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Steps in the Evolution of a 60-mm Cutting System

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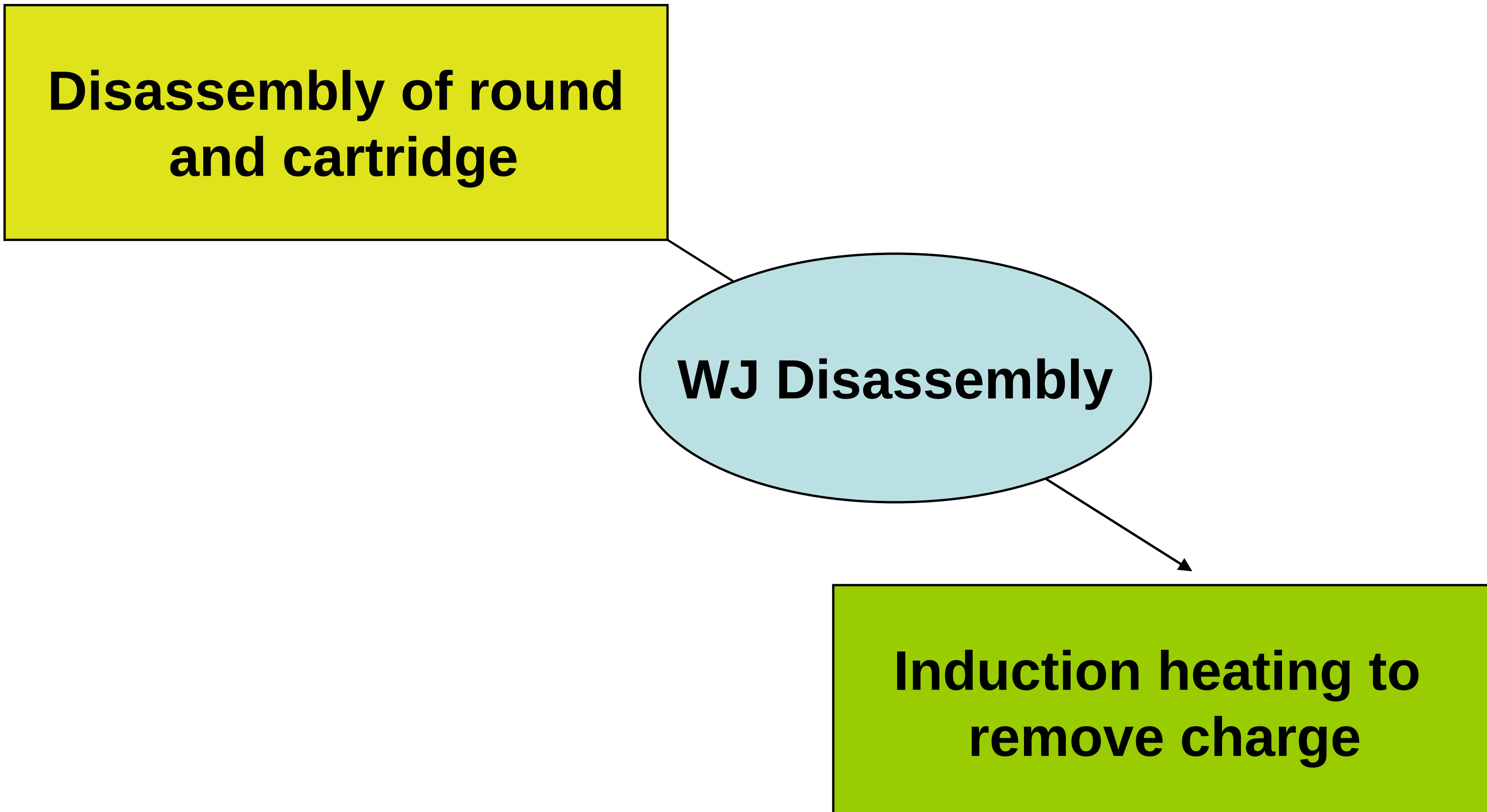
The Waterjet system has been developed to fit between two steps in the Demilitarization By Inductive Heating Meltout (DIHME) system



Abrasive waterjets have been found to be effective in cutting munitions

But need to be cut underwater if we are to avoid the noise and spread of abrasive and debris around the area.

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Nozzle performance testing

By determining the time that it takes to sever the fuze end from the round, it is possible to optimize cutting performance.

