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SIMULATION AND LAYOUT OF A LASER RADAR PRODUCTION FACILITY

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ABSTRACT

As manufacturing operations expand or contract with changing economic climates, there is a need to identify alternative office, factory and plant space requirements. These analyses may include the rearranging of office or factory space, the addition of new facilities and equipment, or the contraction and consolidation of existing space. Often, this analysis is required in a short time with personnel awaiting the results before beginning construction.

Such was the case at the United Technology Optical Systems (UTOS) facility in West Palm Beach, Florida where production of a laser radar system was to be undertaken. A limited amount of space was available for production and it was not known whether this area could be effectively used for manufacturing. Production floor space is a commodity that is hotly contested for within a facility that manufactures several product lines. The laser radar production group was being pressured to finalize their space and equipment requirements as soon as possible, adding to the urgency.

This paper describes a program undertaken by the United Technologies Research Center (UTRC) to develop a simulation model of the proposed laser radar facility and by exercising the model, to assist UTOS in identifying output and production capabilities. The results of this analysis were used as a basis for developing a layout of the production and clean room areas indicating the actual number and location of the equipment needed to meet the desired production schedule.

1. INTRODUCTION

Recently, UTRC scientists developed a laser radar system with operating characteristics sufficiently unique to make the system appear to be a viable new business venture. As a result of preliminary analyses, a decision was made to transfer the technology and its support team from UTRC to UTOS in West Palm Beach, Florida where system production would be undertaken. While expertise existed at UTOS to make ready the facility required to produce these items for sale, there existed no background to conduct simulation and analytical studies that would identify whether the forecast schedule of production units actually could be made in the facility that was to be provided at UTOS. The space and equipment requirements for the production of laser radar systems were needed quickly as there was a high demand for manufacturing space at the UTOS facility.

Within the Industrial Systems Technology Group at UTRC, a high degree of expertise has been developed during the past six years to provide analytical support for the advanced planning efforts associated with the implementation of new/or modernized projects within the Corporation. This expertise includes the ability to create and operate simulation models that define the system operating characteristics and shop lay-out models that identify equipment, locations and flow paths. UTRC was asked to assist UTOS personnel by developing a simulation model of the proposed laser radar facility and then to exercise the model to identify output production capabilities. The results of this analysis were to be used as the basis for creating a layout of the production and clean room areas that would indicate the actual number and location of the equipment and facilities needed to meet the planned UTOS production schedule. These requirements would be compared to the previously estimated facility and space allocation and adjustments could then be accounted for. Construction personnel were put on hold while this analysis was undertaken.

2. SIMULATION MODEL BUILDING

Based on data supplied by personnel from the Electromagnetic Systems Research group at UTRC, a computer simulation was created using **WITNESS**, a visual, interactive simulation system. This computer software is commercially available from ISTEL, Inc. The model was constructed using animated graphics to describe the process sequence and operations relating to key system parts and subassemblies. The model parameters for each work station type were varied until the results matched the desired production output goal could be achieved. During this activity, the data was analyzed and adjusted to ensure proper use of production time (shifts and days) and to minimize the work-in-process (WIP). Once it was determined that the requirements for equipment and work stations could be met, production and clean room areas were identified, and the location and layout of the completed facility was determined.

This final description can then be used by the Plant Engineering and Facilities groups to direct the construction of the actual manufacturing areas.

3. SIMULATION RESULTS

The computer simulation used data on operational times that combine several processing steps which occur in series to represent the overall time and occupancy rates for each work station and area. Figures 1 and 2 show a computer representation of the Electronics and Production Area and the adjacent Clean Room Area.

Electronic boards enter the Production Area and arrive at one of three assembly work stations (ASYPRD). A number of boards are needed for each laser system. After assembly, each board is inspected (EINSP), and some require rework (REWORK). After rework, the board is again inspected and, if passed, is then tested (ETEST). The electronic testing often uncovers some additional problems and some boards are sent back to rework, followed by inspection and test. Once the test results are acceptable, the boards are inserted into the housing (EHINTEG) and sent to the Clean Room for integration with the laser and optics system.

Meanwhile, in the Clean Room, the laser gain-cell and the optics have been cleaned (CRCLN), inspected (CRINSP), and assembled into a laser (CRASY). The laser and optics must be aligned (ALIGN), evacuated, and then refilled in the vacuum processing area (VACP). This latter operation is performed on a number of lasers at one time and takes a long time to perform. The last step is the integration (INTEG) of the laser into the housing that contains the electronics. The package is now closed, protecting the delicate interior components and sent back to the production area for final testing (FTEST) and a light environmental check (SHAKE). The laser system is then sent to Finish Stores for eventual delivery to the customer.

