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In This Issue:

"Telerobotic" Potential for Utility Applications

Article was adapted from author's paper presented at the 1993 Vehicle Maintenance Management Conference at the University of Washington in Seattle.

by James E. McKenna

Current and potential use of telerobotics in the utility industry is a present actuality and a future reality. The ability to perform true work functions by remote manipulation has major inherent benefits to the utility willing to identify need and provide workable solutions to operational problems. It is a true investment in the future.

Let me preface my article by listing the three laws of robotics identified by futurist Isaac Asimov in 1942:

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings except where such orders would conflict with the first law.
3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

The robotic age has arrived. Robots have moved off the pages of science fiction stories and into the real world. Today, there are robots at work in factories, laboratories, schools and homes, performing a wide variety of functions that address efficiency, safety and repetition. There are robots that can see, hear, talk, feel and walk. They are fully capable of performing, under direction, routine and emergency tasks that eliminate risk to their operators.

Units designed for duties such as bomb disposal, hazardous waste clean-up and police and fire assistance have removed a great deal of the personal risks involved in these specialized areas. While we may be somewhat uncomfortable with the concept, there are great strides being made in the area of artificial intelligence that will ultimately provide the ability for robotic decision making and problem resolution.

Robotic engineering, development and manufacture is world wide. In my visits to a number of providers, I have met and discussed robotic activity with many international representatives. Numerous countries have active R&D programs underway with high expectations of positive, usable end results. Pacific Gas & Electric has taken an aggressive step toward the future by purchasing and beginning work on a prototype unit capable of performing energized line work on overhead distribution circuits. We feel the operational enhancements are well worth the time, efforts and costs we're expending. This program, sponsored by now-retired PG&E East Bay Region Vice President George F. Clifton, is focusing on safety, operational efficiency, cost control, employee rehab potential and future personnel and operational restraints.

In a system designed to address the benefits of "telerobotics," the human element is key to success. "Telerobotics" provides the operator with a means to replicate desired manipulation of human capabilities at a remote location. That is, rather than a fixed program of events, the operator controls the unit, makes the necessary decisions and completes required work sequences with allowances for changes that may occur at any time during task completion.

Jim McKenna demonstrates the telerobotic unit as the 1993 Electric Utility Fleet Managers Conference in Williamsburg, Va.

Robotics

Reach All and PG&E created a partnership to develop the next generation of utility line maintenance vehicles.

Additionally, the operator gains enhancements of safety, strength, reach and reduction of fatigue. "Telerobotics" capitalizes on the intelligence of the operator and allows the unit to be an extension of the worker. Expansion into this area seems to be a natural progression for us and in your individual case may be the primary concern.

The concept of robotics may carry a vestige of threat for the average worker and should be addressed up front in your discussions. There is a negative notion in most peoples minds generated by past exposure to media input and lack of positive examples. By being open and available with our development efforts, those concerns have been turned to positive support.

WHY ROBOTICS?

Typical underground structures offer a wide variety of size, shape and access concerns. Energized equipment in a confined space, operating on a continuous demand for quality power, offers an opportunity for "robotics" to address several needs:

- Inspection of facilities without the need for workers to enter the enclosures.
- Load readings-cables/equipment.
- Operation of switching devices to isolate or eliminate hazardous electrical conditions.
- Damage control assessment following equipment failure.
- Sampling/testing vault environment (air/oil/water).
- Removal/repair/replacement of equipment.
- Splicing/repair/replacement of cable and terminations.

While for the most part these desirous possibilities exist only as that, possibilities, it is only through lack of effort or perceived need that we are not a great deal further along in their development.

Discussions with robotic experts indicate that based on today's availability of proven systems, new models or adaptions of proven units can be produced to respond to our needs. Some problems that we might envision as hindering these optimistic developers include:

- Older/crowded installations.
- Non-standard enclosures and equipment.
- Cable racking on any and all surfaces.
- Access size and internal movement limitations.
- Control surfaces incompatible with unit end effecters.
- Unstructured environment requiring decision making.
- Size/shape/weight of tasks required.

The list of both potential positive and negative is seemingly endless, limited only by the design of your current system and what your ideal would be for the future. It is conceivable that a single system with maximum flexibility could answer all your needs but in reality that is a question that requires serious consideration.

WHEN?

