilate new mathematical ideas, and now increasingly to teaching, a complex and multidimensional phenomenon for which effective methods of research are only now being developed.

The size and diversity of this Congress mirrors that of the mathematics education enterprise itself. An added special feature, and benefit, of this Congress is its *international character*. Mathematics education is culturally situated, and takes different forms in different societies. Here you will be able to learn about, and from, those differences. Here, in one environment, you will meet and communicate with co-professionals with whom you rarely have occasion to interact, be they from another continent, or from your home institution. It is a unique event, perhaps at times bewildering, but I hope also edifying, and even inspiring.

A tribute to Miguel de Guzmán and Igor Sharygin

There are many dedicated individuals in the ICMI family who carry forward the work and organization that make these Congresses, and the other work of ICMI possible. We have sadly this year lost two members of that family.

Miguel de Guzmán, my predecessor as President of ICMI, passed away suddenly and prematurely on April 14, 2004. He was a distinguished harmonic analyst, and an intellectual and spiritual leader of the current blossoming of mathematics and mathematics education in Spain. Among Miguel’s important contributions to ICMI is the creation of the Solidarity Project, whose aim is outreach to help improve mathematics education in developing countries. He was a man of broad culture, deep compassion, and an inspiring communicator and teacher. His passing away is a sad loss for our Spanish colleagues, and for the many communities of mathematics and mathematics education worldwide.



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Igor Sharygin, a name perhaps less familiar to you, was a member of the last ICMI Executive Committee. I report with the sadness of all who had the good fortune to know him that Igor passed away on March 12, 2004. Igor was a high school teacher who exemplified the highest Russian traditions of problem-based mathematics education. His love and deep understanding of geometry is evident in his writings. And Igor was culturally a mathematician, who typically used the word “beautiful” in describing both mathematics and mathematicians. We fondly remember his personal warmth and generosity, and his passion for life and ideas.

The ICMI Awards

There are many important new developments in the ICMI world since the last Congress in Japan. To conclude these welcoming remarks, I wish to speak of one of them, the inauguration of two new ICMI awards – the *Felix Klein Medal* for lifetime achievement in mathematics education research, and the *Hans Freudenthal Medal*, for a major program of research on mathematics education during the past 10 years. Michèle Artigue will shortly chair the presentation of these awards.

When I arrived in the ICMI environment, the possible establishment of ICMI awards was one of the first issues I encountered. This question had already had a long and inconclusive history. The ICMI Executive Committee in 1999 appointed a committee of distinguished and respected leaders in the field, chaired by Jeremy Kilpatrick, to study the question and make a recommendation to the ICMI EC. The medals to be awarded today inaugurate a design that follows the essential principles recommended by the Kilpatrick Committee. Suffice it here to share some of the views, partly personal, that shaped this action.

Opposition to giving awards was based on concerns for things like elitism, potential or perceived bias, superabundance of qualified candidates and consequent disappointment of deserving individuals, lack of sufficiently objective and consensual criteria for selection, immunity of the selection process from undue external pressure, etc. All of these are serious concerns, to which substantial attention was given in the design of the award process.

Of the many kinds of important contributions to mathematics education worthy of recognition, we chose, for now, to focus on *mathematics education research*, since this is a domain where norms of evaluation are most developed, and now most demanded. Indeed, we felt that the awards themselves, and the quality controls on the selection process, could help contribute, through such public recognition of exemplary work, to the evolution and better articulation of broadly accepted norms in the field. The Awards Selection Committee consisted of an international group of six distinguished scholars in the field. Its membership remains confidential until expiration of term, except for its chair, Michèle Artigue.

These awards honor extraordinary work of individual scholars, and, in so doing they are meant to encourage the efforts of others in the field. But they have broader purposes as well. As I just indicated, they offer a process for developing, over time, a publicly sanctioned definition of quality in a field that has often struggled to find one. The absence



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of such awards was, in some minds, and in the outside world, a confession of the lack of possibility of such a consensual definition. To less generous critics of mathematics education, it signaled an absence of work worthy of high recognition. When we are now asked to cite exemplary mathematics education research, we should be able to point, with conviction and pride, to those recognized with the award of these medals. A further salutary effect of the awards, an effect already witnessed, is that they will help breach some of the provincial boundaries in mathematics education scholarship, wherein much important work is known only within national or regional boundaries. The works of today's and future medalists will more quickly gain the wide international audience that they deserve.