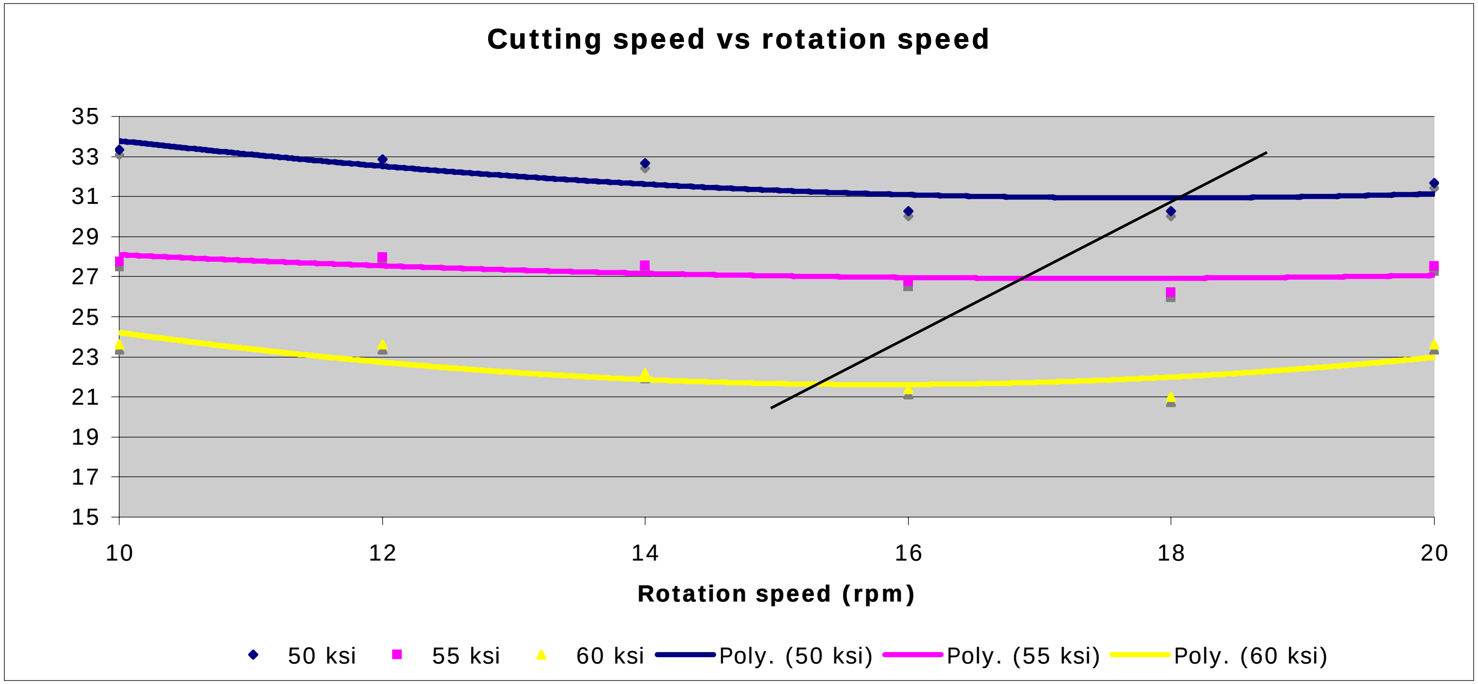
nozzle

Rotation drive

Several slices were made on each shell

A full factorial experiment was carried out.

Only 2 first order results are shown



The experiment varies jet pressure, abrasive feed and rpm. Note that as pressure goes up, curve fitting shows the optimal rpm decreases from 18 to 15 rpm, though in all cases 18 rpm gives the shortest time for cutting.

At 1 lb/min and $3.00 a lb, a saving of 4 sec is $0.20 per shell.

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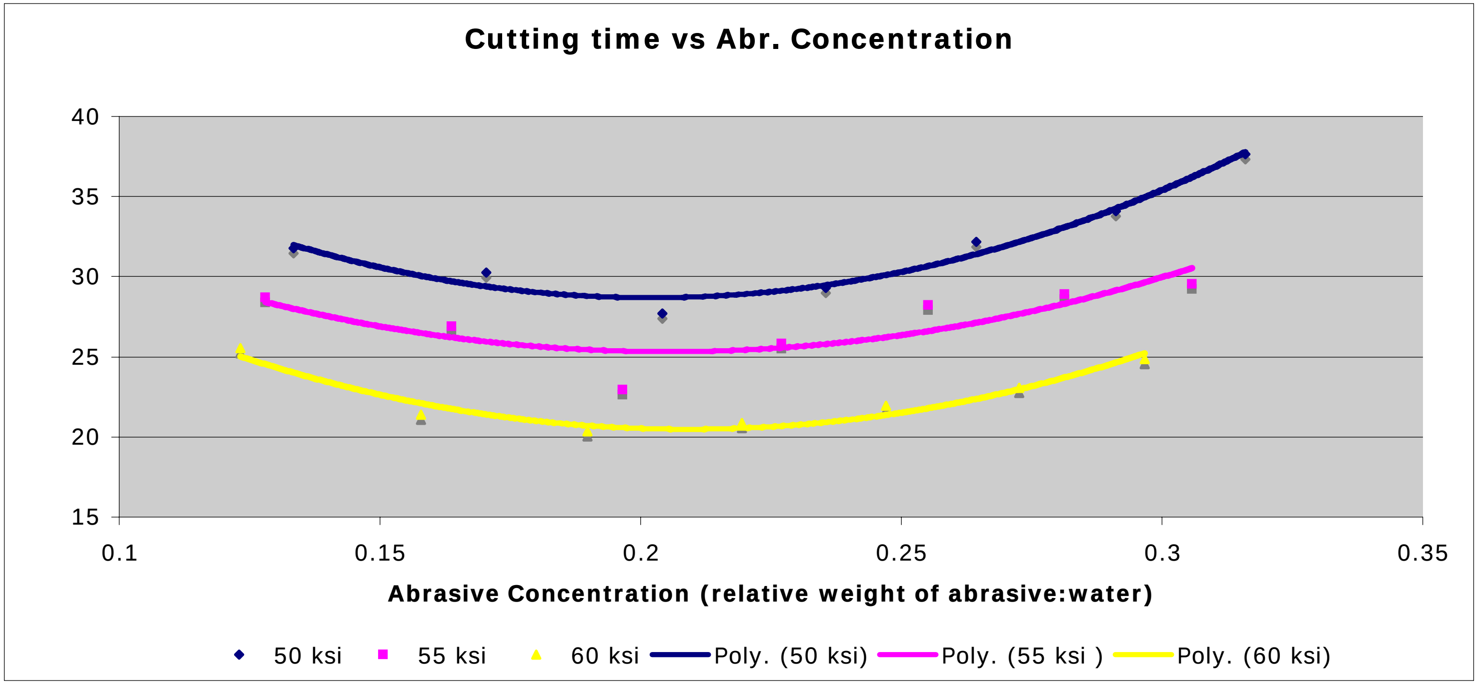
Cost evaluation steps

- *Abrasive cost - $0.60/lb (to buy*
- *Abrasive disposal - $2.40/lb (flash, landfill)*
- *Water cost - $1.80/kgal*
- *Water disposal - $0.04/gal (carbon treatment)*
- *Energy cost - $0.20/kWhr.*

a) Dan Burch, John Griggs, Mike Johnson, Greg Olson, David Summers “Abrasive Waterjet Cutting Demilitarization of 40MM Projectiles”1999 Global Demilitarization Symposium & Exhibition, Tulsa, OK, May 20, 1999

b)Dan Burch, John Griggs, Mike Johnson Greg Olson, “Abrasive Waterjet Cutting Demilitarization of 40MM Projectiles”, 2000 Global Demilitarization Symposium & Exhibition Coeur d’Alene, ID, May 18, 2000

Effect of abrasive concentration



Note that there is no change in the optimal concentration, when the pressure changes, (at 20% by weight ratio of abrasive to water). However this does mean that the abrasive feed rate should change with pressure to ensure the same concentration.

