# Additional Payable Safety Features for Remote Handling Technologies

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**Abstract**

In active High-Radiation activity settings having clear vision of operations is essential. Equally essential is a precise game plan for work which focuses its attention on the skilled remote handling operators who must produce the results. Project success is based on clean, efficient cuts and take-aways, prepared paths for placement and containment, programmed return paths; and of course on practice, practice, practice on the part of the operators. According to Joseph Schumpeter, creative destruction describes the "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one". In the same manner remote handling technology has improved in the last decades. Mechanical design improvements, complex robotic functions and force feedback are examples of progress in that sector. These progresses have also a major impact on the improvement of safety at work. This paper will concentrate on explaining which functions have become cost-effective in the last decades: 1. Virtual Reality, 2. Collision avoidance function, 3. Tool grapping, and 4. Linear movement.

About Wälischmiller: Wälischmiller Engineering has been providing safe, smart and cost-effective remote handling solutions with the famed German quality and reliability for over 60 years worldwide. Our handling systems offer various mechanical telemanipulators for a wide range of applications. Our models A100 and A200 series were successfully employed in Sellafield, Cadarache and Chernobyl. Other products include remote controlled power manipulators from the A1000 series for handling heavy loads; intervention systems with servo-manipulators for repair and maintenance tasks in hazardous and inaccessible zones as well as remote-controlled and automatic equipment for positioning, transport and sampling tasks.

## 1. Virtual Reality

Virtual Reality or VR has been defined as "...a realistic and immersive simulation of a three-dimensional environment, created using interactive software and hardware, and experienced or controlled by movement of the body" or as an "immersive, interactive experience generated by a computer". Virtual realities artificially create sensory impressions, which can include sight, touch, hearing, and, less commonly, smell. Some advanced haptic systems in the 2010s now include tactile information, generally known as force feedback [1]. The use of VR finds multiple fields of application, e.g. education and training, video games, entertainment, engineering...

The most known VR is the flight simulator, which artificially re-creates an aircraft flight and its environment. Pilots can practice cockpit procedure and get familiarized with the instruments. The most important reasons on using simulators over learning with a real aircraft are the reduction of transference time between land training and real flight, the safety, economy and absence of pollution [1].

## Advantages of this new and innovative approach

As professionals in the remote handling industry, we aim to achieve a fine balance between customer's need for better technology, user friendliness, and economical constraints, as budget, return on interest and lifetime of the equipment. It is in this effort that we progress and develop our manipulators and systems.

User friendliness has always been a driving force behind our design and manufacturing. For decades, computer assisted technology and force feedback have solicited considerable sums in R&D and sales, along with significant customer desire and attention.

There is a large diversity of remote handling equipment on the market today, all with varying technologies and functions. Yet, it is customer desire for advanced solutions and comfort that encourages manufacturers to develop smarter equipment.

Today's remote handling technologies have reached a new breakthrough stage. Operations can be prepared in a virtual environment, which presents several advantages over traditional preparation and testing methods:

*Interactive Feasibility Studies*
The virtual reality adds more dimensions to the planning of single steps, especially those requiring critical handling procedures. The situation and the operation which have to be done can be analyzed from different view and any angle, which are not possible with traditional cameras. Changing the view with a view selector makes it possible to create different views and perspectives. Additionally the virtual test enables an ideal positioning of the cameras in the hot cells. This modern techniques opens new possibilities for planning the tasks, which have to be done. Different scenarios can be conducted to find the best way and solution for effective and safe dismantling operation.

*Saving in Cost*
Until now challenging dismantling steps have to be tested and trained on complex construction of test rigs. The commissioning of these rigs are cost-intensive and time consuming. The virtual suite offers a fast and cost-effective test environment close to the reality. Additionally, the operations can be trained as often as necessary. Actually the test environment can be re-build in next to no time in the virtual reality. In contrary, when the test rig is used, it cannot be re-build so fast. Operating personnel can be trained on a virtual test stand without taking the risk damaging expensive remote handling equipment. Consequently, the remote handling equipment will not be used which also lead to cost saving.

*Improvement of Safety at Work*
Operating personnel can practice in the virtual suite and familiarize with the projects. Cutting procedure for dividing objects with special tools and automatic detecting of suitable objects for cutting can also be trained. As this happen in a virtual environment, operators cannot damage the arm, the in-cell equipment and injure someone. Consequently, the safety at work is improved. The inhibition to damage expensive equipment by making a wrong handling is minimized in a virtual reality. Consequently, the self-confidence is improved and gives operators a feeling of safety. The detailed structure of the manipulator and the operational facilities in the hot cells are modelled and simulated in real time. The optical collision detection during the simulation avoids damages on the manipulator and the facilities. The collision detector sends the signal to stop the arm before collision occurs.