Opening of the Congress

It is now my privilege and joyful duty, on behalf of the International Commission on Mathematical Instruction, to declare officially open this 10th International Congress on Mathematical Education.

For my first act within the congress, it gives me great pleasure to introduce Professor Michèle Artigue, Chair of the Awards Selection Committee, for the ceremony of presentation of the Felix Klein and Hans Freudenthal medals.

Michèle Artigue, Chair of the Awards Selections Committee

As was explained by Hyman Bass, a moment ago, when the ICMI Awards Committee was built, he proposed to me the immense honour of chairing it. I accepted the task, conscious as were my five colleagues in the Awards Committee of the responsibility which was put on our shoulders, of the tremendous difficulty of the work given to us and of the decisions we would have to take.

On the one hand, the creation of these two awards was the official acknowledgement of the maturity acquired by the field of research in mathematics education, of the role that this research could play and should play for improving mathematics education at large; the ICMI gesture had thus a high symbolic value. On the other hand, the field was so diverse, so multicultural, as are educational cultures, that selecting two persons among those, so many, who for more than thirty years have worked for the development of this field of research and contributed to it, looked as a nearly impossible task.

Our first task was to reflect on the criteria we would use, and also of course to disseminate the information about the awards through different channels: ICMI national representatives and affiliated study groups, journals in mathematics education, national and international associations. I would like to thank all those who contributed, thanks to this process, to the diffusion of the information, and all those who then, through the nominations and documentation they sent me, helped us so much in our task.

Soon enough, we converged on some main criteria: *impact, sustainability, depth and novelty*.



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These awards had to go to scholars who had played or were playing a central, decisive role in shaping the work and identity of the research community, but such a role can be played in many different ways and we had to be open to this diversity.

These awards had to go to scholars who had offered to the field deep and original contributions, whose research had been in some sense seminal for the field and had influenced its evolution.

And, in a research field which, too often, seems to change directions, following one ephemeral trend or another, we also wanted to award contributions that have proved to have lasting effects, to resist to the erosion of time.

Finally, we also thought that these awards had to go to scholars who were not just prominent researchers but tried to put their research advances and their research notoriety at the service of the improvement of mathematics education.

These criteria were, in our opinion, common to the two awards. What differentiated these was more the way the criteria had to be taken into account: thinking about the Klein award, we had to take into account a lifelong achievement in all its possible dimensions, and not limit ourselves to the current state of the field to judge the impact, sustainability, depth and novelty of the research work. Thinking about the Freudenthal award, we had to develop a different vision, focusing more on a specific area and a limited period of time.

For a while, our idea was to reserve the Freudenthal award for young scholars in the field, rising stars in some sense. But the selection between these quickly appeared as too random. The field of mathematics education is a field belonging to the human sciences, even if it deals with mathematics and requires of its scholars strong mathematical knowledge. Substantial advances don't result from flashes but from patient and long term work; novel approaches take time to reach a reasonable state of maturity; the possible influence of ideas and results on the field can rarely be appreciated correctly soon after they have been published and known. This was the reason why, after long discussion and case study examinations, we changed our mind and opened the Freudenthal award to mature researchers.

Defining criteria certainly was an essential step in our enterprise, but not necessarily the most difficult one. Much more difficult was to think about how these criteria could be made operational, when looking at specific cases. How could these be used in order to make selections, comparisons, and finally choices? How to appreciate for instance the exact influence of a researcher? There was no doubt to us that just counting her or his publications, how many times she or he is quoted, which tends to become the general trend in research evaluation, was too much of a superficial view. How to appreciate the deepness and novelty of a research contribution, without knowing intimately this work, and also all those which tend or have tended to address the same or similar issues in other contexts, relying on other theoretical frames?

More and more, we were seeing our task as an extremely demanding task, and the two years given to us which appeared as such a long time at the beginning, was soon seen to be too short.



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I will not enter any further in the details of our work. I would only say that along the road, this work became more and more fascinating. We came from very different educational cultures; all of us had a lot of international connections, this was one of the reasons for us being appointed; but we were discovering the limits of our respective knowledge of the field, we were discovering the incredible richness of the field, we were discovering disconcerting proximities... We learnt a lot from each other in the friendly and scientifically challenging atmosphere of our exchanges. And, progressively, through an e-mail discussion with so many rebounds that, at some moments, we had the feeling that we were characters in a suspense novel, we came to a final agreement on two names: one for each award.