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UMR designed and build a prototype fixture to:

- Section 4 x 40mm rounds simultaneously
- Develop a concept that can work for rounds in the size range from 20mm to 120mm.
- Rotate the rounds during cutting
- Make 2 cuts, to remove fuze and tracer ends
- Trim the ends to remove protruding TNT.
- Separate the cut parts to remove loose material
- Place the parts so that they can be picked up.

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Must be able to rotate the rounds in the range from 1 - 25 rpm.

- Moving the rotating mechanism forward to grip and rotate the round requires a complex sealing structure.
- The rotation must take place with the presence of abrasive and high pressure water during cutting.
- Any gripping mechanism must also cope with the presence of abrasive in the surrounding water.
- The cutting will take place under water.

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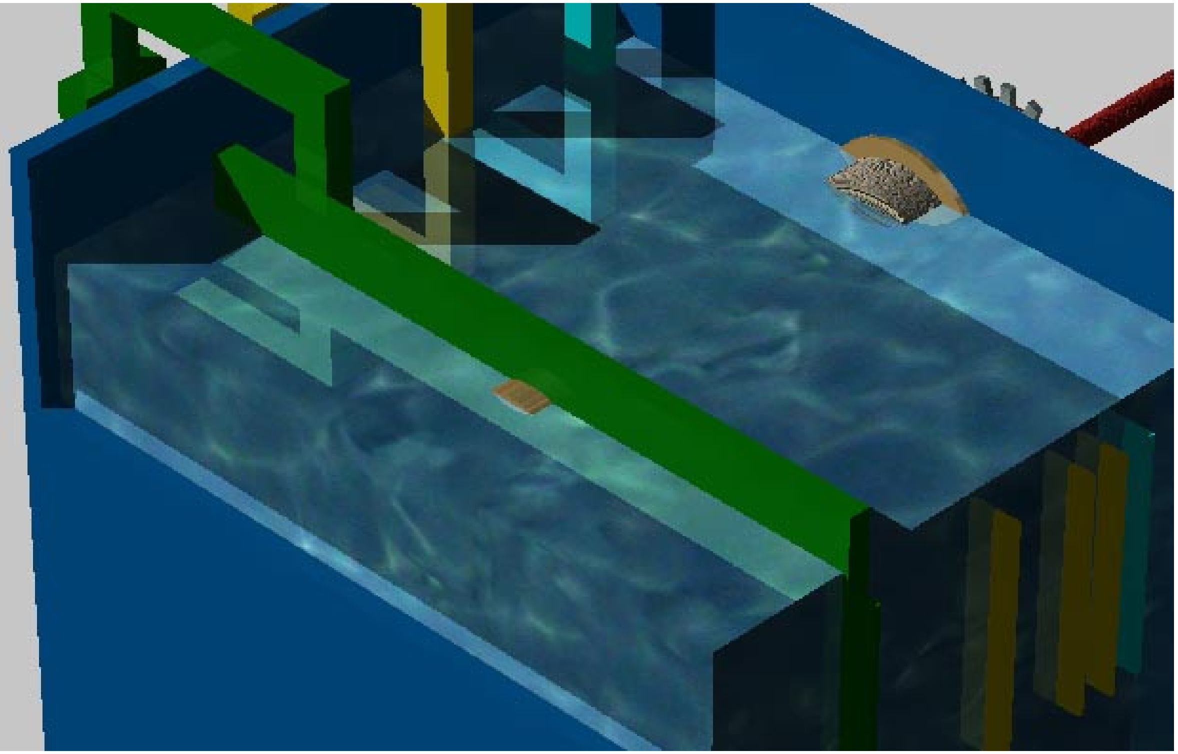
To control noise, and collect the abrasive, the shell is submerged, for cutting.



Note

Raising the water level is a standard procedure in cutting tanks and requires an air inflated bladder in a protected position in the tank.