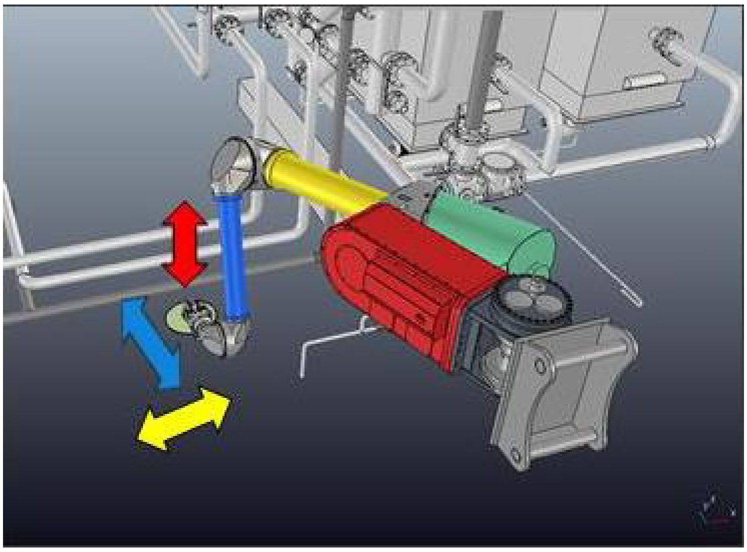

Fig. 1. 3-D Model of manipulator arm

## 2. Collision avoidance function

Robotic functions made possible for real-time monitoring and collision detection by 3-D-simulation (Fig. 2).

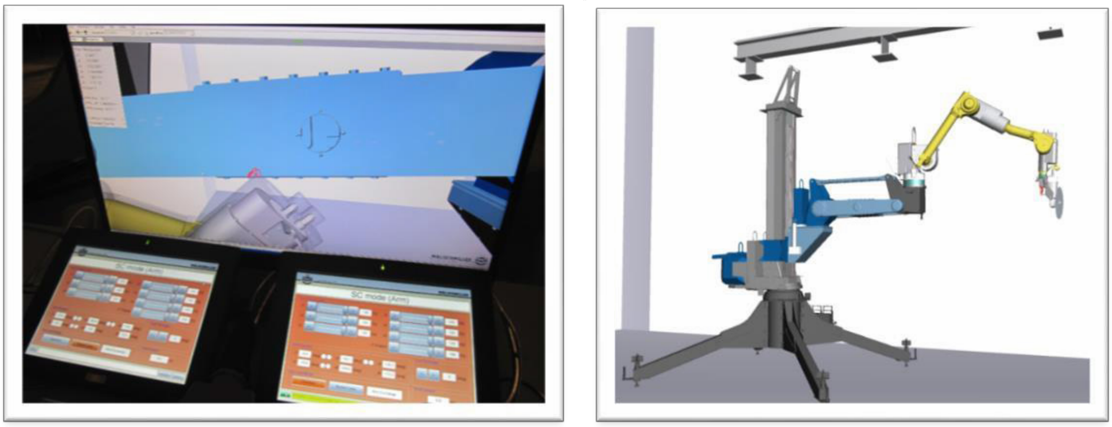

Fig. 2. Collision detection by 3-D-simulation

The detailed structure of the manipulator and the environment of the dedicated facility are modelled and simulated in real time. The collision detection by 3D-simulation avoids damages on the manipulator and on equipment placed in the hot cell. The collision detector sends the signal to stop the arm before collision occurs. This function was tested in detail at customers' premises and directly in the facility. The tests demonstrated that the function is more than useful because it avoided damage on the arm and in the facility. On the other hand, the operators feel more confident by using the manipulator and improved the safety of work (Fig. 3).