We perfectly know that the story could have had another end: there were several excellent candidates with so many different personalities and contributions that the final choice could not be something really objective, even if we used our criteria meticulously. But we are deeply convinced that the choice we finally made is a choice which responds to what ICMI has decided to value when creating these two awards. The two eminent scholars who will receive these awards in the next minutes perfectly exemplify what can be an outstanding scholarship in mathematics education and the multiplicity of dimensions that this scholarship takes. They exemplify also a cultural diversity which is an essential characteristic of the field of mathematics education, also an essential source of its richness and productivity, while at the same time making research in this field so challenging and communication between cultures so crucial.

Before coming to the next phase of this ceremony, as the chair of the Award Committee I would like to express my deep gratitude to my five colleagues in the Committee. Their scientific and human qualities, the sense they had of their responsibility allowed our group to work during these two years, free of any kind of ideological and political pressure, only for the benefits of science.

I am now proud to officially present the first awardees of the Klein and Freudenthal Medals.

The Felix Klein Medal for 2003 is awarded to *Guy Brousseau*, Professor Emeritus of the University Institute for Teacher Education of Aquitaine in Bordeaux, France

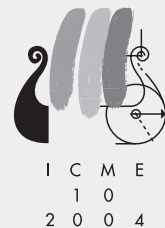
This distinction recognises the essential contribution Guy Brousseau has given to the development of mathematics education as a scientific field of research, through his theoretical and experimental work over four decades, and to the sustained effort he has made throughout his professional life to apply the fruits of his research to the mathematics education of both students and teachers.

The Hans Freudenthal Medal for 2003 is awarded to *Celia Hoyles*, Professor at the Institute of Education of the University of London, United Kingdom

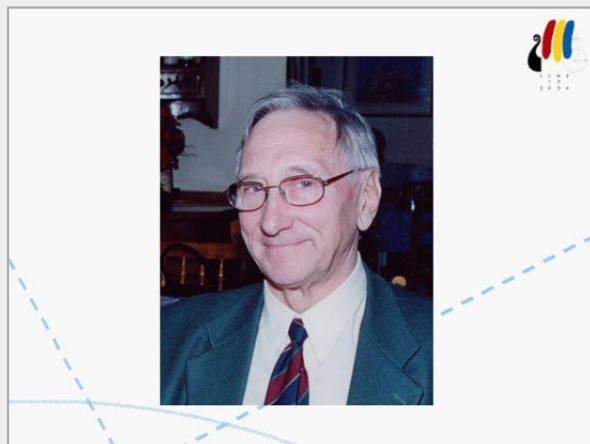
This distinction recognises the outstanding contribution that Celia Hoyles has made to research in the domain of technology and mathematics education, both in terms of theoretical advances and through the development and piloting of national and inter-

national projects in this field, aimed at improving through technology the mathematics education of the general population, from young children to adults in the workplace.

Guy Brousseau's work will be presented by Carmen Batanero who is a member of the current Executive Committee of ICMI.



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Carmen Batanero, Member of the Executive Committee of ICMI

Dear authorities, dear organisers, dear friends.

It is for me an honour and a really great pleasure to introduce to you professor Guy Brousseau who has been awarded the first Felix Klein medal of the International Commission on Mathematical Instruction. I am sure you all agree that this distinction is well deserved because of all the work he has done throughout his professional life. Brousseau began his career as an elementary school teacher but his interest in continuous training led him to major in mathematics and also to do a Ph.D., *Doctorat d'Etat*, in mathematics education and to start doing research on his ideas. He entered the University of Bordeaux in 1996 where he became a full professor at the Institute of Teacher Education in 1998. He is now a professor emeritus at the University Institute for Teacher Education of Aquitaine, doctor honoris causa at the University of Montreal and doctor honoris causa at the University of Geneva.

