Team-mates

ABB MultiMove functionality heralds a new era in robot applications

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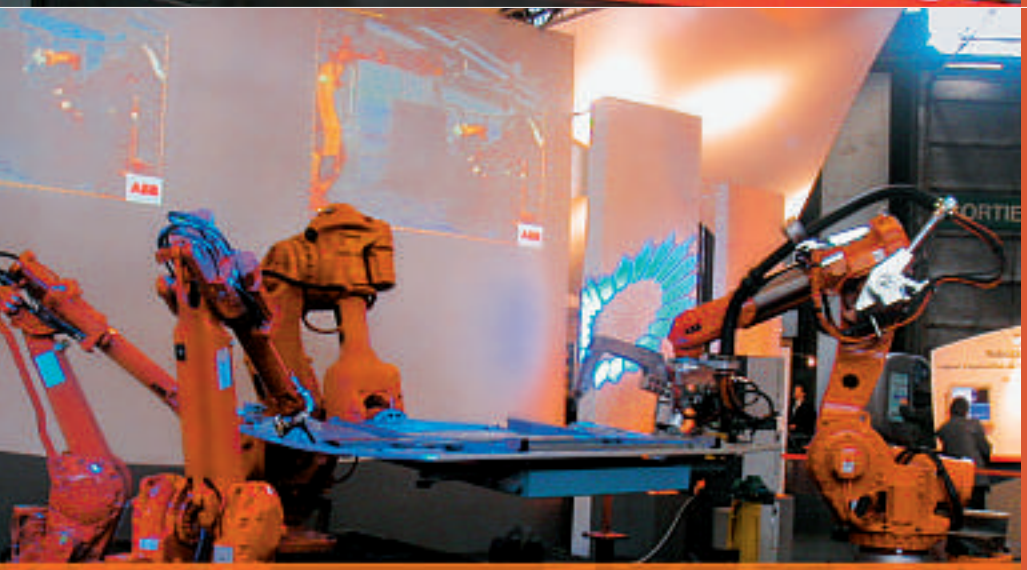

There is more to robot coordination than avoiding collisions. Operators wish for more precise synchronisation so that robots can team up to complete tasks that a single robot cannot perform. Two robots could, for example, lift an object that is too heavy or too bendy for a single robot. Or a group of robots could simultaneously work on an object while it is moving or rotating.

Such tasks require a very high degree of synchronisation. ABB's new IRC5 controller makes this possible, permitting robot groups to handle more complex tasks than ever before.

The technology step taken by ABB in the development of its fifth generation robot controller, the modular IRC5[1)], is one of the biggest since the launch of its first generation S1 in 1974 and the IRB6 – the world's first electric drive robot. Of the advances made with the IRC5, it is perhaps the introduction of *MultiMove* that will have the biggest impact in terms of applications and customer benefits.

MultiMove is a function embedded into the IRC5 software that allows up to four robots and their work-positioners or other devices to work in full coordination. This advanced functionality has been made possible by the processing power and modularity of the IRC5 control module that is capable of calculating the paths of up to 36 servo axes.

Such power, however, does not inflate cost as the modular concept of the IRC5 permits a lean solution. Irrespective of whether the cell has single or multiple robots, only one control module is required. Expansion only requires the addition of a drive module per robot up to a maximum of four. This approach significantly reduces the requirement for communication links compared to the more common multiple controller solution.

