

## Inform<sup>IT</sup> Aspect Object Viewer – the Industrial<sup>IT</sup> equivalent of Adobe Acrobat

To carry the 'Industrial<sup>IT</sup> Enabled' symbol, all current and new ABB products are tested and certified at one of four levels. The lowest level (level 0) specifies a base set of information available for every Industrial IT product or application, and the higher levels define capabilities that allow interaction with other products or in system configurations. Today, more than 36,000 ABB products are at least level 0 certified.

To become what is officially known as Industrial IT Level 0: Information Enabled, a product must have the following characteristics or Aspects:

- Product identification
- Product documentation:
  1. Product data sheet or technical reference manual
  2. Installation and commissioning manual
  3. Application manual
  4. Operating manual
  5. Maintenance and service manual
  6. Declaration of conformity regarding CE marking

7. Environmental product declaration
  8. Environmental information
- CAD data
  - Technical data and product classification

All this product information is collected and stored in one file as an Aspect Frame Work (AFW) file. The .afw extension denotes a proprietary file format that is designed to encapsulate Aspect Objects<sup>1)</sup> for use in distributing product information (Level 0 Enabled products).

The above-mentioned Aspects and Aspect Objects are used by ABB to model all information about products and processes. The Aspect Objects are created, changed and displayed using a common ABB architecture called the Aspect Integrator Platform, or AIP. However, many potential customers of level 0 Industrial IT certified products do not have AIP already installed and would not be able to access the AFW file. A small, easy-to-use tool was therefore required – the Industrial IT equivalent of the Acrobat Reader – that would allow viewing and navigation of AFW files without the need to install AIP. In addition, it should serve as an important marketing tool and appetizer for ABB's Aspect Object platform.

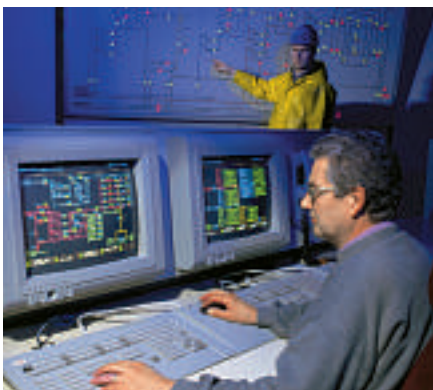
Scientists from ABB's Polish and German research centers, together with Industrial IT experts in Sweden, developed an Aspect Object Viewer (AOV) in response to this need. This very compact (approximately 8-MB) application is smaller than the Acrobat Reader

program and permits viewing of AFW files using navigation methods very similar to the plant explorer, but operates fully independent of AIP software.

Under the name Inform<sup>IT</sup> Aspect Object Viewer, the project was completed in six months and version 1 was released for external distribution in January 2003. An upgraded version 2.1 was released in September with the following new features:

- Support for bookmark Aspect
- File association – assumes AOV as the default application for viewing AFW files
- Automatic upgrade – automatically removes the previous version of AOV
- Descriptive error messages – for more understandable messages when something goes wrong
- Search function – for searching for object properties

Two ABB businesses are already using AOV. The low voltage business has produced a CD cataloging its circuit-breakers, electrical relays and control products. Each CD now contains AOV to allow viewing of product information. Since the middle of 2003, the power transformer business has made AOV available to customers as part of the Aspect Object information distributed with products certified to Level 0.



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<sup>1)</sup> The Industrial IT concept defines the collection of information required to support each plant component as an Aspect Object<sup>TM</sup> – containing all the characteristics – or Aspects of the device.

## The 'human touch' – advanced robot programming

*An ABB collaboration has resulted in an improved programming method that not only speeds up the programming of robot automation tasks, but also opens up areas for automation that are presently inaccessible due to traditional programming being too complex and taking too long in relation to production time.*

ABB robots have to be extremely versatile. Used across almost the whole of industry for tasks ranging from automated assembly and materials handling to arc-welding, every extra ounce of versatility added to them can significantly increase their range of application. As a robot is essentially a moving object, spatial information has to be conveyed accurately and reliably to it. Adding flexibility therefore makes traditional program-

ming more complex and time-consuming. The advantages to be gained from finding new, alternative methods of relaying information fast (and accurately) to the robot make this field of research as challenging as it is interesting.

With robots playing an ever more important role in our everyday lives, the idea that humans should be able to communicate with them using methods as close as possible to those they use to communicate with each other is gaining momentum. Communication among humans is multi-modal (ie, a combination of gesture and speech) and often intuitive, and institutions like Carnegie Mellon University (CMU) have used this idea to increase human-machine interaction. As a world leader in industrial robot technology, ABB is benefiting

from this experience by working together with the Advanced Mechatronics Laboratory at CMU on a project which uses the idea of the human arm and hand gestures as a natural way to convey spatial information – in other words, gesture-based programming. ABB's approach is backed up by Professor Pradeep Khosla, head of the AML and Electrical and Computer Engineering Department at CMU when he says, "As robots enter the human environment and come into contact with inexperienced users, they need to be able to interact with the users in an intuitive way. The keyboard and mouse are no longer acceptable as the only means of input."