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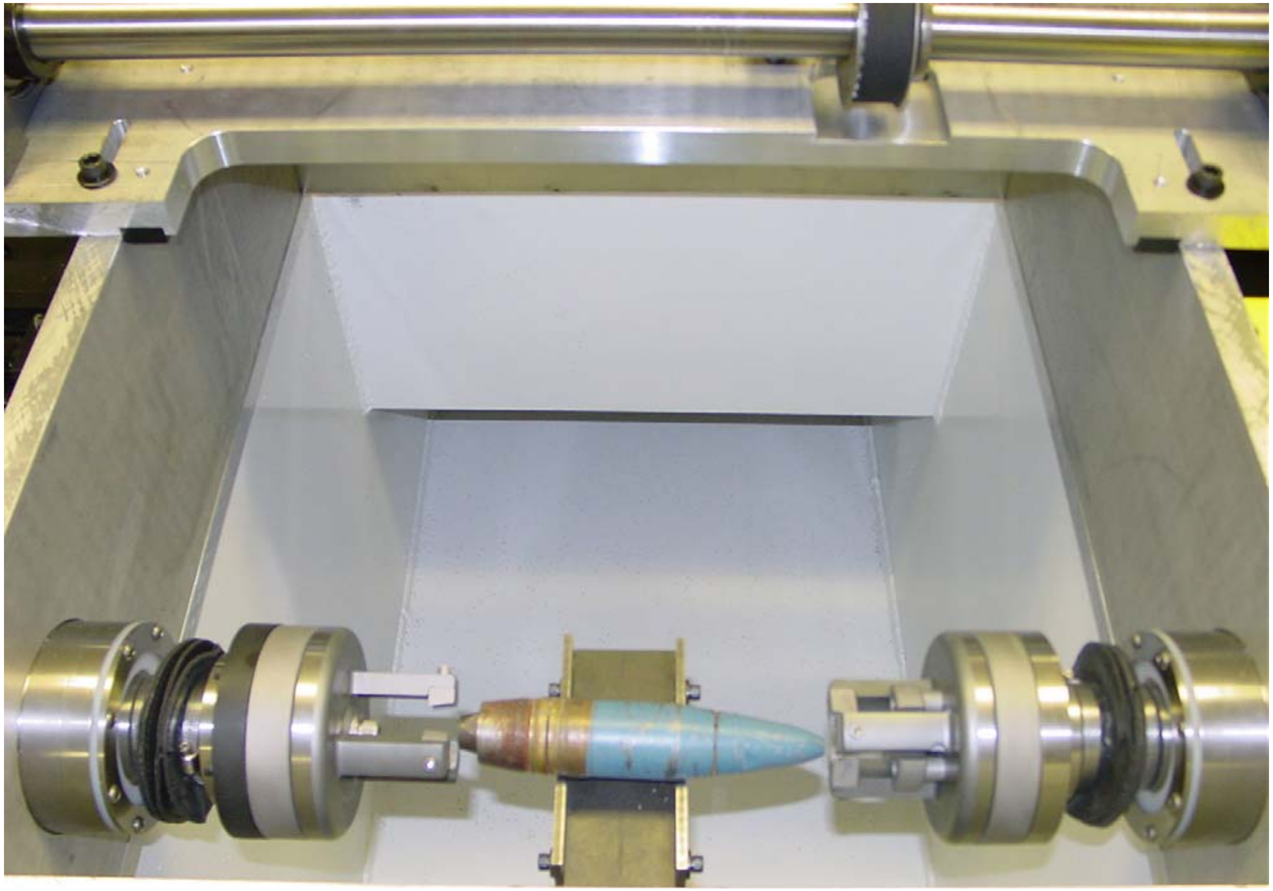
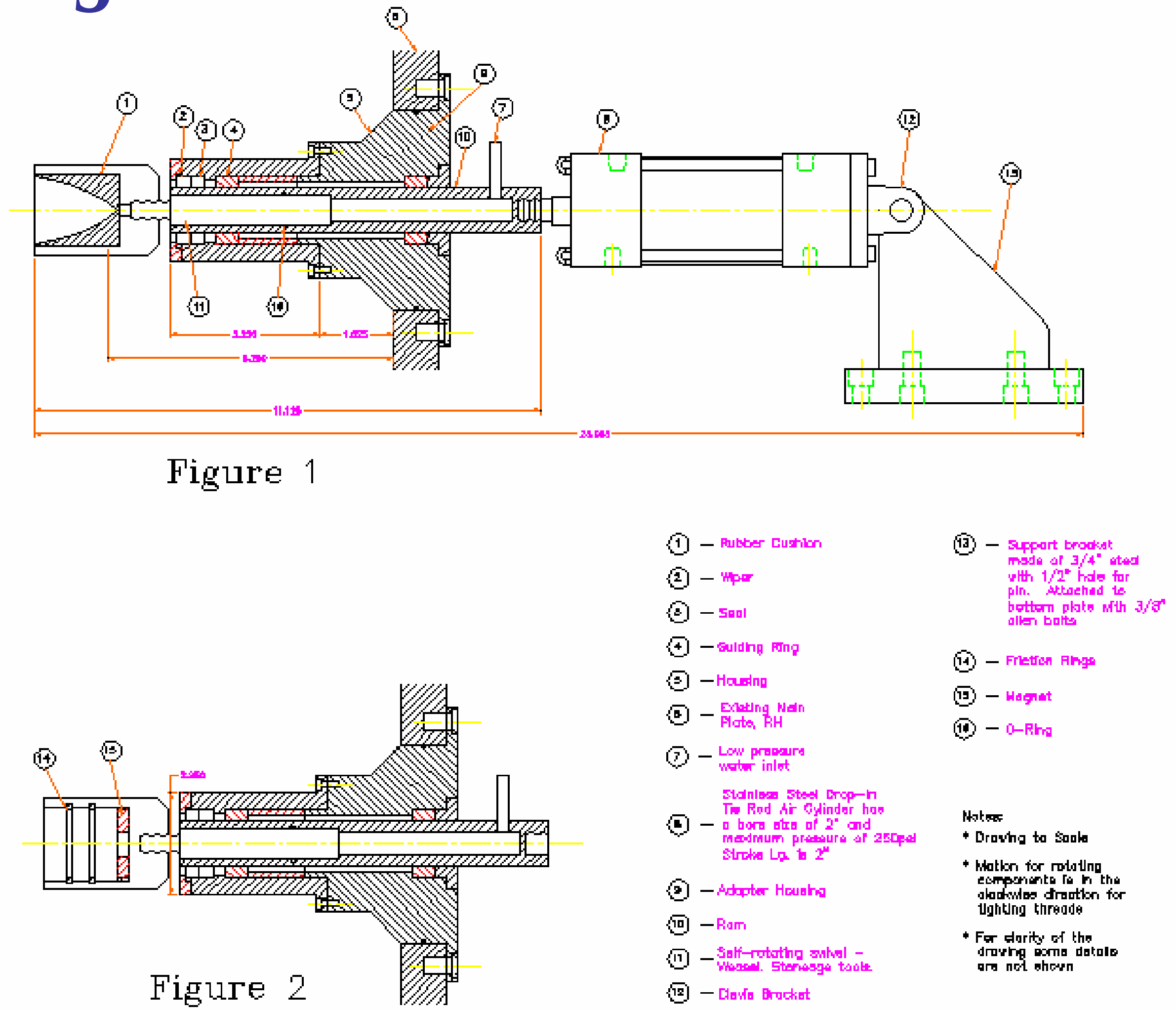
The initial system used 2 diaphragm chucks to grip and a drive that rotated the shells from both ends.



Requirements

- *The four 40 mm rounds must be on a 5 inch centerline to centerline distance.*
- *The longitudinal centerline axis of the four 40mm rounds must be located at 36" above the floor.*
- *The waterjet nozzles need to be 1" below the waterline during the cutting operations.*
- *Must have sensors that indicate when cuts have completed for each fuse/tracer on each round.*
- *Must interface with the waterjet robot end of arm tooling and hardware.*

The initial holding and rotation fixture was changed



The fuse end chuck was replaced with an idling chuck

The concept of maintaining the fuse end chuck as an idling component, significantly simplifies the mechanism.

