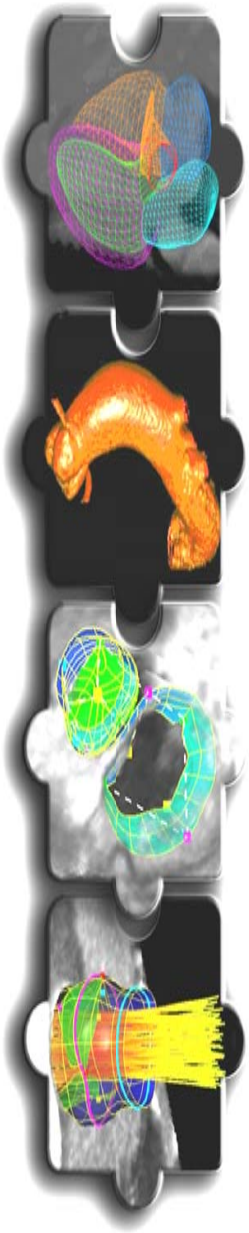
January 2011 - Issue no. 1

Sim-e-Child Newsletter January 2011



www.sim-e-child.org

Sim-e-Child: a 30-month Specific Targeted Research Project co-funded under the 7th Framework Programme priority "Information Society Technologies"

An Introduction to Sim-e-Child

The FP7 STREP Sim-e-Child (SeC) started in January 2010 and has now completed its first 12 months of work. The objective of the SeC is to strengthen the impact of the FP6 Integrated Project "Health-e-Child" (HeC) which was completed in April 2010, rated as "surpassing expectations" by the EC and the winner of the ICT08 Best Exhibition Award, by creating an international simulation and validation environment for paediatric cardiology, supported by integrated data repositories. The project is working to go beyond the state-of-the art by providing comprehensive and patient specific models for the dynamic and longitudinal interactions occurring in the left heart, with a focus on the congenital aortic arch disease and repair.

The Sim-e-Child Consortium

In addition to some of the original HeC partners (Siemens AG, Ospedale Bambino Gesù, maat France and Lynkeus Srl), three major US centres of excellence (John Hopkins Children's Centre, Siemens Corporate Research and the American College of Cardiology), and two further European partners (Technische Universität München and Siemens Program and Systems Engineering, Romania) complete the consortium.

The Goals of Sim-e-Child

Since the development of the project's proposal, the SeC consortium has been working to improve clinical outcomes of paediatric cardiology patients. The treatment of paediatric congenital heart disease is hampered by the scarcity of relevant cases, the lack of integrated data and the limited opportunities for clinical comparison among others. Yet, advances in paediatric cardiac surgery, interventional cardiology, intensive care and non-invasive imaging have led to a substantial increase in life expectancy for many patients with congenital heart disease. However, difficult challenges still persist due to the evolving nature of a child's heart and vascular system. In order to achieve better and more reliable risk stratum, to improve and personalise therapies, and to ultimately increase the patient survival rate, SeC is focused on developing comprehensive and accurate computer models from patient specific data and simulated physical constraints.

Sim-e-Child: a 30-month Specific Targeted Research Project co-funded under the 7th Framework Programme priority "Information Society

Sim-e-Child's Grid Infrastructure

The first 12 months of work has seen Sim-e-Child develop the first Trans-Atlantic platform for large scale simulations in cardiology. Sec's clinical applications are being built on an evolution of HeC's original grid infrastructure based on the EGI Grid middleware (the gLite technology and European Grid Infrastructure - www.egi.eu) and the enabling GÉANT network, that together provide virtually unlimited computing power, data storage capacity and network bandwidth.

SeC has engaged a significant infrastructure setup and migration in the first reporting period, aimed at interconnecting HeC and SeC, with the ultimate goal of making HeC's mature components sustainable and therefore reusable in SeC, while giving SeC a significant technical basis onto which further expansion will take place for the duration of the project.

