Strategy for the Linné Flow Centre

Fluid mechanics

Fluid mechanics deals with many natural phenomena, for example the flow in the atmosphere, the currents in the oceans, the flight of birds and the circulation of blood in the body. Since the beginning of modern civilization fluid mechanics know-how has also been used as an engineering tool to improve the living conditions for humans. In ancient times technical knowledge in the area of fluid mechanics was needed for water transportation (irrigation, aqueducts), transportation (ships), energy production (wind mills) etc. These engineering enterprises were carried out without a scientific background and were mainly depending on tradition and empiricism. It was not until the days of Newton that fluid mechanics emerged as a science and then engaged in new emerging engineering fields. Now it is a fundamental aspect of many manmade systems such as air and ground vehicles, almost all types of combustion and energy conversion systems and a multitude of industrial processes used by paper manufacturing, electro-chemical and pharmaceutical companies, for example.

The Linné Flow Centre and its vision

The Linné Flow Centre (FLOW) is one of twenty original centers of excellence set up by the Swedish Research Council (VR), as the result of a highly competitive process with international evaluation. The centre was established with a vision

> *as an outstanding environment for fundamental research in fluid mechanics, where innovative research is born and future research leaders are fostered*.

This vision is realized by

- collaborative research projects integrating experiments, computations and theory
- combining expertise in stability and transition, flow control, turbulence and geophysical flows, micro-fluid flows, aero-acoustics and numerical analysis
- outreach and network activities such as seminars, workshops, summer-schools and guest researcher programs
- actively incorporating junior faculty members in positions of responsibility and leadership

Overall FLOW strategy

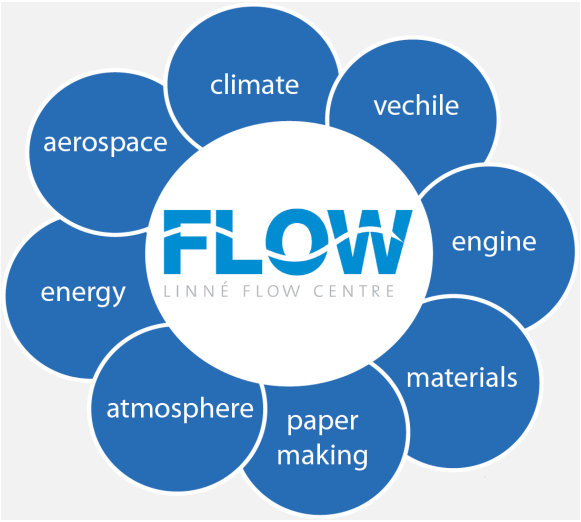

Figure 1: Flow applications

Goals of the Linné Flow Center

The immediate goal of the Linné Flow Centre is to integrate the participating research groups into a single flourishing research environment.

In the intermediate term, within the next five year, we envisage to have

- a continued production of research at the highest international level
- established at least one new research area
- educated one new generation of PhD students
- fostered a generation of new research leaders
- become visible, nationally and internationally, as a natural meeting point for fluid mechanics researchers
- exchanges of personnel with the best fluid mechanics centres
- research results that are of value in fluid dynamics applications, a number of them seen in figure 1.

Relationships to KTH research, other KTH centres and international research

The centre comprises the fluid mechanics research groups of the Department of Mechanics (MEK), the Marcus Wallenberg Laboratory for sound and vibration research (MWL) and the numerical analysis group (NA) from the School of Computer Science and Communication. It has strong connections to other centres at KTH, such at the KTH Computational Science and Engineering Centre (KCSE), Centre for Internal Combustion Engine Research Opus (CICERO) and the Centre for ECO^2 Vehicle Design.

Researchers in the Linné Flow Centre also have strong connections to other prominent fluid mechanics research groups worldwide, which are described below in conjunction with the research strategies.