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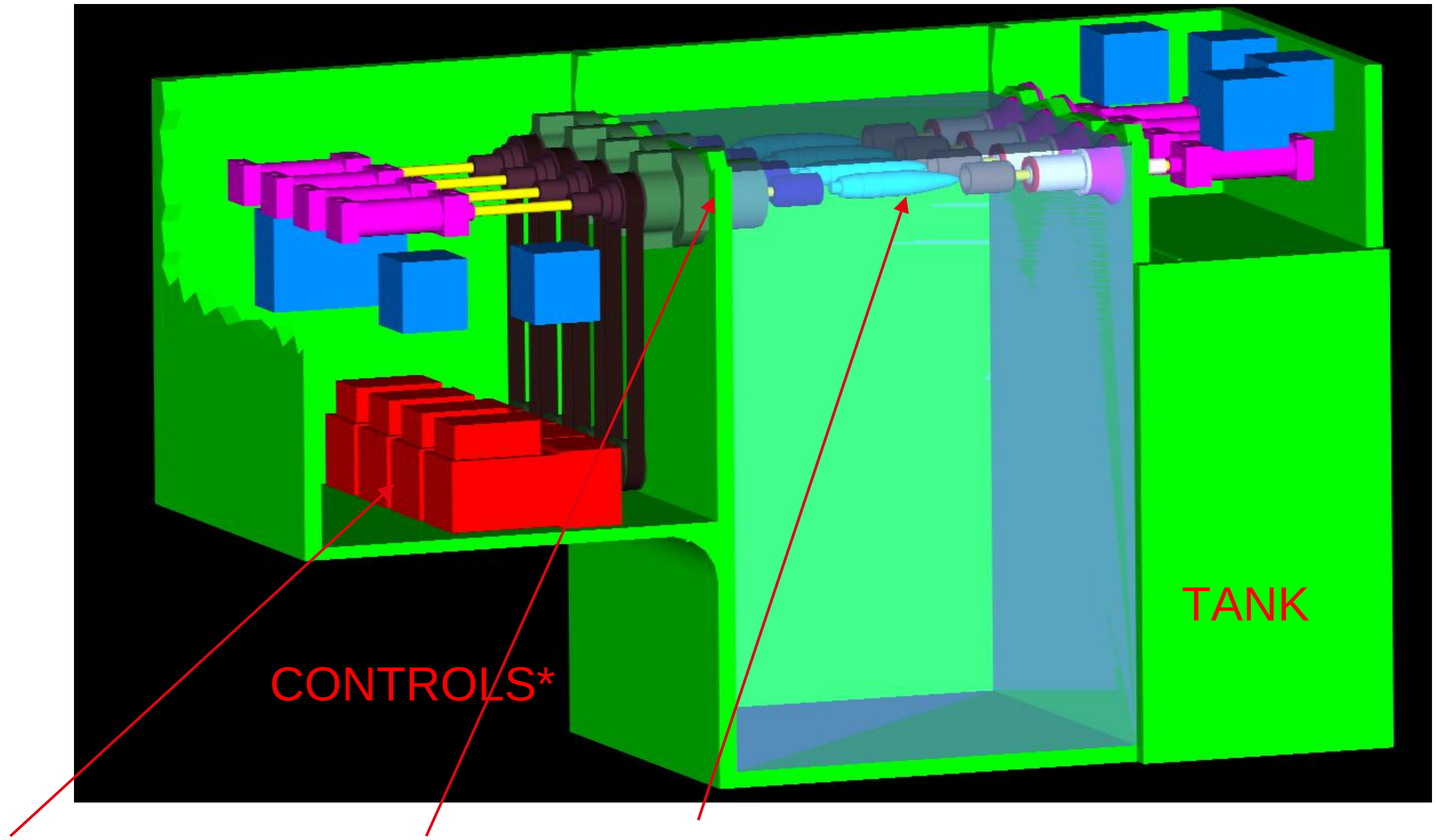
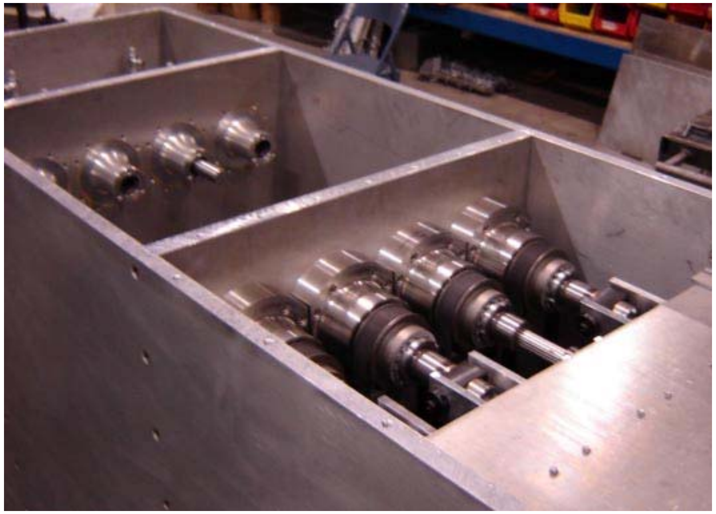
The fixture that was built is meant to hold four rounds, and to rotate them under the nozzles

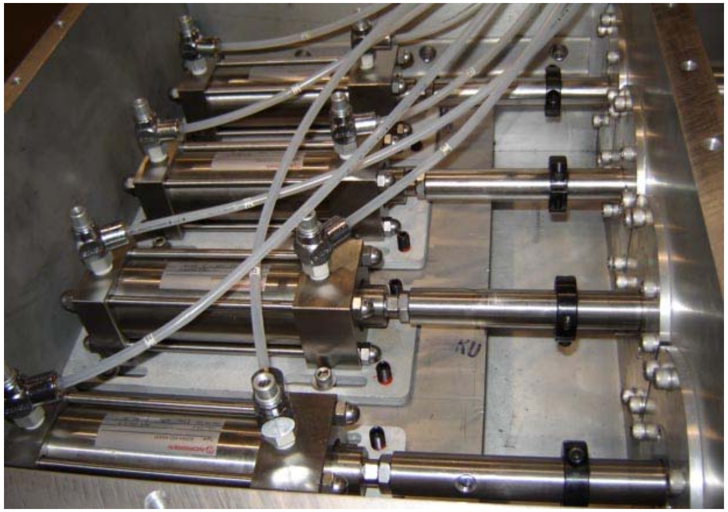
Drives are located in the end wells, and the rounds in the center well.