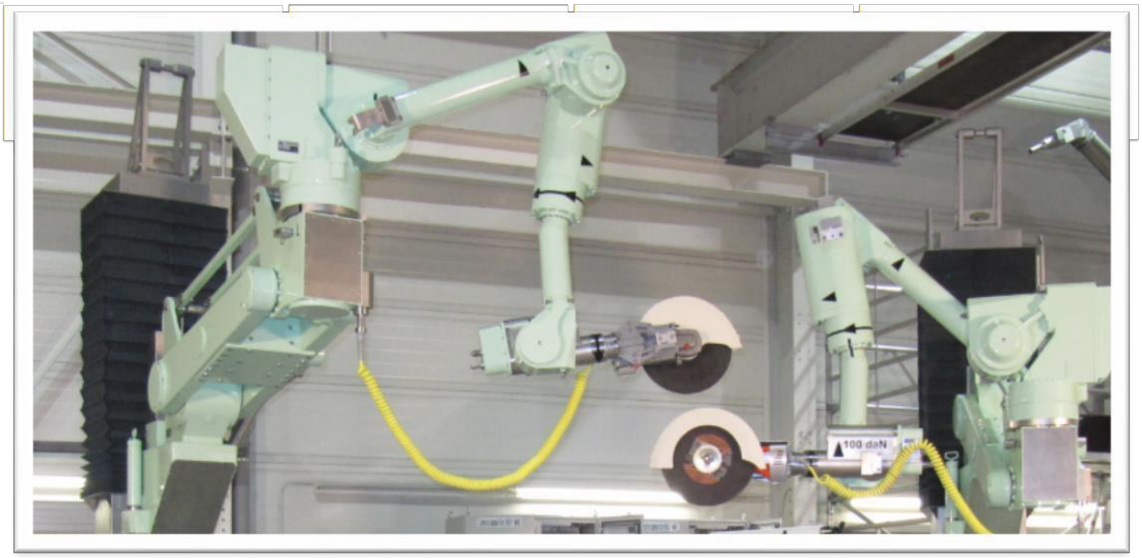


Fig. 3. Coordinated works with two A1000S

### 3. Tool grapping

The advantage of the 3-D modelling is also the possibility to program specific paths. At Wälischmiller, this user friendly control system is called GoTo-Mode and is an in-house development. It is a teaching and playback system, especially designed for remote controlled manipulators. The unique feature of the GoTo-Mode is the quick-teaching function, and human interactive playback function. During the playback operation, the operator always remains in control. Thus, the automatic mode is very flexible. The operator can adjust the trajectory speed, direction and points at any time during the movement.

During several tests, the GoTo-Mode improved the working efficiency in the complex environment. In a typical case, the hand of the manipulator had to reach tools in a tool rack, the path points can be taught, so that the backward path or the next path will be simply repeated by single lever. Thus the GoTo mode makes changing tools easy. The exact position of each tool can be saved. It can be automatically recalled. Therefore, the mode proves itself to be useful for repetitive work. The work becomes easier.

### 4. Linear movement

#### Showcase: decommissioning experience

In 2013, Wälischmiller Engineering won a contract for two remote handling systems dedicated to a dismantling cell. For this project, Inconel and other metals needed to be cut. One of the main cutting methods was decided to use of an angle grinder handled by a robotic arm.

Cutting a thick material with an angle grinder requires repeatable precise linear motion, in order not to damage the disc. The angle grinder should be handled with a manipulator which can cut in all directions in a linear motion, since the objects which should be cut are usually very large and fixed in any direction.

The large objects to dismantle by cutting are fixed, and the cutting line is not simply vertical or horizontal. Therefore, one requirement was that the cutting line has to be in any direction. Tests with Inconel were performed to validate the requirement concerning the linear cutting with an angle grinder (Fig. 4).

Fig. 4. Cutting with angle grinder

The 6 D.O.F. of the A1000S manipulator with Cartesian control made it possible to cut in any direction. Also, the user interface was a very important aspect to reduce the operators stress. Especially in case of a deep cut, the cutting trajectory was repeated on the same line precisely otherwise the disc would break. No major damages on the disc or on the grinder happened.

The software was designed so that the cutting mode Cartesian coordinate frame is quickly defined by the operator through the touch panel operation. Consequently, the operator can operate simply 2 levers (for the necessary dimension X: cutting direction, Z: cutting depth) to get the precise cutting result without stress (Fig.5).

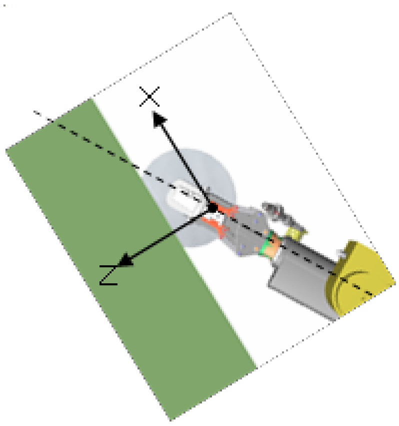


Fig. 5. X: cutting direction, Z: cutting depth

## References

[1] https://en.wikipedia.org/wiki/Virtual_reality