### Gesture-based programming in a nutshell

CMU has been working in the area of gesture-based programming (GBP) for many years now. The goal of GBP is to provide a more natural environment for the user, and to generate more complete and successful programs by focusing on task experts rather than programming experts.

The process begins with a person demonstrating the task to be programmed. The person's hand and fingertips are observed through a sensorized glove with special tactile fingertips. The modular glove system senses hand pose, finger joint angles and fingertip contact conditions. Objects in the environment are sensed with computer vision while a speech recognition system extracts high-level control information. Primitive gesture classes are extracted from the raw sensor information and passed to a gesture interpretation network. The system is self-adaptive in the sense that knowledge of previously acquired skills retained by the system is used to interpret the gestures during training, with control feedback provided during run-time. The output of the GBP system is the executable program for performing



the demonstrated task on the target hardware.

#### What it means for ABB

Since robotic arc welding is inherently three-dimensional, hand gestures would be an intuitive tool for providing parameters such as position, velocity, acceleration, size, direction, angle and angular velocity to enable faster and accurate programming of the robot. Speech would also play an important part in enhancing this system by providing high-level control information. Therefore, CMU scientists together with ABB experts have developed and evaluated a programming system with a multi-modal interface for robotic and arc-welding applications.

The system has the following main components:

- Cyberglove to measure the position and movement of the fingers and wrist (gesture sensing)
- Polhemus Fastrak 6-DOF sensors for position sensing
- Microsoft speech recognition system
- PC
- WebWare for robot-PC communications
- ABB robot

The PC mediates between the multi-modal input devices (glove and speech) and the ABB robot. On the input side it runs software that translates raw voice and glove inputs into robot controller commands. On the output side it sends commands to the robot that contain correct position and orientation information based on the appropriate coordinate transformations.

The robot is programmed in three modes: absolute, jogging and slave. In absolute mode, 'waypoints' are programmed by pointing to and storing various positions in space with the index finger. However, due to the limited accuracy of the positioning system ( $\pm 5$  cm), the stored positions have to be adjusted to meet the required accu-



racy ( $< 1$ mm) for arc-welding. These adjustments can be performed by either 'jogging' or 'slaving'. Jogging, as it is used in robotics, means controlling the end effector (a device or tool connected to the end of the robot arm) directly using either a joystick or push buttons. In this case the joystick and pushbuttons are replaced by gestures and voice commands. For example, the 'jog' command makes the robot move a certain distance in the direction of the index finger. In slave mode, the robot mimics the motion of the hand using an adjustable scaling factor. This means that if the human hand moves a distance of 1 cm, the robot responds by moving 1 mm (depending on the scale settings) and so on until the desired accuracy has been reached

The system has been tested and evaluated in a real arc-welding environment using ABB's IRB140 and IRB1400 robots. The programming system has so far proved capable of producing the necessary accuracy, allowing high-quality

welds to be produced. In addition, observations from the evaluation indicate that it is a very easy method to learn and master.

The joint collaboration between engineers at CMU and ABB experts has, in addition to generating valuable results, built up extensive know-how which will be used within ABB for further research in the field of robot programming.

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## A new web-based simulation tool for polymer plant operators

*A simulation system that makes use of state-of-the-art web technology is used to train Novolen® gas-phase polypropylene process plant operators on a rigorous dynamic plant model via Internet, Intranet, or as a stand-alone system.*

Simulation-based education is the method preferred by many companies today for providing 'on the job' training. As computational capabilities become ever faster and improved tools appear on the market, computer-based educational services, particularly in the chemical process industries, are expanding. These services can mimic true plant operation through computer simulation, thus providing a safe and efficient method of training plant operators and other production personnel. In addition, operators may be trained to handle normal and abnormal plant operating conditions without endangering the actual plant [1].

ABB Corporate Research has developed a simulation-based process-learning tool for polypropylene plants. Together with Novolen Technology Holdings C.V. (NTH), a joint venture of ABB Lummus

Global and Equistar, ABB has developed a learning tool aimed at the Novolen process owned by NTH. Called Novolen Operator Training Simulation (Novolen OTS), the tool's strengths lie in its unique model, the robustness of the software and simulator, and its ease of maintenance and extendability. Because plants using the Novolen process are located around the world, using a web-enabled tool is particularly appropriate. Novolen OTS based training is possible over the Internet, Intranet, or on a stand-alone computer.