The original configuration, showing motors



The Holding & Rotation Fixture has been built





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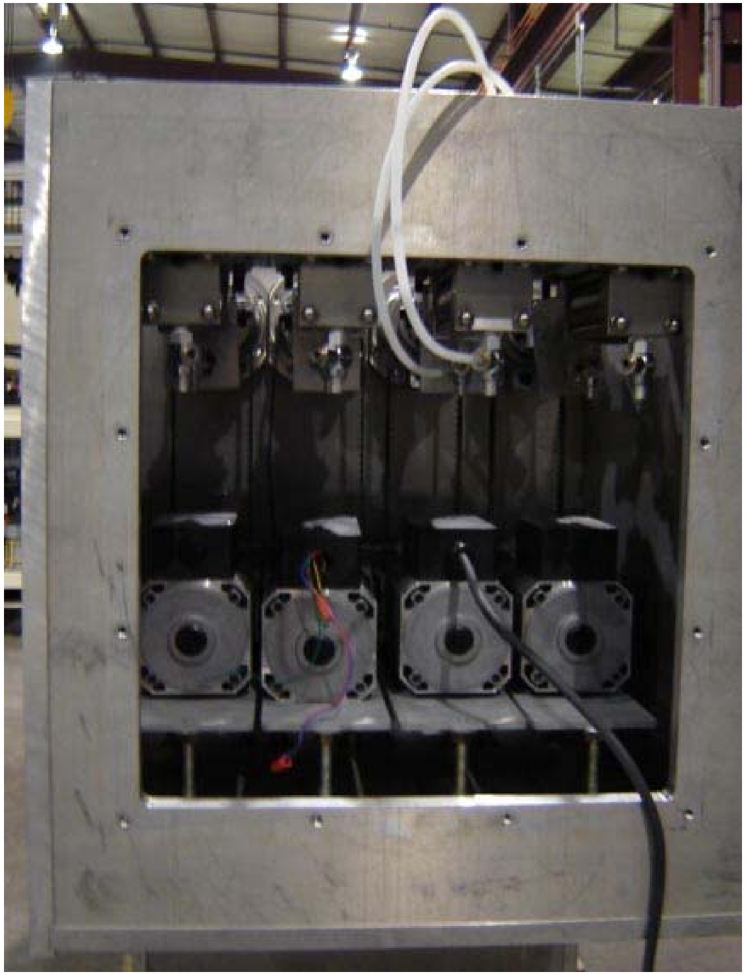
A set of drive motors is located at the end of the frame



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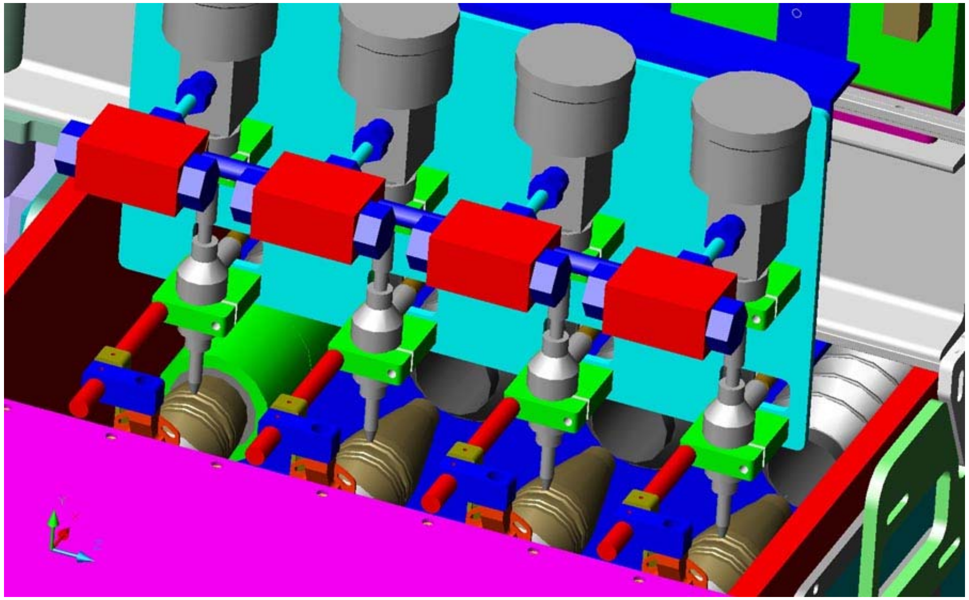
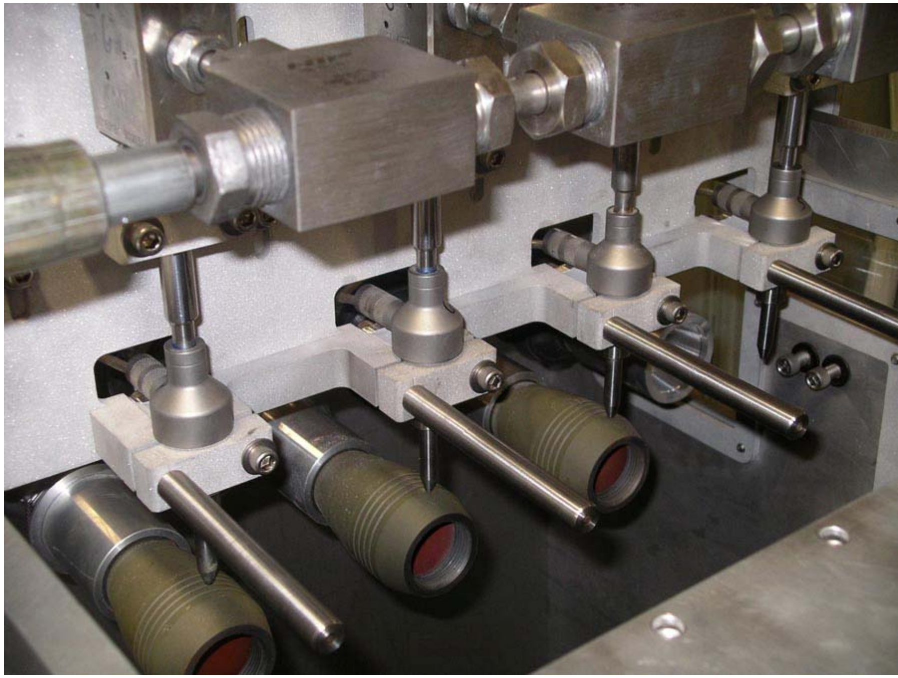
The target rounds were then changed to 60-mm mortar rounds, which could be held from a single end





