# ABB's research activities in the Automation field

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ABB is today focusing on two core areas – Automation and Power. After the ongoing divestments there will remain two divisions within the ABB Group – ABB Automation Technologies and ABB Power Technologies.

The main overall strategy for ABB is Industrial IT, which focuses on making products from throughout ABB as well as from our partners to work better together over the complete product and plant life-cycle. This brings big advantages to our customers and allows us to overall increase ABB competitiveness.

The Group R&D (Corporate Research) within ABB is likewise organized in two Global Labs – Power Technologies (GLPT) and Automation Technologies (GLAT). The automation research is mainly performed in the research centers in Sweden, Germany, Norway, Switzerland and United States. Currently we are about 400 researchers active within automation. GLAT is a strategic technology partner to the product development organization of the ABB business units in the automation field, ensuring that new technologies are applied in the most efficient manner to maximize the future business value for ABB. The research activities are organized in six research programs:

Control & Optimization: Where we develop methods/algorithms that generate or support actions and decisions in industrial enterprises to increase the value of the production for the client.

Sensors & Microsystems: Where we create technology breakthroughs enabling new products in the field of sensors and instrumentation.

Software Architecture & Processes: Where we focus on both the software technology and the software development process in order to deliver the right plug and produce solutions with substantially increased customer value.

Power Electronics: The focus is on innovative power electronics solutions and new power semiconductor devices in industrial automation and power systems, as well as the development of breakthrough technologies in the critical areas of power semiconductor chips and power modules.

Advanced Industrial Communications: Where we create technology breakthroughs within the area of industrial communication, by utilizing new wired as well as wireless technologies in ABB applications/products.

Mechatronics & Robotics Automation: A multi-disciplinary area which focuses mainly on advanced robotics systems, applied optimization and optimum control of Mechatronic Systems.

Most of the research regarding simulation and modelling is done within the Control & Optimization program, and also to some extent in the Mechatronics and Robotics program. Some of the current activities and accomplishments in this area will be outlined below

ABB has a long tradition of using dynamic models for control design. Already more than 20 years ago the first adaptive controller was introduced. In those days the focus was on regulatory control based on empirical (black-box) models. Although regulatory controllers still remain an important part of our business (albeit less often adaptive nowadays), it is more and more common that model based solutions today take place higher up in the value chain.

It may be a model predictive controller (ABB has recently released version 3.0 of its MPC called Optimize$^{IT}$ Predict & Control) delivering setpoints to the low level PID controllers. However, dynamic models are increasingly used for optimization of variables more directly formulated in economic terms rather than the traditional process terms (flow, pressure etc). Within the Control and Optimization program there are currently optimization projects in such diverse application areas as pulp and paper, power plants, pharmaceutical and cement industry.

Another area where models are important ingredients is asset condition monitoring. To detect and diagnose malfunctioning equipment ahead of time (preventive maintenance) will be a key area for the future in all industries since our customers want to maximize the lifetime and uptime of their assets with minimum amount of maintenance. Here we have in various projects and products applied a number of different techniques; for example multivariate statistics, neural networks and Bayesian networks.

Another trend is that model based solutions today more often use physical models derived from first principles rather than purely empirical models. For that purpose you need appropriate modelling tools and languages, and therefore we are frequent users of, for example, Matlab/Simulink, gPROMS and Modelica. On top of gPROMS we have developed our own product called Dynamic Solutions, which provides a user interface based on Microsoft Visio and access to data via an OPC server. For Dynamic Solutions an extensive model library for chemical processes has also been developed.

In this progress towards more and more model based control and optimization we see some challenges ahead:

- To get economy of scale we need to be able to re-use models and, for example optimization environments. This is easier said than done in a large company such as ABB where many different modelling tools and solvers are used today. It is probably not realistic to standardize on only one modelling tool and one optimization solver. However, for several reasons we seek to keep the numbers to a minimum and provide conversion between them.
- Manage all models and other information around a process object (e.g. a pulp digester). For a single object there may be everything ranging from simple empirical models to full fledged nonlinear dynamic models.
- A related problem is to maintain all these models during the life cycle of the plant, including keeping track of different versions of the same model during its development.
- To tie together all aspects of a plant using some type of model; be it a process diagram, control configuration and tuning, production optimization or asset management.

For all this we intend to utilize ABB's new Industrial IT platform with Aspects Objects as the common user model and information infrastructure. There are already today projects underway in this direction, e.g. prototype for automatic generation of functional structures from P&I diagrams or Modelica models.