



Summary

FP7 Marie Curie European Re-integration Grant No. 224817

Educational, Scientific and Technological Aspects of Splines - **ESTSpline**

The ESTSpline grant was awarded to Dr. Ewald Quak for the 3-year period from May 1, 2008 to April 30, 2011. During this time, the main purpose of the grant became the contribution to three different sets of activities related to Dr. Quak's scientific research field of 3D geometric modelling:

1. Development of the Laboratory of Wave Engineering (<http://wavelab.ioc.ee>) as a new part of the Center for Nonlinear Studies (CENS, <http://cens.ioc.ee>) within the Institute of Cybernetics (IoC, <http://www.ioc.ee>) at Tallinn University of Technology (TUT, <http://www.ttu.ee>) in Estonia;
2. Investigations of industrial applications of 3D geometry and road maps for future research in this subject area;
3. Initialization of a 3D scientific visualization capacity within CENS.

Apart from publishing articles in scientific journals, Dr. Quak was the editor (together with T. Soomere) of the edited volume "Applied Wave Mathematics - Selected Topics in Solids, Fluids, and Mathematical Methods", published by Springer, containing twelve tutorials intended for non-specialist researchers and students to highlight the importance of applied mathematics in the studies of wave phenomena. Dr. Quak was also guest editor for the special issue "3D Physiological Human" of the journal The Visual Computer, together with Prof. Nadia Magnenat-Thalmann (U Geneva, CH).

1. The Laboratory of Wave Engineering was formally established as a new research unit of CENS within the IoC in January 2009. The team focuses on complex and nonlinear phenomena in wave dynamics and coastal engineering, and the applications of mathematical methods in wave studies. The scope of research involves, but is not limited to, long wave theory and applications (with emphasize on fast-ferry waves, shallow-water solitons, runup phenomena, tsunami research, and generic aspects of coastal hazards), surface wave modelling, wave climate studies, and wave-driven phenomena in coastal engineering, with application to integrated coastal zone management. The laboratory is led by Prof. Dr. Tarmo Soomere, a member of the Estonian Academy of Sciences (<http://www.akadeemia.ee>) since 2007, with Dr. Ewald Quak and Dr. Irina Didenkulova as senior researchers. As of June 2011, it has 17 members.

Obviously national and international research grants are vital for the development and expansion of the team. The currently most significant project is BalticWay (The potential of currents for environmental management of the Baltic Sea maritime industry, for which Dr. Quak is a member of the organizing team and serves as dissemination manager, and which is co-ordinated by Dr. Soomere (http://bonusportal.org/bonus_projects/research_projects/balticway/). BalticWay is a BONUS+ project financed by the BONUS EEIG, the Joint Baltic Sea Research and Development Programme (<http://bonusportal.org/>), co-funded by FP7 and the national funding institutions in the Baltic Sea region. The BalticWay project aims at developing the innovative concept of fairway design to reduce the danger to vulnerable areas through a substantial decrease of marine-industry-induced environmental risks and impacts on bio-diversity, particularly on fragile ecosystems. The core

objective is to develop a scientific platform for a low-cost technology of environmental management of shipping, offshore, and coastal engineering activities. The technology will be applied to place dangerous activities in areas, where an accident will have minimum impact to vulnerable areas.

The main part of the ESTSpline grant was used to establish and run a secretariat for the Laboratory of Wave Engineering, paying two administrative/research assistants: Anna Terentjeva and Katri Kartau. The importance of guaranteeing a well-functioning administrative nucleus for the inception and initial development of the laboratory simply cannot be underestimated. It is also important to note that the assistants' duties also included research contributions.

2. In 2010 Dr. Quak became a member of the editorial board of the newly established scientific journal titled "Journal of Mathematics in Industry", (JMil), a high-quality, peer-reviewed, open access journal that brings together research on developments in mathematics for industrial applications. Here, "industry" is understood as any activity of economic and/or social value. As such, "mathematics in industry" concerns the field as it actually improves industrial processes and helps to master the major challenges presented by cost and ecological issues.

Since 2003, Dr. Ewald Quak has been co-organizing workshops on "Industrial Challenges in Geometric Modeling, Computer Aided Design, and Simulation", held at the Fraunhofer Institute for Computer Graphics (IGD) in Darmstadt, Germany, the most recent ones partially sponsored by ESTSpline. These annual events are set up to promote the co-operation of industry and academia in addressing relevant and challenging mathematical problems from geometry, computer-aided design, shape modelling, and other related areas such as simulation. Practitioners from industry and application-minded people from academia are brought together to discuss current research issues, investigate future trends and explore concrete opportunities for collaboration.

As a member of the Activity Group on Geometric Design of the Society of Industrial and Applied Mathematics (<http://www.siam.org/activity/gd/>), Dr. Quak also organized Forward Looking Sessions and moderated plenary panel discussions at the activity group's biennial conferences on geometric design in 2007, 2009, and the upcoming one in 2011, partially supported by ESTSpline. The goal is to have experts suggest topics for future research, which are scientifically challenging, of practical industrial relevance, and in the subject area of the conference and the activity group. The problems span from being very specific, in need of a quick and concrete solution, to suggesting a whole new line of research. The subsequent panel discussions are then intended for lively discussions of future research directions involving all conference participants.

3. The concept of a 3D visualization system for CENS was developed jointly by Dr. Ewald Quak and Dr. Heiko Herrmann and partially funded by their re-integration grants ESTSpline and ESTWave. The aim was to establish a 3D visualization system for scientific data at CENS (IoC), which has not existed there before. Scientific simulations, like computational fluid dynamics or simulations using the discrete element method, produce very large data sets, which are usually 3D. For the interpretation of this data a real 3D display is much better than a projection on a standard 2D computer screen. Also some features of the 3D data can only be seen if the data is visualized in 3D and not when viewed on a standard 2D computer screen. The acquired graphics-workstations are also used for what is nowadays called GPU (Graphics Processing Unit) computations, as they contain multi-core processors of the newest generation and powerful graphics cards that can be used as massively parallel processors.

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