Role and activities of the Linné Flow Centre

The role of the Linné Flow Centre is to bring together and coordinate the fundamental fluid dynamics research performed by the partners. It will enable a strengthening of key areas as well as spearheading into new developing areas. In particular the long term nature of the funding will enable development of numerical and experimental tools, something very difficult in ordinary more short term projects. The Linné funding, although in itself substantial, will only be a small part of the total effort within FLOW, but at the same time the key catalyst for the development of a common strategy and enabling coordination of research activities.

The enhanced coordination and collaboration within FLOW will also enable the members to more successfully solicit funding to the area of fluid mechanics from other sources and in this manner further enhance the research environment.

The activities of the center are planned to include the following

- Seminar series and Linné visitors program
- Organization of workshops, summerschools and international conferences
- Project evaluation and follow-up activities
- Leadership and career planning activities
- Regular research group meetings
- Organization of an annual meeting

Research strategy

We have defined five areas in which research in the centre will concentrate. They are to some degree overlapping and a typical senior researcher is involved in more than one area.

The area of *Stability and transition* deals with how and why orderly laminar fluid transitions to chaotic turbulent flow. Research will be concentrated on receptivity, stability of flows in complex geometries and classical stability problems.

The area of *Flow control and optimization* takes a step further from analyzing and understanding flows and deals with how flows can be manipulated and optimized in order to achieve the objectives at hand. Research will be concentrated on feedback control, laminar flow control and separation control.

The third research area within the Linné Flow Centre is *High Reynolds-number turbulence including geophysical flows*. High-Reynolds-number turbulence is the archetype of highly nonlinear chaotic systems possessing many degrees of freedom and a wide span of scales and geophysical flows deals with the flows in the atmosphere and oceans.

Aero-acoustics is the part of fluid mechanics where the generation and propagation of sound in a moving media are studied. Within the area of Low Mach-number aero-acoustics research will be concentrated on interior flows where new and improved experimental and numerical methods will be developed for characterizing aero-acoustic sources. The use of flow control on aero-acoustic sources and dissipation of acoustic energy will also be studied.

The fifth research area within the Linné Flow Centre is *Micro- and complex fluids*. Micro-fluidics deals with research on the special problems that appear when flow systems are built in micron sizes or less whereas complex fluids usually refers to fluids with more challenging properties than single phase flows of air and water, such as polymeric solutions, foams and emulsions.

The Linné funding will enable us to initiate and strengthen research projects within the areas described. Through the collaborative nature of these projects, this will strengthen the dialogue and exchange of knowledge and ideas between and within the research groups. A great benefit from these collaborations will stem from the close interaction of experts in experimental techniques and numerical simulations, with the common interest of fluid mechanics.

Organization

The center is run by a management group which takes care of the day-to-day activities and a board which is responsible for the strategy. Each research area has a person responsible which takes care of organizing group meetings and project coordination.

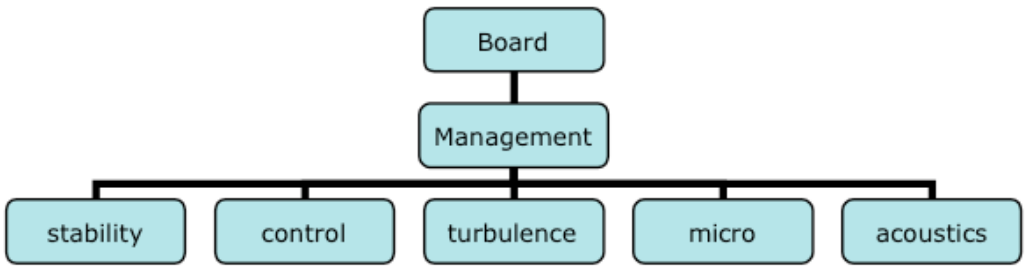

Figure 2: Organization of the Linné Flow Centre

There are about 30 graduate students, about 10 junior researchers and about 10 senior researchers currently involved in the centre. The total research funding to the centre is about 30 million Swedish crowns per year.

Additional information can be found on the web pages www.flow.kth.se and from the centre director Prof. Dan Henningson, KTH Mechanics, 10044 Stockholm, Sweden with email henning@mech.kth.se