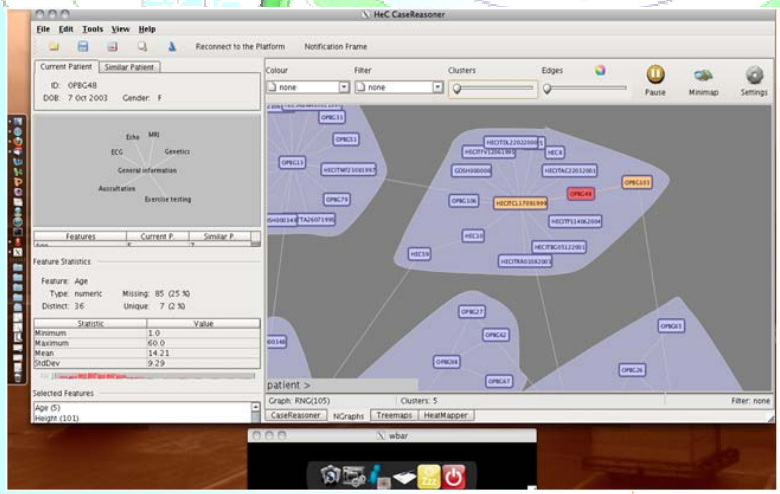
Sim-e-Child's Web portal

The SeC Web portal, is now well advanced, and with public and private parts, is providing users with access to the grid and integrated applications. In the first ten months of operation, SeC has started utilising the high bandwidth pan-European GÉANT research network to:

- Establish a multi-site, web-accessible database of paediatric cardiology data, information and knowledge for translational research
- Develop a grid-based platform, supporting the definition, execution and sharing of scientific cardiac modelling and simulations.

Some of the operation features include:

- The SeC Grid infrastructure and computing resources, using a standard and internationally recognized GridPMA certificate. The Portal is cross-platform and therefore works under MS W7/ XP, major Linux distributions and Mac OS X in latest version.
- The SciPort database and interfaces for manipulating data and simulations' outputs is being integrated to the security infrastructure so that it will be possible to enter SciPort directly once logged in the SeC portal in the future.



Above: HeC's CaseReasoner working through the SeC portal

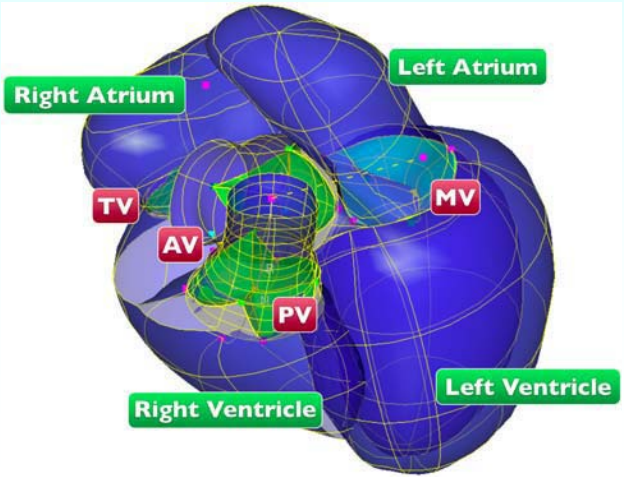
By integrating the portal and the grid infrastructure, SeC will provide paediatric cardiology professionals in Europe and the US with a Virtual Physiological Human based decision-support system and virtual laboratory. This will enable them to construct and validate multi-scale and personalised models of a growing child's heart and blood vessels. Ultimately this will support their clinical decisions and allow better understanding of their patient's condition.

Sim-e-Child's Heart modelling results of 2010

Besides technical interoperability requirements elicitation and infrastructure bridging, the work focused also on the development and validation of a comprehensive cardio-vascular anatomical model enabling first patient-specific haemodynamics simulations. The main achievements were:

- The existing HeC heart models were validated by the clinical partners on MRI data from Tetralogy of Fallot (TOF) cases. Using linear regression and Bland Altman plots, left and right ventricular systolic (LV ESV and RV ESV) and diastolic volumes (LV EDV and RV EDV) and ejection fractions (LV EF, RV EF) were compared between manual and automated methods. In addition, the average processing time per patient was compared between techniques.

