DRAFT TRIP REPORT

ROBOTICS DISCUSSION

LA JOLLA, CALIFORNIA

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This report covers three topics discussed by Mike McDonnell and T.M. Knasel with a group of SAI managers and staff concerning the use of robotics. The meetings took place March 16, 17, and 18, 1983 in La Jolla, California and Sorrento Valley, California. Informal draft notes follow.

__Special Purpose Robots__ - discussion with J. Glancy, V. Orphan, G. Houghton.

After review of the situation generally, and viewing a video tape on robotics, several topics in special purpose robotics were ranked. Highest priority was assigned to a 50 lb. handling robot for the wheel rim NDT equipment. The group felt that a moderate precision, low cost robot such as an IRI or MOBOT would do the job of picking the rims of an overhead hanging (accumulating?)conveyor. Rims are oriented at this pickup point and in roughly known position, however wheel size and type are subject to random sequence. Currently the size and type are determined by sensors and input to the NDT controller. Manually wheels are set on a long conveyor to load the machine currently. Once inside the machine and past the shielding, special purpose handling equipment unloads the conveyor, upends the wheel for inspection, rotates and twists the wheel rim as required for a thorough inspection. After inspection the wheel rim is tipped and loaded onto the output conveyor and eventually is off loaded by the operator, and manually placed on the output overhead conveyor.

Robotic handling would have these advantages:

1) Eliminate 1 manual operator, 2 shifts, 5 days/week

2) Eliminate need for much of the shielding

3) Eliminate the conveyers, tipping and special purpose handling equipment

4) Result in a smaller overall system

5) Reduce the amount of special purpose wheel rim orientation equipment

6) Eliminate hazardous work (radiation, backstrain, etc.)

7) Provide a more general purpose capability at no increase in cost.

G. Houghton estimated a savings of $60,000 on a $210,000 unit. If $10,000 is allocated to the robotic equipment then a $160,000 price results. It is assumed that non-recurring engineering costs would be paid out of IRD funds.

The action on this is for Tim Carlin to sketch up a concept with the assistance of George Houghton, and to visit IRI and MOBOT to secure quotes. The pick up from the conveyor, mating in the NDT equipment, and drop off on the output conveyor are the spots needng the most attention in the design.

The next priority is to further investigate with Charles Pelletier and Pat Leonard the use of a robot in the plugging of leaking heat exchanger pipes in an "on-line" reactor. Based on earlier discussions with H. Liers, T.M. Knasel, and Leonard it was concluded that a robot based on a cartesian space frame would be suitable. Considerable modification of existing off-the-shelf robotic equipment would be required to make the robot water tight, to add tactile sensing, and to design a plug scheme suitable for robotic insertion. For example, a self expanding plastic device instead of the brass stoppers currently hammered in is a potential solution. The action item is for Liers and Knasel, Pelletier and Leonard to proceed with a conceptual design. Liers should then price out the equipment with unimation/Westinghouse and Nova, and other as may be determined at the Robots 7 show in Chicago.

Third priority but for immediate action, was the special purpose robot for the torus fusion reactor. Glancy and Knasel had as a result of a prior discussion and memos determined that the project was complex and technically risky. Toshiba has a prototype robot with approximately the characteristics needed. It was decided that Glancy would approach DOE for study funds to survey requirements and select equipment that could meet the needs prior to doing a specific concept study.

In addition it was noted that the ammo handling robot being designed for the U.S. Army appeared to be capable of orienting the large neutron source remotely in aircraft wing inspection. Orphan and Knasel were tasked to study whether the robot could be built in Orphan's assembly area. A time was set up and McDonnell and Knasel reviewed the capabilities. It appeared that subject to scheduling, that adequate support and space was available. Knasel was tasked to determine if McRary's group had interest in and capability to provide support, particularly in the controller areas. Knasel and McDonnell were asked to visit SAIT and review their capabilities to manufacture special purpose printed circuit boards.

Ammo Handling Robots - General Discussion

The situation with the US Army ammo handling program was reviewed. The strategy to expand marketing to the Air Force and Navy (and possibly foreign governments) was outlined. Tom Carpenter and Ralph Sievers are to rapidly review the marketing possibility and report back to the group. Jerry Gaulston should be contacted for his inputs and recommendations re Navy interest.

Robots in Manufacturing - discussion with R. Fitzwilson, D. Laser, R. Johnson

Finally the use of robotic systems in SAIT manufacturing was reviewed by Fitzwilson, Knasel and McDonnell with D. Laser, R. Johnson and others at SAIT. SAIT manufactures about 2000 to 3000 printed circuit boards per year. These are single layer boards with typically 100 to 300 components. Component selection and board manufacture are to MIL STD 883D levels, with considerable care taken in component ordering, preparation, board coating, test and packaging. Review of the process steps and applicability to robotics was as follows:

1) Component incoming inspection and test did not provide any obvious opportunities since much automated equipment was already in use; there was relatively little handling and it was not a bottleneck. Discussions with Dave Strobel helped illuminate this area.

2) Component preparation may provide the best opportunity for robotics. Currently about 600,000 components per year are preped. Preping includes cleaning, fluxing and dip tinning all leads on axial components and descretes. This is followed by lead trim and packaging. This station is all manual at present with the exception of a lead trimming maching. The sequence is for a package to be opened, operator selects one, or more axials at a time, orients leads and dips the leads in a cleaning fluxing bath. Then the operator dips the leads in solder to within 1 mm of the case. With TO-5 can descretes this ends the sequence. In the case of axial components (resistors, capacitors) the operator reverses the orientation (thus touching the hot tinned leads) redips the component in a cleaning fluxing bath and the solder. The components go to a cooling bath and are repackaged after drying. Periodically the operator skims slag from the solder pot at two stations but need not at the third since a reflow solder system is used. The operator provides some quality control by inspecting the brightness of the tinning. Three operators work an 8 hours, 5 day shift. The station bills at about \$20/man hour. Wages and minimal fringes would account for 3 x 2000 x \$5 = \$30,000 year for 3 stations. It was determined that this was the best candidate at SAIT because of the hazardous nature of the job-fumes,

hot solder, etc., the monotonous work and difficulty in retaining workers, although this was not currently a problem. Automated solder dipping would remove the risk of inserting the body of the component in solder and hence damaging it, or too little tinning near the body due to operator caution. Action is for McDonnell and Gordon to study the problem and possibly mock-up the process with either the NBS PUMA 760 or IBM RS-1. SAIT is to provide example components as well as the complete process flow for the component prep station. If possible component lead trimming and forming could be automated by loading components into the machine by another robot.

3) Board assembly did not appear suitable for robotics due to the low volume and the use of many odd form passive and descretes on the boards.

4) Board conformal coat also did not appear suitable due to the complexity of the task and operator skill needed. There is no bottle neck at this station, and environmental hazards did not appear to be a problem. Should no volume grow or concerns on environmental issues become important, robotic spray painting should be reconsidered.

5) Heat shield glueing and bonding also did not appear suitable for the same reasons as stated in 4.

6) Final test did not appear suitable for the use of robots due to the low volume and lack of a suitable match for robotics.

7) Redico operation were also reviewed including machining, coating and assembly. Due to the low volume of any one type of instrument robots were not recommended.