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Zurich Heart: Five Open Doctoral Positions

In industrial nations, approximately 1-2% of the population suffers from severe heart failure summing up to 10 million people in Europe. Heart transplantation is the only curative treatment of end stage heart failure. However, the number of patients on the waiting lists for organ transplantation is increasingly disproportionate to the number of heart transplants. An alternative treatment option of patients with end stage heart failure is the use of mechanical circulatory assist devices (VAD) in order to support the function of the failing heart. However, there is a number of unresolved challenges associated with the use of ventricular assist devices such as thromboembolic complications, infections, and inefficient blood flow regulation.

The Zurich Heart project was initiated with the goal to improve critical components of contemporary assist devices regarding energy supply, system regulation, and implanted surface properties. It aims at developing a science base coupled with technical solutions to overcome current challenges. A major research track of this program targets the development of pump-related technologies and their integration into a new implantable pump device, significantly improving the state of the art. In the long run, the Zurich Heart project also aims at disruptive innovations and technologies towards radically new artificial heart designs and assist device technologies of tomorrow.

After a first successful phase, the Zurich Heart project is now entering a second phase and, based on the continuing support of the Stavros Niarchos Foundation, is seeking to fill five new doctoral positions. The main target of Phase II of the abovementioned research track will be the development toward integration of key technological research achievements of Phase I into a fully assembled pump device optimized for pre-clinical trials. To address the main complications related to current VAD technology (see Figure 1), the pump prototype will feature the integration and collaborative function of four main innovation outcomes, combining the individual results of Phase I. These are:
1. The translation of the existing technologies into settings containing all in vivo environment elements. 2. Their integration into a functional device. 3. The pre-clinical in vivo evaluation of the prototype device. 4. The clinical translation to align research developments with the clinical application.

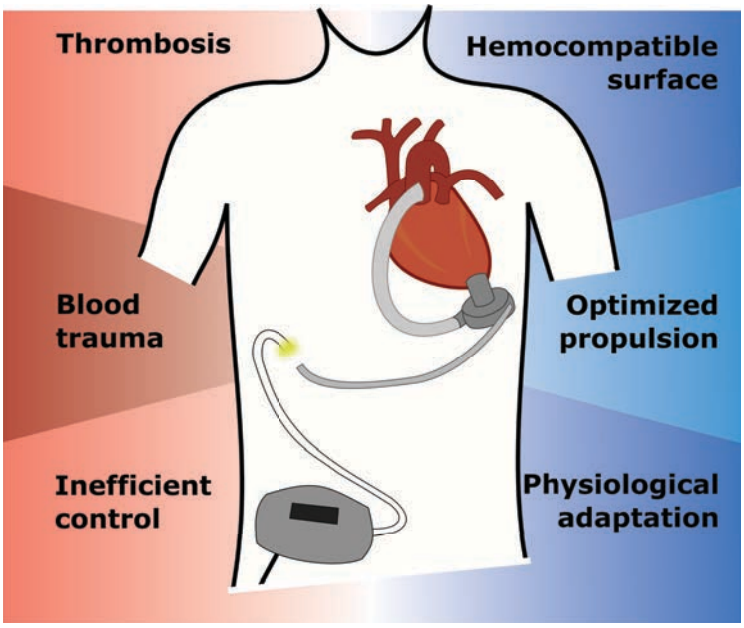

Figure 1:
Sketch of technological solutions proposed for Phase II of the project

Five doctoral positions are now open with the following task profiles:

1. Antithrombotic and/or microengineered surfaces. Rationally-designed microengineered geometries supporting the generation and maintenance of an autologous endothelial monolayer at the luminal surface of VADs. Research and development of a surface structure or coatings to be used at the inner pump and cannula surfaces under realistic haemodynamic conditions, with the goal of creating a living protection thus minimizing thrombogenicity and hemolysis.
   Group Prof. Dimos Poulikakos.

2. Intervening layers with optimized biomechanical response. Mechanical optimization of silicones to support endothelialization at the luminal device interface. Elastomer technologies applied to the fabrication, characterization and selection of a silicone layer able to withstand the hemodynamic conditions generated by the pump function. Development of technological approach for the surface structure and chemistry optimization and for conformal deployment on the inner pump surface. **Group Prof. Edoardo Mazza**.

3. Hemocompatible blood propulsion. Development of a unique framework for hemocompatible rotor design and efficient pump operation under dynamic physiological conditions, accounting in particular for loss of von Willebrand Factor (VWF) function. Analysis and optimization of the flow fields using computational fluid dynamics, in vitro biochemical analysis of VWF damage and activity, as well as in vivo measurements. **Group Prof. Vartan Kurtcuoglu**

4. Additive Manufacturing. Systematic investigation of currently available additive manufacturing (AM) techniques and materials with respect to their usability in different development stages and integration levels of the pump. AM of pump impellers and evaluation of their hydraulic performance and impact on blood trauma as a function of the building accuracy, surface quality, and durability. Investigation of post-processing techniques of AM surfaces, in particular aiming towards compatibility with devices-blood interfaces developed in the framework of the Zurich Heart project. **Group Prof. Mirko Meboldt**

5. Physiological control of pump actuation. Pressure sensor integration technologies enabling physiological control of a pump. In collaboration with the group of Prof. Meboldt, this will include an adaptive control system connected to a feedback loop integrating the information measured by an integrated pressure sensor. Development of a bio-affine structuring of the parylene membrane of the pressure sensor to improve sensor stability upon implantation. Development of a contact interface between a sensor (e.g. a pressure transducer) and the blood stream. **Group Prof. Christofer Hierold**

A close cooperation and interdisciplinary exchange between the doctoral students in the different fields and the clinical experts is crucial for the success of the project.

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We particularly encourage Greek nationals to apply for the positions.