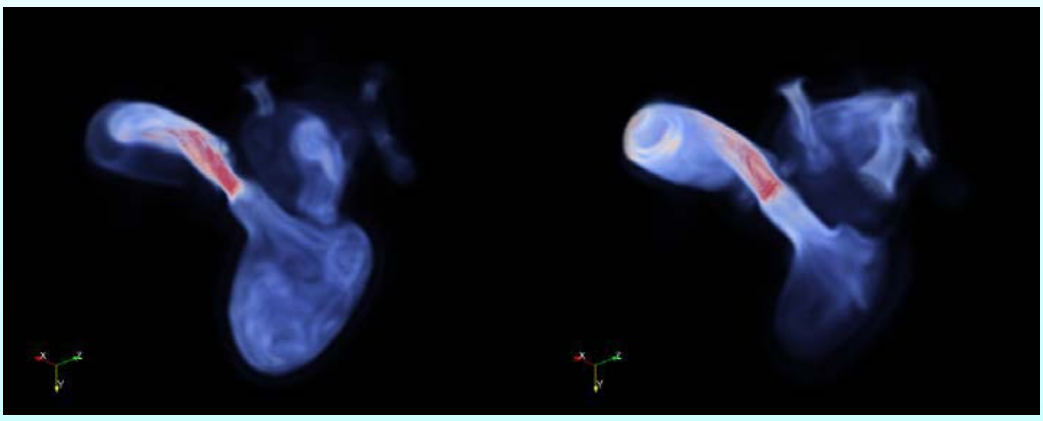
- The existing HeC heart models were extended by integrating and enhancing existing Siemens Corporate Research models, of the aortic and mitral valve. To exploit the morphological, functional and pathological dependencies and variations of the different heart valves, the pulmonary valve (PV) and tricuspid valve (TV) have been modelled in addition. The heart valves represent a critical component for the analysis, modelling, and simulation of the whole heart function and this work represents the first data-driven modelling of the complete valvular apparatus.



Above: Comprehensive, patient-specific heart model including the complete valvular apparatus.

Patient-specific Cardiac Blood Flow Simulations

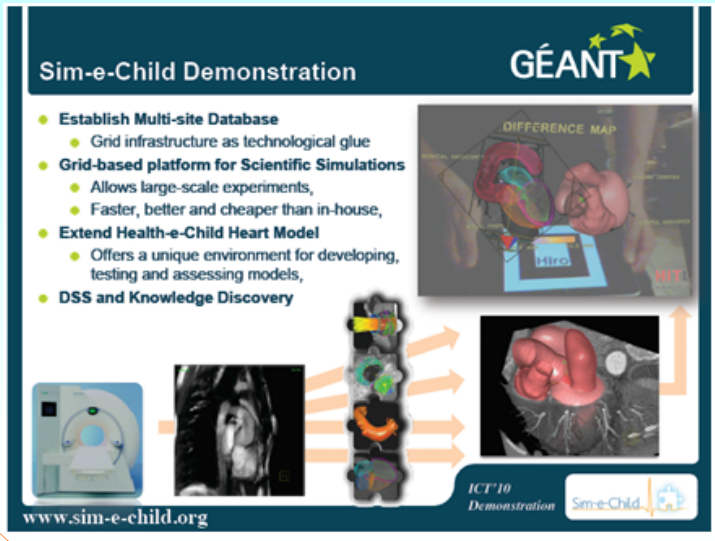
SeC Clinicians were provided with first, simulated, patient-specific cardiac blood flow across the entire cycle. Thanks to this work clinicians will, for instance, benefit from a better understanding of the vorticity which can convey crucial information about the formation and dynamics of potentially harmful "spins". By integrating these elements, SeC will provide paediatric cardiology professionals in Europe and the US with a Virtual Physiological Human based decision support and virtual laboratory. This will enable them to construct and validate multi-scale and personalised models of a growing child's heart and blood vessels. Ultimately this will support their clinical decisions and allow better understanding of their patient's condition.