Suggestions and thought processes for prototype systems are centering on portable units that would be transported to work areas as the need for their use was generated. Current units are too

costly to consider permanent placement except in the case of demonstrated daily need. We have had discussions with robotic developers who visualize two serious design concepts.

1. An ultra flexible unit that would be an attachment to a piece of rolling stock, having the ability to enter, maneuver and perform required work directed by a remote operator.
2. A self-contained, crawler unit that would be placed into the enclosure and would then be directed in its activity from virtually any distance away.

Both of these units now exist beyond the drawing board stage but would require additional engineering and design work based on expected performance. Consider modifications of such units that are commonplace in much greater size and complexity now in use everyday at nuclear power plants. Some of these units have the beginnings of artificial intelligence systems although primarily for collision avoidance, and they rely highly on very structured environments. An exception to the rule might be inspection and clean-up units in hot cells following the 3-Mile Island and Chernobyl disasters.

Today's demand for high quality and continuous service to a wide variety of customer needs and future expectations have already provided the road map for utility direction. Established robotic innovators are eager to listen and detail their potential solutions. Additionally, the inherent safety built into a remote manipulation system is readily apparent to all. Accidents and their potential negative after effects can be devastating. Funds committed to R&D that can offset this type of activity are well invested.

As a note of caution to those willing to consider the potential application of robotic technology in their areas of responsibility, it is only fair to say, at this time, that while the goal is admirable, progress is painfully slow. All good intentions aside, the simple fact that this is a new and untried field lends considerable stumbling blocks to desired accomplishments. There are no quick fixes, easy solutions, door-to-door salesmen or catalog to draw from. However, based on experience gained on our robotic project, the chase is well worth the effort. It is particularly rewarding to hear visitors and guests remark upon their perception of things they can visualize as beneficial. We have adjusted our basic direction as a result of these comments and are further along the way as a result.

HOW?

Any discussion of "how" to involve telerobotic manipulation should necessarily begin with a review of past practices, their benefits and limitations, and where ideally you would seek to apply this technology. Our emerging program is based on perceived need with constant monitoring and a heavy focus on continuous improvement. In other words, we see our unit as a prototype that is evolving as a response to a particular need, has initial maximum design flexibility, is adaptable to a variety of work demands and whose interim concept will be proven applicable through field trials and subsequent modification.

Consideration should also be given to the fact that there will be inevitable spin-offs from any specific direction taken and opportunities for development beyond original goals should be recognized and integrated into the base plan.

Of particular assistance is the opportunity for partnering with manufacturers or other interested parties who may draw mutual benefit from the development. We feel the work being done on our base prototype has application in substation and gas transmission and distribution field work.

Critical to successful program progression is vendor selection. Our experience has indicated an overt willingness to share information and to "get involved" by all we have talked to. Unfortunately, not all have the expertise or capacity to deliver. Critical evaluation of capability and full understanding of commitment required is essential. Dealing from a practical basis, regarding what we need as opposed to what may be provided and then modified to our needs, seems to avoid many unnecessary steps. Having interested parties involved in the design and ongoing evaluation only adds to the acceptance value when a usable model is rolled out.

HOW MUCH?

My article so far has involved some semblance of reality since I have written primarily from our actual experience. Closing on a financial note is probably the last thing I should do but in reality will probably address the first question you will be asked if you choose to pursue a robotics project. The simple answer is "I don't know." A more realistic response would be to say it will cost more than you expect and generate more value than you can imagine.

As an example, our project will very likely exceed $1 million in development costs to put a unit into the field for operational tests. Once we have proven the design and made the inevitable modifications, we expect the units could be reproduced for approximately $350,000 in 1992 dollars. While that figure is noteworthy, you must balance the cost against expected enhancements in worker safety, operational efficiencies, improvements in system maintenance, potential impact on A.B150 and future personnel and operational restraints.

We are convinced that as a utility functioning in constantly changing and ever more restrictive environment, we must investigate, evaluate and integrate improvements into our ability to serve. Robotic technology is one such area we are considering. While our current focus is fairly narrow, it appears readily apparent that spin-offs into our underground electric, gas and sub-station departments will be a logical result.

As a closing thought, if you feel the concept of "telerobotics" is beyond the capability of your operations or work force, consider what the average backhoe operator has been doing since 1957. **UCM**

James E. McKenna is manager of robotics and technology for Pacific Gas & Electric. He can be reached at (510) 373-2756, and will be at Reach All's booth, C140, at ICUEE '93.