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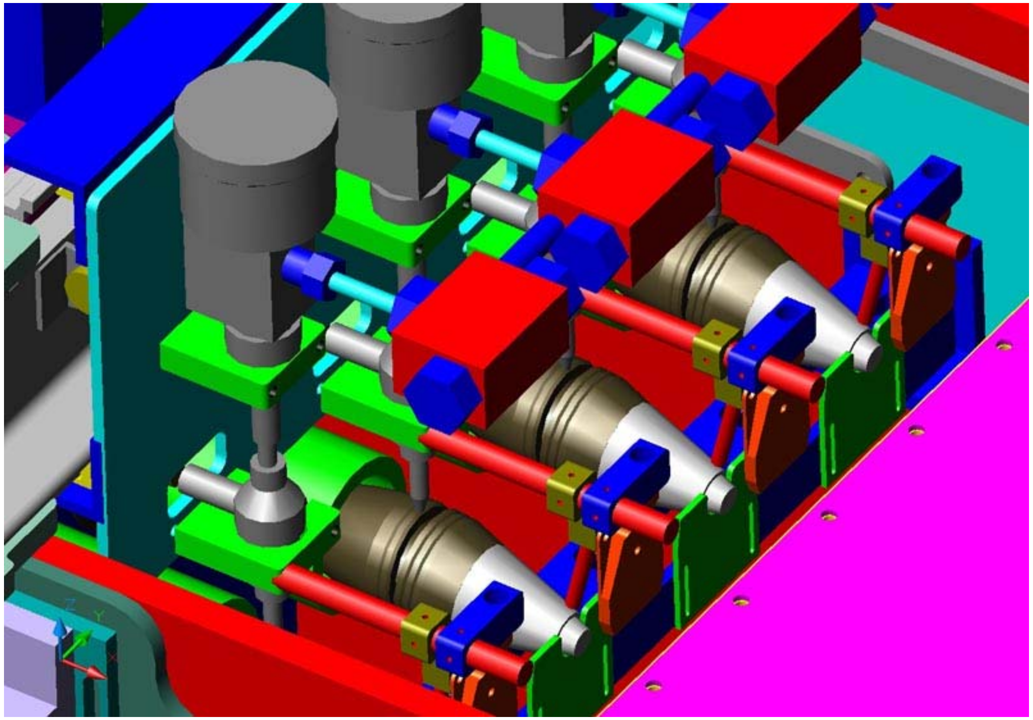
Sensing the cut completion



By rotating from just one end, one can sense when the separation cuts are made, by noting when the rotation of the body of the round stops, and the fuze drops away.

Each individual nozzle has its own control valve

So that flow can be stopped as cutting is complete

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And each also has a controlled abrasive hopper feed

This allows overall control of abrasive use for each nozzle

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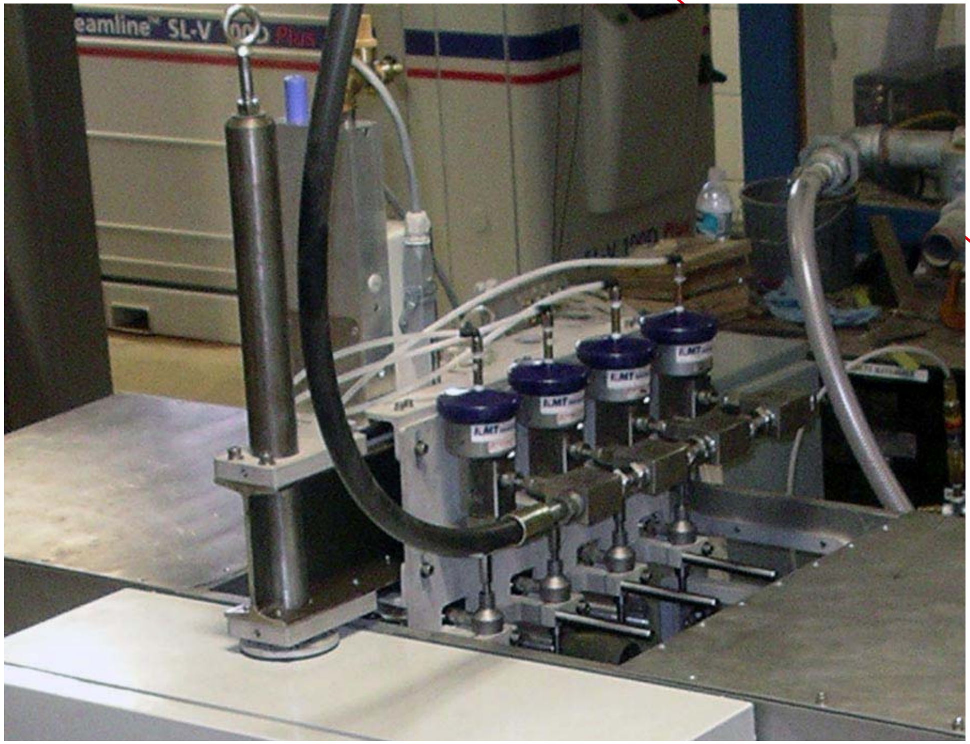
The cutting heads are mounted on an arm

The assembly on the arm is mounted on a post, and driven by a confined hydraulic system.