The targeted users are Novolen process plant operators, operator trainers, and process engineers. A major training objective is that the operators learn the dynamic characteristics of the plant during standard operation and in abnormal situations, including process disturbances, start-up/shutdown of the plant, and transitions between different product grades. Moreover, they obtain an understanding of the relationship between operating conditions and resulting product quality. This permits operators to improve their ability to operate plants and to diagnose problems.

### The Novolen process plant

In the Novolen® process, polymerization is conducted in one or two gas-phase reactors. Only two reactors connected in series are needed to produce a wide range of products, including super-high impact copolymers. In addition to the reactors, components in the plant include condensers, degassing vessels, product silos, an extruder, controllers, and emergency valves **1**.

### OTS component overview

The main components of the Novolen® OTS system include:

- A simulator, which includes a model of the process, the control system and the safety interlocks
- A generic operator station as a human system interface
- A software framework, which integrates these main components and provides for simulation services over the Internet.

The graphical user interface (GUI) is a generic representation of an operator station **2**. As the Novolen® OTS is used in self-paced mode, no instructor station is required. A standard web browser, such as Internet Explorer, represents the GUI, displaying simulation results as well as allowing user input.

The components in the user interface, such as valves, numeric text boxes, buttons, level indicators, and flares, reflect the current status of the simulation. When necessary, the components are used to change the course of the simulation. For instance, valves are closed/opened by clicking on them, and specific numbers are entered using the numeric text boxes. The condensers, degassing vessels, product silos, extruder, controllers, and emergency valves are all represented in the tool.

Besides the above-mentioned basic functionality, additional functions are implemented for an enhanced learning experience. For example, the speed of the simulation can be increased in order to use the tool more efficiently, or a snapshot of the current state can be taken and reused in later training sessions.

A normal training session starts by navigating to the web site of the server. After a login procedure in which access rights are checked, a simulation is started with one of several pre-configured scenarios. The trainee may then change the course of the simulation by changing process parameters, such as flow rates or temperature set-points. These

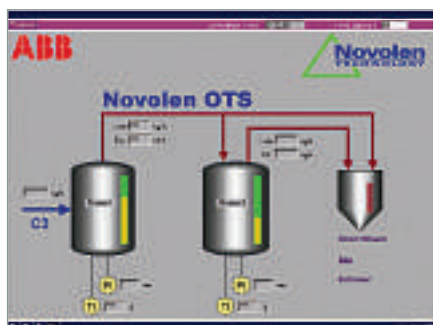
1

An NTH polypropylene plant



2

Tool screenshot, showing an overview of the process



changes result in a dynamic response, which the trainee observes and reacts to accordingly. Stopping the simulation and closing the web browser terminate the session.

The Novolen® OTS can be fully installed and run on a standard off-the-shelf PC. Alternatively, it can be run over the Inter/intranet so that only a web browser is needed on the user's side.

### Technology

The dynamic model is a first-principle based model of the Novolen® process with major unit operations [2]. It is composed of ordinary differential equations and has about 100 states. A wide range of operating conditions was required because the process tool was designed in answer to a major training objective: to focus on the dynamic characteristics of the plant during standard operation (eg, transition between different polymer grades) and abnormal situations (eg, a blocked pipe).

The model is parameterized to easily permit adjustments that reflect different plant sizes and configurations. Special attention has been given to the integrity of the numerical solution to avoid simulation crashes during training.

The tool uses a client-server architecture where the simulation services are server based. The GUI is presented on the client's computer. The interaction between the client and the server takes place via HTTP, the most common communication protocol on the Internet. The screens within the tool are built as HTML pages with Java applets representing the data. The HTML-based approach makes it possible to flexibly link to other information sources, and enables integration with other e-learning systems. The use of Java makes it possible to program a variety of specialized components, allowing the user to influence the data in various ways. Despite this, all major browsers with Java capabilities can be used for server access.

On the server side, a web server framework (consisting of a multi-layer architecture) provides the functionality needed for dynamic data to flow to and from the web pages. Innermost is an OPC server, which encapsulates the model and provides a standard interface to its data. The web server creates an HTTP-based service where data can stream from the OPC to Java servlets. These servlets are connected via HTTP to the Java applets 'living' on the client side. ABB developed the internal OPC connectivity by using the Java Native Interface to bridge the gap between Windows 32 applications and Java [3].

### Value extension

With Novolen® OTS, NTH has extended the value proposition of its current technology offering with the creation of a highly robust and extendable tool using standard software and modeling technologies. This tool will enable current and future licensees of the Novolen process to improve the understanding and operation of their plants. Licensees will be able to choose between web-based or stand-alone training sessions. Initial feedback from users has been so positive that many feel such a tool will eventually become essential for any company in the chemical process industries.

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