One main achievement is his theory of didactical situations, which he began to create as part of his doctoral dissertation and continued to develop over the years, and which has inspired a large number of researchers around the world. At the time where the dominant vision of the field was psychological/cognitive, he was convinced of the need of implementing and introducing also social, mathematical, and epistemological dimensions in the study of mathematics education. Thus he helped clarify the relationships of mathematics education with other disciplines and to characterise the object of study, while at the same time developing concepts and models to interpret and analyse mathematical teaching and learning. This theory has been a constant source of inspiration and has given rise to many constructs such as adidactic and didactic situations, institutionalisation, action, devolution, and so on. Furthermore notions such as didactical contract, memory, milieu, informational graphs of types of obstacles, etc. have been



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made widely accessible through the translation of his work to many different languages and, in particular, by the publication of the Kluwer book in 1997 *Theory of Didactical Situations in Mathematics Education*. His research addresses all levels from primary school to university but has mainly concentrated on primary school, dealing with several different topics, from the learning of algorithms of multiplication and division, numeration, rational numbers and proportions, decimals, to the transition from arithmetic to algebra, geometry and probability. At the same time he has explored and used a variety of mathematical models, such as statistics, multivariate statistics, graphs and game theory to model and explain numerous didactical phenomena, and also to propose an original methodology of research, which we now call didactical engineering.

Brousseau is not just an original and inspired researcher in our field but he has also contributed to mathematics education in many other respects. For example, at the national level in France, he was involved in the creation of the association of mathematics teachers, the *IREMs* (the research institutions for mathematics education), the journal *Recherches en didactique des mathématiques*, the association for research in mathematics education, the summer school and the national seminars on *didactique*. At the international level he was involved in creating of the group *Psychology of Mathematics Education (PME)* at the ICME-3 in 1976 in Karlsruhe. He also played a major role in the *CIEAEM (Commission Internationale pour l'Etudes et l'Amélioration de l'Enseignement des Mathématiques)* for 30 years. He was its secretary from 1981 to 1984. He has been invited and continues to be invited to give talks, contribute papers and chapters in books, to participate in international conferences and so on and so forth. Moreover, he has helped initiate mathematics education as a research field in many different countries. For instance, this is the case of my university, University of Granada in Spain, where Brousseau coordinated a team of five researchers who came for four years to give courses and help supervise dissertations when only two people in the department held doctoral degrees, thus enabling us to start a doctoral programme. This was the first doctoral programme in Spain in mathematics education, the establishment of which would certainly not have been possible without his help. He has done the same in many other countries in Europe, Africa, Asia, Latin America where he has supervised more than 50 doctoral theses, many of these by doctoral students from different countries who, when returning to their home country, established research groups. In that way he has contributed to spread his ideas of mathematics education and research all over the world. Brousseau has taken part in many international committees and projects related to research, teaching and teacher training. This tremendous work has been reflected in an impressive number of publications in main journals. Throughout his scientific career his passion for and interest in mathematics education, combined with constant energy, untiring determination, great curiosity, extreme precision and his critical intellect, have led him to develop the most thorough and complete theory in the past 30 years. At the same time he was generous enough to spend his time and effort in the service of the national and international mathematics education community, in particular helping the training of young teachers and researchers.

It is to recognise all these different contributions to the advancement of our field that the Felix Klein medal for lifetime achievement in mathematics education has been awarded to Guy Brousseau. I am convinced that we are all happy that the first presenta-

tion of this prize has been given to a colleague, or better to a friend, who so well fits our model of the ideal mathematics educator from both a scientific and a human point of view. So now I invite professor Brousseau to come on stage to receive the Felix Klein Award.



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Hyman Bass presents the Felix Klein Award to Guy Brousseau accompanied by fanfare by Royal Danish Brass.



Michèle Artigue, Chair of the Awards Selections Committee

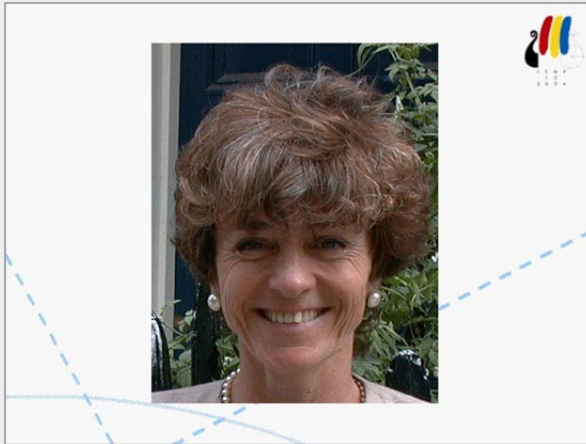
I am now very proud to announce that, as mentioned before, the first Hans Freudenthal medal has been awarded to Celia Hoyles, professor at the Institute of Education, University of London, United Kingdom.