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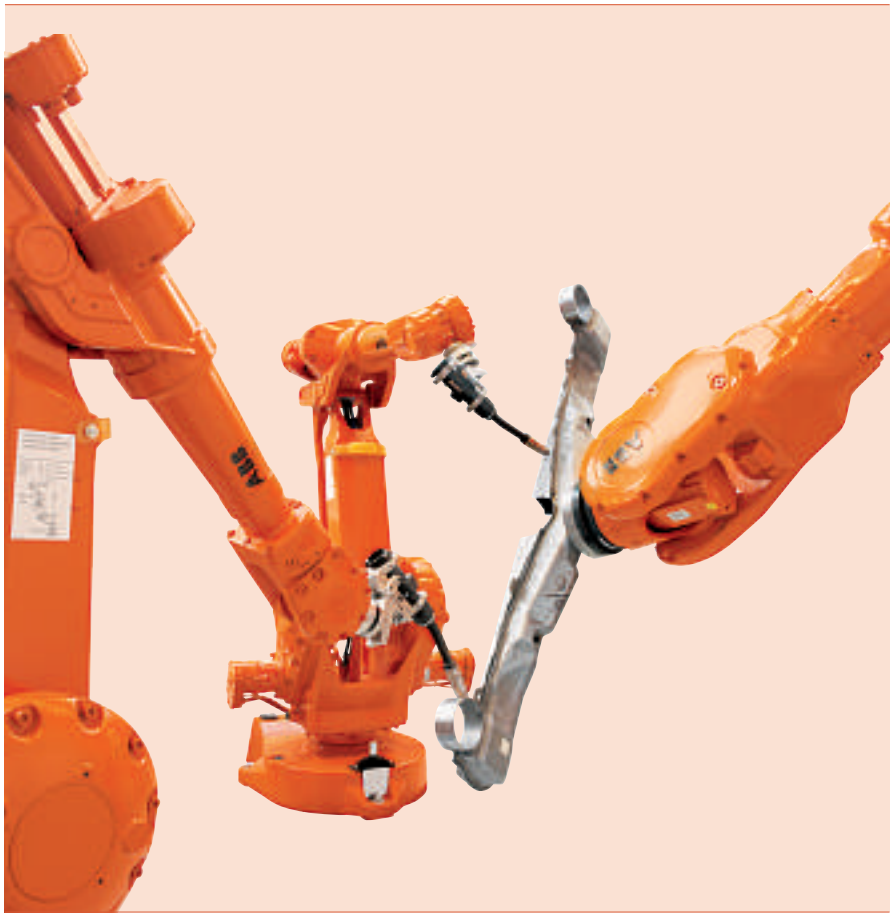
The principle of MultiMove is an expansion of that used in coordinating a robot with a work-positioner, but this older technology can coordinate only two robots or other devices. With MultiMove, the work-handling device, which can be a robot or work-positioner, controls the work object. The other devices are coordinated to move relative to the work object. This is achieved by defining the object coordinate systems of each of the coordinating devices as relative to the work-object held in the handling device.

Footnote
1) www.abb.com/robotcontroller

1 The MultiMove function, which is embedded into the IRC5 software, allows up to four robots and their work-positioners or other devices to work in full coordination.



When the work-object moves, the other devices move in symphony.

Even though MultiMove is a complex function to implement and requires large processing power (particularly in the path planning and synchronisation of the drive motors of all robots), its operation has been kept simple. Feedback from customers given early exposure to MultiMove has indicated that anyone familiar with programming an ABB robot, particularly when coordinated with additional axes such as a work-positioner, should have little difficulty in creating MultiMove applications.

A key to the easy implementation of MultiMove is that each robot or additional device in the cell has its own program. This may be written and edited in ABB's RAPID robot programming language. Each program may be viewed and executed totally or partly independently of other programs using either the Windows style FlexPendant graphical teaching unit, which has been developed as an integral part of the IRC5 controller, or a PC. This concept of program separation in the MultiMove function is unique to ABB.

MultiMove is totally flexible because of its ability to switch between coordinated and independent operation of the robots in the cell. For instance, all the devices can operate totally independently of each other all the time; or they can be synchronised at certain points in their cycles (semi-coordinated movement); or they may work in coordination with fully synchronised sequences and movements. Furthermore, the robots can operate in groups with two or three coordinated, while the other robots in the cell work independently.

In semi-coordinated operation, the robots in the cell work on the same stationary object. This requires some time synchronisation in the sequence of operations but not any coordinated movements. For example, a positioner moves the work-object while the robots wait, and the robots only work on the object while it is stationary. This semi-coordinated movement requires synchronisation only to "advise" the positioner when the workpiece

should be moved and when the robots can work.