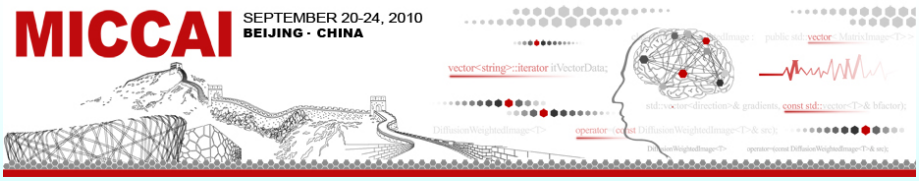


Above: CFD blood flow simulation results based on patient-specific anatomical model: Vorticity pattern in patient with bicuspid aortic valve during early systole (left) and mid systole (right).

Sim-e-Child at ICT10

One highlight of SeC's dissemination activities was the cooperation with **GÉANT** and **neuGrid** at **ICT2010** on running jointly a booth that gave practical examples of how the data networking services developed within the GÉANT project, such as Bandwidth-on-Demand and performance monitoring tools, were having an impact on EC funded research. SeC's demonstration showed off a prototype of the services that will become available to clinicians by combining the use of an iPad and Augmented Reality (AR) to display medical image processing pipeline outputs. 3D/4D models were personalized from HeC's patient records and displayed in augmented reality instead of regular visualization. The iPad was used as an advanced remote controller to browse datasets and select pipelines to be run (everything was delivered through Web interfaces interacting with a grid infrastructure underneath). Once the analysis was





Sim-e-Child at MICCAI 2010 in Beijing

The high quality of SeC's work on cardiac anatomical modelling was recognised in September 2010 when two members of the consortium, Sasa Grbic (Siemens) and Razvan Ionasec (SCR), both PhD students supervised by Prof. Nassir Navab (TUM), received the MICCAI Young Scientist Award for 2010 in Beijing, China. The winning paper was supported by SeC and represents the first data-driven modelling of the complete valvular apparatus. The heart valves represent a critical component for the analysis, modelling, and simulation of the whole heart function. The MICCAI awards commission citation read:

"*The original contribution of this paper is in the estimation of patient-specific cardiac valve parameters from cine images enabled by a new constrained Multi-Linear Shape Model. This work addresses a very challenging clinical problem, which is a complex 4D modelling problem, and demonstrated impressive results.*"

Sim-e-Child FactSheet

Sim-e-Child in figures

Project Identifier	**FP7-ICT-2009-4 (248421)**
Timeframe	**January 1, 2010 to June 31, 2012**
Total cost	**€1.86m**
European Union funding	**€0.99m**
Number of partners	**11**
Number of Workpackages	**6**
Number of Deliverables	**20**
Total estimated funded efforts	**223 person months**
Total estimated unfunded effots	**55 person months**

Sim-e-Child Partners

1. **Siemens AG (Siemens)**
2. **Lynkeus Srl (Lynkeus)**
3. **maat France (MAAT)**
4. **Technische Universität München (TUM)**
5. **I.R.C.C.S. Ospedale Pediatrico Bambino Gesù (OPBG)**
6. **Siemens Corporate Research, Inc. (SCR)**
7. **Johns Hopkins University (JHU)**
8. **American College of Cardiology Foundation (ACCF)**
9. **Siemens Program and System Engineering Srl (PSE)**

Who's who in Sim-e-Child

Chairperson of the Governing Board:	**Michael Sühling (Siemens)**
Chairperson of the Scientific Committee:	**Dorin Comaniciu (SCR)**
Project Manager:	**Edwin Morley-Fletcher (Lynkeus)**
Chairperson of the Ethical and Legal Committee:	**Gerard Martin (ACC)**

Sim-e-Child Workpackages and Workpackage Leaders

WP1	**Project Management**	**Siemens**
WP2	**Interoperability Requirements Analysis**	**Siemens**
WP3	**Clinical Protocol and Data Alignment, Ethical Clearance and Monitoring**	**OPBG**
WP4	**Simulation and Collaboration Platform Development**	**Maat**
WP5	**Development and Assessment of Personalized Child Heart Models**	**Siemens Cooperate Research**
WP6	**Dissemination**	**Lynkeus**

www.sim-e-child.org

Sim-e-Child: a 30-month Specific Targeted Research Project co-funded under the 7th Framework Programme priority "Information Society Technologies"