Celia will be presented by Frederick Leung, who is also a member of the current executive committee of ICMI.



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Frederick Leung, Member of the Executive Committee of ICMI

Ladies and gentlemen.

It gives me great pleasure to introduce Professor Celia Hoyles, the recipient of the first Hans Freudenthal Award of the International Commission on Mathematical Instruction. Celia Hoyles studied mathematics at the University of Manchester winning the Dalton Prize for the best first class degree in mathematics. She began her career as a secondary teacher and then became a lecturer at the Polytechnic of North London. After earning her Ph.D. she became professor of mathematics education at the Institute of Education, University of London, 1984. Her early research in the area of technology and mathematics education began by exploring the potential offered by LOGO and she soon became an international leader in this area. Later, in 1996, her book *Windows on Mathematical Meanings Learning Cultures and Computers*, co-authored with Richard Noss, has inspired major theoretical advances in the field and notions such as *webbing* and *situated abstraction* are now ideas that are well known to researchers irrespective of the specific technologies they are studying.

From the mid-nineties, Celia's research on technology integrated the new possibilities offered by information and communication technologies, as well as the new relationships children develop with technology. She has recently co-directed two projects funded by the European Union: the *Playground* project in which children from different countries designed, built and shared their own video games, and the *WebLabs* project, which aims at designing and evaluating virtual laboratories where children in different countries build and explore mathematical and scientific ideas collaboratively at a distance. As an international leader in the area of technology and mathematics education, she was recently appointed by the ICMI Executive Committee as co-chair of a new ICMI Study on this theme.

However, Celia Hoyles' contribution to research in mathematics education is considerably broader than this focus on technology. Since the mid-nineties, she has been involved in two further major areas of research. The first, a series of studies on children's understanding of proof, has pioneered some novel methodological strategies linking quantitative and qualitative approaches that include longitudinal analyses of development.



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The second area has involved researching the mathematics used at work and she now co-directs a new project, *Techno-Mathematical Literacies in the Workplace*, which aims to develop this research by implementing and evaluating some theoretically-designed workplace training using a range of new media.

In recent years Celia Hoyles has become increasingly involved in working alongside mathematicians and teachers in policy-making. She was elected Chair of the *Joint Mathematical Council of the U.K.* in October 1999 and she is a member of the *Advisory Committee on Mathematics Education (ACME)* that speaks for the whole of the mathematics community to the Government on policy matters related to mathematics, from primary to higher education. In recognition of her contributions, Celia has recently been awarded the *Order of the British Empire* for "Services to Mathematics Education".

On a more personal note, I am fortunate enough to have some personal acquaintance with this great scholar. When I started my Ph.D. study in London, Celia was originally my supervisor. Her insightful advice had helped shape my Ph.D. study as well as the research agenda that I embarked on afterwards. Unfortunately, for some reasons she had to withdraw as my supervisor but she eventually became one of the examiners for my Ph.D. thesis. I can still remember, at the oral examination, the very sharp and critical questions she asked but also the very perceptive and constructive comments. The exam lasted two hours and she and the other examiners gave me a hard time. But eventually I passed my Ph.D. After my graduation from London we continued our contact through e-mails and occasional meetings in conferences. I am always struck by her dedication to scholarship and her amicable and caring character. In Celia there is no trace of arrogance that you sometimes find in some highly accomplished scholars.

Well, ladies and gentlemen, a personal friend, a former teacher of mine and a great scholar of the time, it is my great honour to present to you for the Freudenthal Award, Professor Celia Hoyles.



Hyman Bass presents the Hans Freudenthal Award to Celia Hoyles
Accompanied by fanfare by Royal Danish Brass.



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Ingvill Stedøy

Congratulations to the two great prize winners! The next person to come to the podium is the Secretary General of ICMI, Bernard Hodgson who is a professor at the University of Laval, Québec in Canada.

Bernard R. Hodgson, Secretary-General of ICMI, presentation of the ICMI Medals and Logo

Dear friends and colleagues.