An example of this is two robots welding the same workpiece in different areas and on two different sides. The positioner first moves the workpiece to present its upper side. Then the robots perform their welds while the positioner waits. Next, the positioner rotates the work. Finally, the robots perform their welds on the lower side.

In fully coordinated movement, several robots operate on the same moving object 1. The positioner or robot holding the work and the robots operating on that work, move in synchrony. Therefore, the coordinated robots must start and stop their movements at the same time and must execute the same number of move instructions.

An example of fully coordinated movement is a spot welding task in which the work is continually moved along an arc by one robot while two spots are applied by a weld gun held by another robot that is coordinated with the first robot. A single instruction in the work handling robot's program is sufficient to move it from the start to the finish of its trajectory along the arc. However, because the welding robot applies two spots in different spatial positions and, therefore, requires two instructions in its program, the handling robot must also have two instructions. Therefore, the arc movement must be accomplished using two move instructions, one to a midpoint and another to the end of the arc, which are executed synchronously with the two move instructions in the welding robot program.

Shorter lead times, increased productivity and improved quality are some of the generalised potential benefits of multiple robot operation with the new IRC5 controller.

Another feature of MultiMove is the ability to jog multiple robots using the joystick on the FlexPendant 2. During "coordinated jogging", the relative positions of all the devices remain constant and are exactly the same as during the full speed execution. At any point, any of the devices can be switched to an independent jog so that their relative position may be adjusted and then switched back again for the coordinated jogging to continue. This is a powerful tool in fine-tuning MultiMove programs and is only offered by ABB.

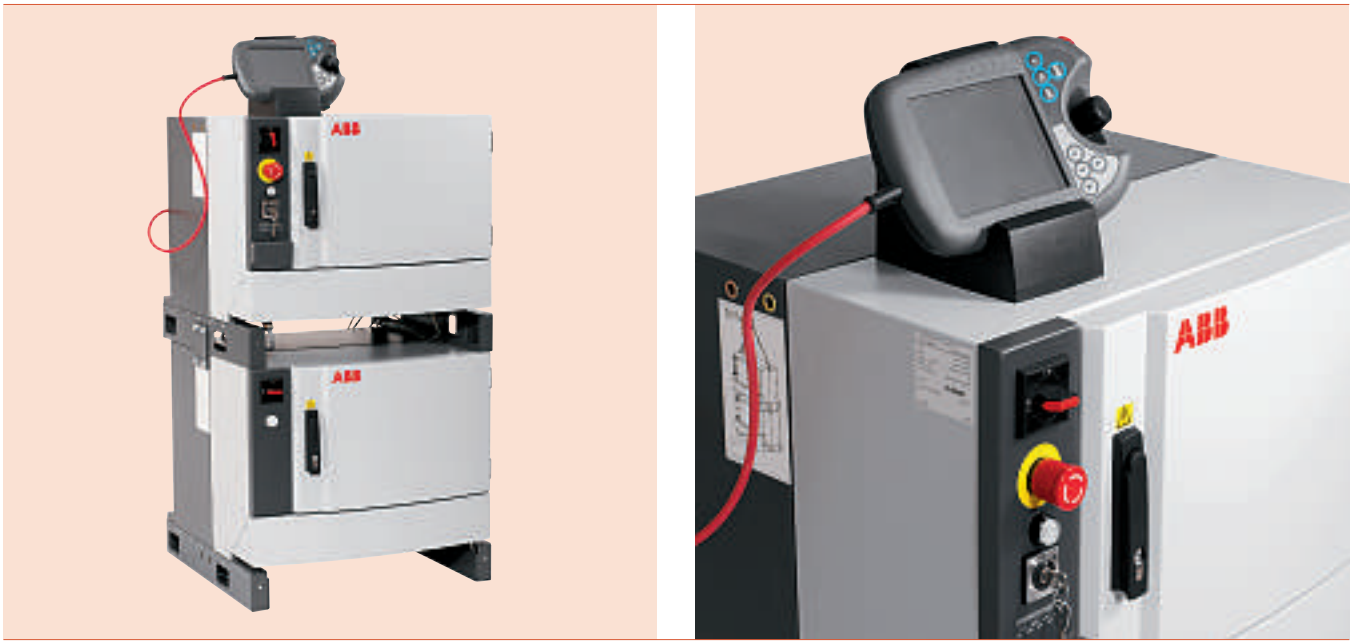
Recovery from a production stop due to equipment or process failure is a potential problem due to the complexity of the choreography in MultiMove operations. Not only has the robot at "fault" to avoid work and tooling, but it must also coordinate with its "partners" during its retraction to a safe position as well as on returning to its last position. The problem is eased by the IRC5 controller because of its path recording functionality. This is activated for every robot in a MultiMove operation. Knowing the path leading to the error point enables the faulty robot to retract in synchrony with the coordinated robots to a safe point that is identified in its RAPID error recovery routine. The same path data will similarly be used after recovery to return all the coordinated robots to the program positions at which the error occurred.

