Proposal on Development of Higher Mathematics for Applications

1. We have to encourage and develop expertise in areas in applications of mathematics which are not sufficiently cultivated in India. Immediate steps should be taken to create experts in these fields.

2. Some of the areas which need to be strengthened are: Dynamical systems, Encryption, coding, security, Mathematics in oil and gas exploration, Data Mining, Mathematical finance, use of Mathematics in service industry, Image Analysis, numerical analysis, weather prediction, etc.

3. In order to build competence and expertise in applied mathematics and to inculcate a culture combining theoretical Mathematics and applications, we have to develop and introduce curriculum and courses at the university level, with a judicious combination of theory and applications. Courses given in institutions like Brown University may serve as a model. Applied Mathematics concentration courses combining foundational Mathematics with specialisation in an applied area, may also be considered.

4. Intensive, instructional schools, study groups and modeling weeks (at various levels) should be organized.

   • Modelling: Participants, divided into small groups, are assigned practical problems and have to come up with solutions, having a clear idea of the theoretical Mathematics involved, as how to model the problem and finally suggest a solution.

   • Mini courses with theoretical lectures combined with intense computational work using sophisticated computers, if necessary.

   • Organise instructional conferences in which advanced Mathematics at very high level is taught while giving examples of sophisticated applications of the theory e.g. in Numerical Analysis.

5. Training programmes in applications of Mathematics intended for teachers in universities must be initiated, who in turn would motivate students.

6. There is a very high level of competence in the country in areas of Mathematics with high potential for applications, for example, Theoretical computer science, P.D.E, Number Theory, Algebraic Geometry. This potential has to be tapped by

way of inducing some of these mathematicians to get directly interested in applications or at least to share their expertise by ways of lectures or discussions.

7. We have to build structures to facilitate interaction between applied Mathematicians and Industry, and create awareness of the uses of Mathematics for Industry. Here Mathematicians have to be proactive and reach out to Industry, especially in a country like ours where Industry does not seem to aware of (or willing to use) the uses of Mathematics.

    Public sector industries should take a pioneering role in applying Mathematics to solve some of the problems. We should set up (say, a group of experts) who would actively interact with industry and advise potential users.

8. We have to look into the lack of data of career paths available to students trained in applications of Mathematics, to identify and publicise career opportunities A guide to "Careers in Applied Mathematics" can be published.

9. National Centre for Applications of Mathematics: Taking into account the enormous amount of task involved in creating a viable culture, structure and programmes in applications of Mathematics and taking this to industry, it is suggested that a National Centre for Applications of Mathematics be created, for instance partly modeled on the lines of INRIA in France. Creation of such an institution was also recommend by the workshop report of "Perspectives and future prospects in Higher Mathematics" held in NIAS in 2006.

    • A staff consisting of some high level mathematicians and a few engineers (who can talk to people in the 'shop floor') would be appropriate.

    • Many of the activities outlined above should be carried out by the centre.

    • In addition, the Centre should evolve additional programmes and methods for applications of Mathematics and take these to users.

    • The Centre will be a nodal point for training at all levels to meet the strategic needs of the country.

    • It would be a place providing opportunities for meeting and interaction between teachers, students and relevant personnel from industry.

- Arranging regular workshops, study groups, visits to and from industry.

- To launch pilot projects on techniques usable in industry "Transfer of Mathematical technology".

- To foster, wherever possible, interdisciplinary work.

- It would be a main purpose of the Centre to reach out to industry, inform how application of Mathematics can help industry to solve some problems and advise industry when it comes with specific problems, thus maintaining Liaison with industry.

- The Centre should have provision for Associateships/Internships/ Post-doctoral fellowships for academics and people from industry. Here we can draw upon the experience of ICTP, Trieste, and Newton Institute, Cambridge.

- To train graduates to work in modern applications of Mathematics.

- To pursue basic research in applied mathematics.

In addition to INRIA, the experience of the Centre for Industrial and Applied Mathematics of the Oxford University and Technomathematik group in Kaiserslautern could be useful.

10. In the meanwhile, we could ask some of the existing institutions in the country with expertise in applied mathematics to carry out some of the programmes (like training programmes) envisaged above. They should be given sufficient financial support for this purpose.

11. We can arrange for a 'brain-storming' session to profit by the experience of (and problems faced by) groups in India and abroad who have thought about and solved problems of applications of mathematics.

12. An "Applied Mathematics Programme Initiation and Monitoring Committee" should be setup. This committee, which would mainly consist of Mathematicians, will initiate and also implement the recommendations of the Task Force. The committee should have sufficient autonomy and financial resources. The term of the committee could be 5 years.