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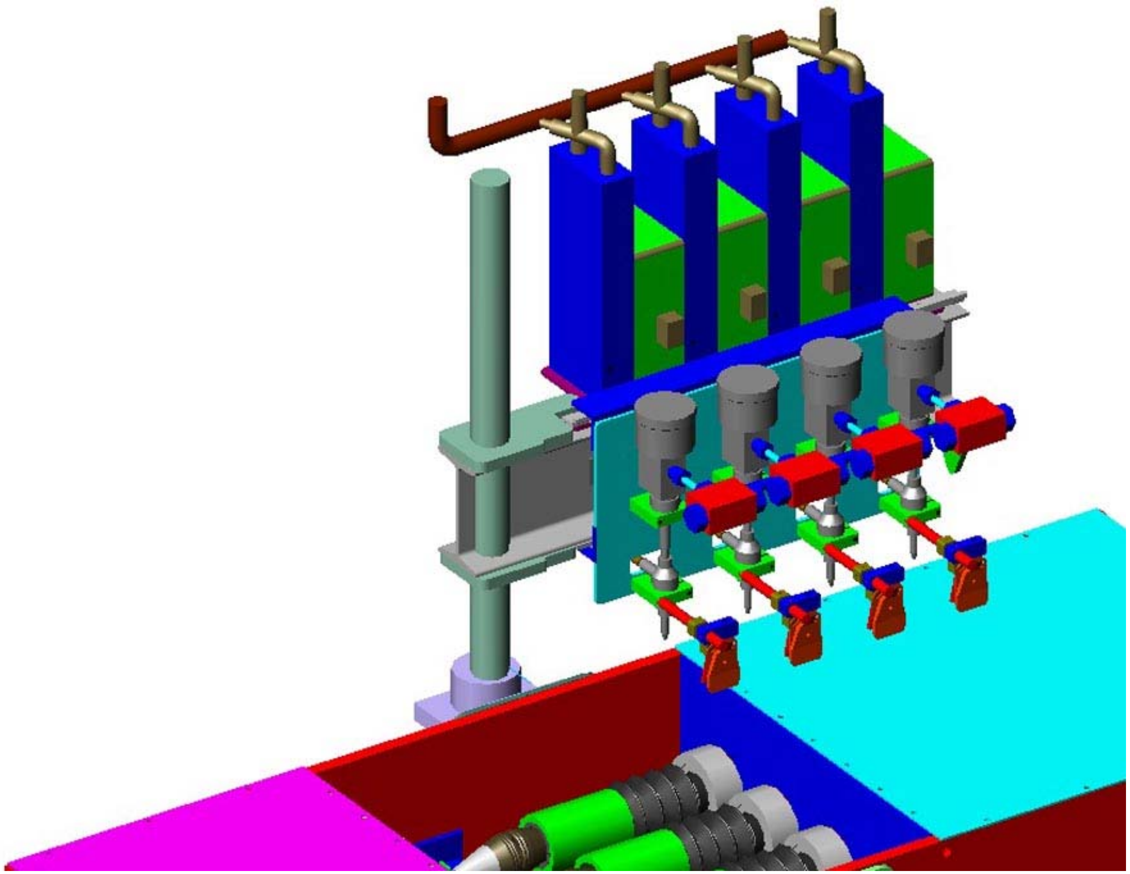
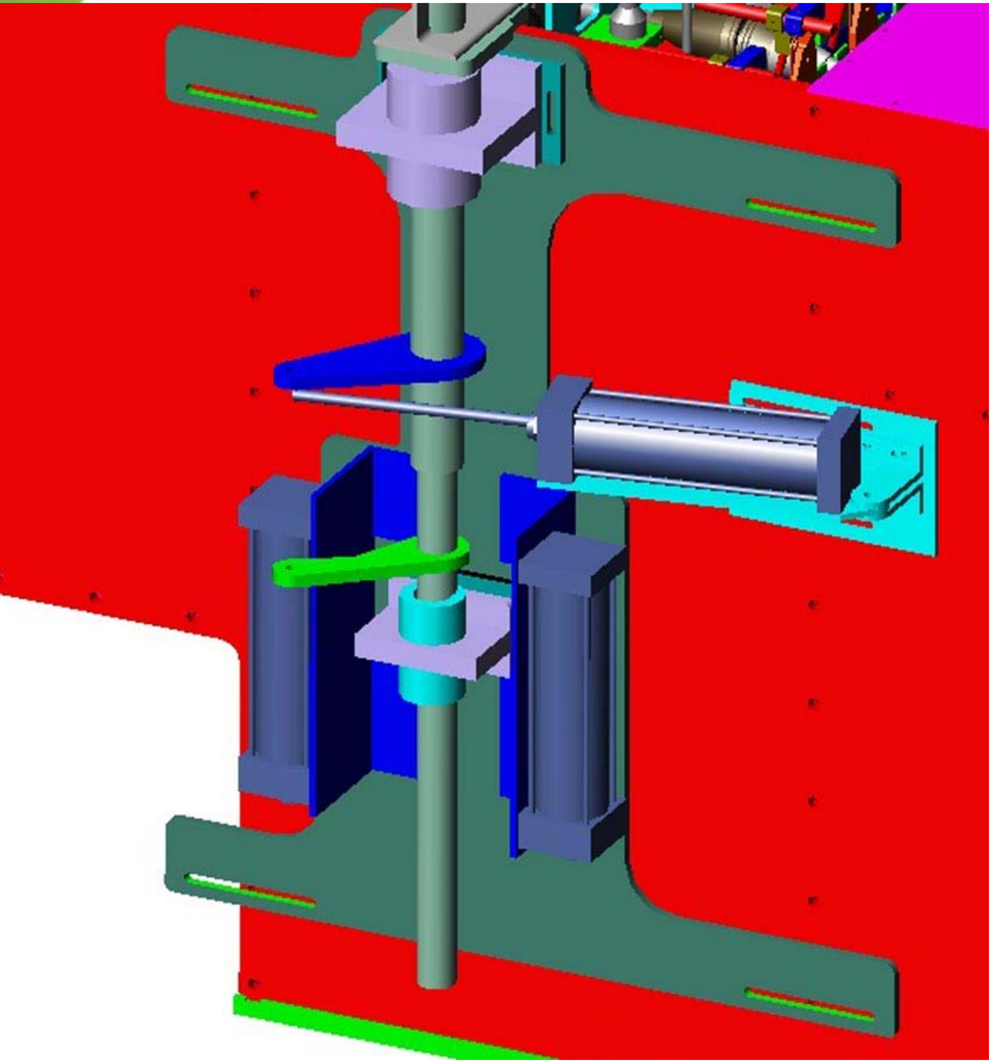
Arm in the open position



The fan jets (not shown in real pictures as they block the view) clean the area as the arm moves after cuts.

Hydraulic arm controls



Conclusions:

- *A rotational speed of 18 rpm is recommended for process optimization.*

- *To simplify selection of an abrasive feed rate, an AFR of 20% abrasive, by weight is recommended.*

- *The economics of operating pressure vs operating cost is a function of nozzle lifetime at different pressures. This is being investigated.*

- *At this AFR the cutting head position does not influence the cutting time.*

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Thank You for your kind attention