Some errors necessitate the re-execution of a command (otherwise known as a "retry") rather than returning the robot to its last known position. An example of this is an arc failure during arc welding. In this case an arc restrike makes more sense than a retraction. Therefore, a "retry" will be specified in the RAPID error recovery routine. In MultiMove all devices need to be coordinated during the retry.

To make it easier to recover from such errors in arc welding, ABB has developed a new *"asynchronously raised error"* function in RAPID. For

2 ABB's Flexpendant (a) is part of the IRC5 package. It supports robot programmers (b) through its ergonomic design, customized menus and touch screen.

3 The “brain” of a synchronised robot cell is the IRC5 controller.



instance, in the above example it is most likely that the arc failure will occur along the programmed path after the instruction has been executed but before the robot has completed its movement to the end of the path. In this case, it is necessary that the error recovery routine is executed at the point of the arc failure and not at the completion of the instruction. The asynchronously raised error function allows this to occur in MultiMove as well as in single robot routines.

Shorter lead times, increased productivity and improved quality are just some of the generalised potential benefits of multiple robot operation with the new IRC5 controller 3. Even in totally independent robot operations, time and costs are reduced due to the efficient internal communications and minimal handshaking of the single controller. When some degree of synchronisation is introduced, waiting times can be minimised leading to further reductions in cycle times.

Better product quality is a high potential benefit of MultiMove. This can be achieved, for example, with two or more robots working together in order to balance the load on the workpiece. To illustrate this, think of simultaneous arc welding to eliminate the risk of distortion due to uneven shrinkage on cooling. Another is the use of two or more robots to handle delicate or flimsy workpieces that may flex or bend under their own weight.

It is also possible to expand the “part-on” concept with MultiMove by coordinating a workpiece-handling robot with one or more process robots, helping to simplify and reduce tooling and fixturing. This can also reduce cycle time as the time to place the workpiece in the fixture has been eliminated and the process robots may be able to start their operations as soon as the part is picked up. Moreover, the 6-axis robot has more dexterity in manipulating the workpiece as compared to a rigid fixture or even a servo-controlled positioner. This could mean, for instance, that the process robots are able to access all areas of the work, allowing the operation to be completed in one handling with no intermediate stops for reorienting the work. This is called one-stop or one hit processing.

Another advantage of coordinating a work-handling robot with two or more processing robots is the higher relative speeds attainable, for instance, between the weld torch and the workpiece, leading to possibly better quality welds and/or shorter cycle times. A further benefit is in lifting heavy loads. It may be less costly to employ two smaller robots to lift the load rather than a larger one, or the load may be heavier than the capacity of the largest robot but not of two robots working together.

The unique functionality that MultiMove brings to the whole ABB robot range sets new standards in robot technology and opens up a range of applications that were previously impractical or uneconomic. Its development has been backed-up by the knowledge gained from the previous four generations of ABB robot controllers and aided by the expertise generated from over 125,000 ABB robots installed worldwide. MultiMove further strengthens ABB’s lead in advanced robot systems.

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