The ICMI Awards in mathematics education research, as you have just witnessed, consist of a certificate and a medal, accompanied by a citation describing the contribution of each recipient, but unfortunately, I have to say, without a financial component. The establishment of these awards, announced four years ago at the Closing Session of ICME-9, induced a new challenge for the Executive Committee of ICMI: the design of the Felix Klein and of the Hans Freudenthal medals, serving as a tangible sign of recognition. This in turn reinforced a need often expressed in the past in other circumstances, namely the need for a visual identification of the International Commission on Mathematical Instruction in the form of a logo to appear on the reverse side of the medals. I would now like to present briefly the ICMI medals and the ICMI logo.

The ICMI medals were conceived and made by Thomas Soufflard, a current student of École Boullé in Paris, a renowned French school of art and design. Founded in 1886, École Boullé is named after a famous cabinet-maker of king Louis the 14th, André-Charles Boullé, after whom a well-known curved chest of drawers is named also. The medals were produced as a project in a course for students completing their degree at École Boullé. The technique used is that of modelled engraving, where a hollowed or relief motif is obtained by cast, strike, or ornamentation. The engraving was made by hand and the medals were stroke-pressed a few weeks ago at the Monnaie de Paris, using a special 600-ton press.

On one face of the medals are shown the past Presidents of ICMI whose names are attached to the awards. On the reverse side the logo of ICMI appears, surrounded by the name of the Commission, written in French and in the form of a circle, *Commission internationale de l'enseignement mathématique*. This is a testimony to the intensive use of French in the early years of ICMI, as is reflected, for instance, in the issues of that period of the journal *L'Enseignement Mathématique*, the official organ of ICMI since its inception.



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The logo of ICMI, chosen a few months ago by the Executive Committee of the Commission, is also the result of students' work. It was designed by Anick Légaré and Priscilla Lavoie, two students from the Studio École of the School of visual arts of Université Laval, in Québec. More than 35 proposals of logos were received, in response to a call made already in 2000 at ICME-9 and repeated in the *ICMI Bulletin*. These proposals, representing a remarkable richness of visions and creativity, mainly originated from three groups located in Denmark, France and Canada. The concepts on which the various proposed logos rest are very different one from each other, and it was not an easy exercise for the members of the Executive Committee to come to a conclusion. Among the criteria used in the final decision were the simplicity and the efficiency of the design, as well as its flexibility.

The visual identification adopted for ICMI is described as follows by its designers: "The square is a simple geometrical object, one of the very first shapes met by a child. The square refers here to the world of education and its structure is intended to convey stability, solidity and support. This square has been opened up by other geometrical shapes representing the acronym of the Commission, I, C, M, I. These openings introduce rhythm and movement, and the network of lines they create evoke communication and transfer of information. The letters are built from simple shapes, straight lines and circles, and recall basic symbols used in mathematics while suggesting some kind of symmetry. The curved ends of the letters introduce suppleness as well as harmony to the whole. The acronym ICMI has been integrated into the logo so as to facilitate recognition and create a lasting image. The colour blue is traditionally associated with the world of education and suggests learning and knowledge. The colour white brings in some fresh-

ness while the grey colour of the signature, more neutral, refers to communication and technology". The designers concluded that because of its simplicity, the logo will be easy to use in various settings.

Those wishing to know more about the ICMI medals or the ICMI logo are cordially invited to the ICMI Awards stand located in the registration area, where they will be hosted by a student of École Boulle who will show them some of the material used in the preparation of the medals and of the logo. I also invite those who wish to know more about the two past Presidents of ICMI, Felix Klein and Hans Freudenthal, after whom the ICMI Awards are named, to attend a lecture to be given tomorrow by Geoffrey Howson, past Secretary General of ICMI. The title of the lecture is remarkably clear, namely "Klein and Freudenthal". Thank you.

Ingvill Stedøy

Thank you to Bernard. And now we are approaching the end of this opening session, but before that Elin Emborg, the congress secretary, and Morten Blomhøj, both from Roskilde University Center will come with some house keeping remarks.

Elin Emborg, Congress Secretary, Morten Blomhøj, Chair of the Local Organising Committee

Provided various comments concerning the practicalities of the congress, such as time table, programme changes and corrections, guidelines for power point presentations, use of computers, lunch arrangements, happy hours and social gatherings, including the new-comers programme, campus lay-out and so forth.

Musical postlude by the Royal Danish Brass:

Svend Asmussen: Oh, What a Day

Joseph Zawinul: Birdland

Ingvill Stedøy

Hereby the opening session has come to an end. I wish you all a most successful congress.



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