The initial space allocated for laser production at UTOS included an area near the existing tool crib, and accordingly the initial analysis, Case 1 (see Table 1), included that area. The number of work stations and the utilization of the equipment are shown in this table for the Production and Clean Room areas. Three electronic assembly work stations, two inspection, and six testing stations were needed to process the electronics to meet the desired production goals. The utilization of these work stations is quit high: Electronic Integration is over 92%; Assembly and Rework are at 83%; and Testing approaches 80%. Utilization of the work stations within the Clean Room were shown to be quite low with the cleaning, inspection, assembly, and alignment areas being utilized at less than 14% each. None of these areas appeared to be a potential source for a production bottleneck. An accompanying economic

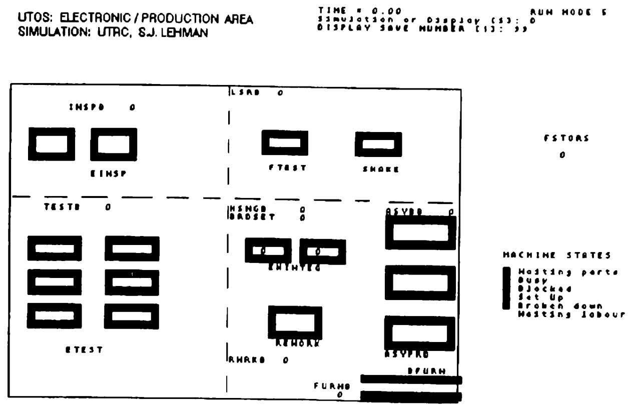

Figure 1: Production Area

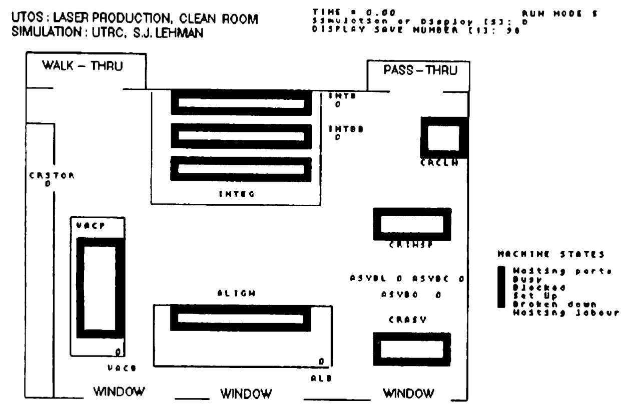

Figure 2: Clean Room Area

Table 1

Laser Production Simulation Results

Work Station	Case 1 / Case 2 (*)	Util. Rate, % Case 1 / Case 2
Production Area:		
Elect. Assembly	3 / 2	83 / 62
Rework	1 / 1	84 / 42
Elect. Inspection	2 / 1	43 / 43
Elect. Test	6 / 3	79 / 79
Elect. Integration	2 / 2	92 / 49
Final Test	1 / 1	50 / 26
Environ. Test	1 / 1	51 / 26
Clean Room Area:		
Clean	1	7
Inspect	1	14
Assembly	1	14
Alignment	1	9
Vac. Processing	1	39
Integration	3	69

(*)
Case 1: Both areas - 1 shift/day
Case 2: Production Area - 2 shifts/day
Clean Room Area - 1 shift /day

Production in both cases is the same

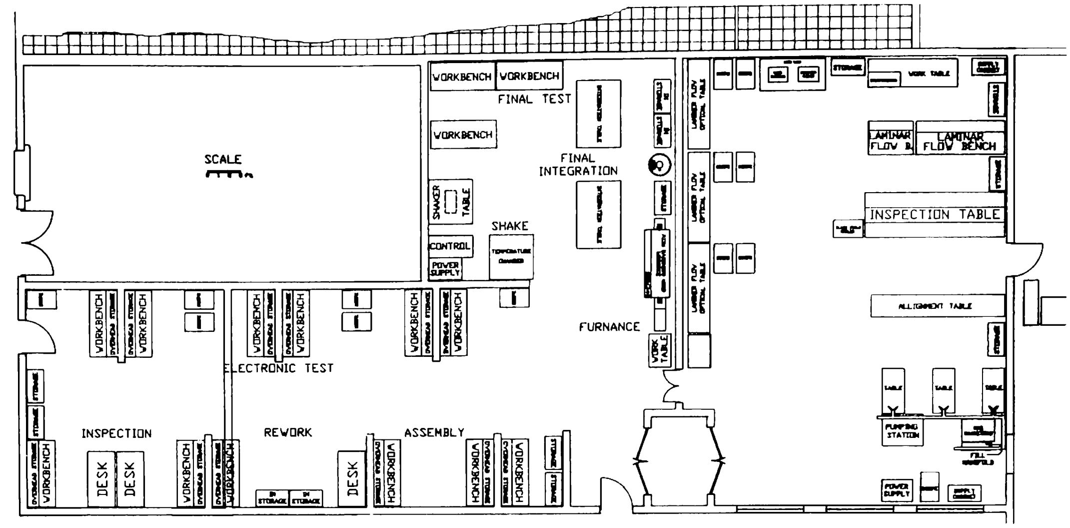

Figure 3: Production Facility Layout for Case 1

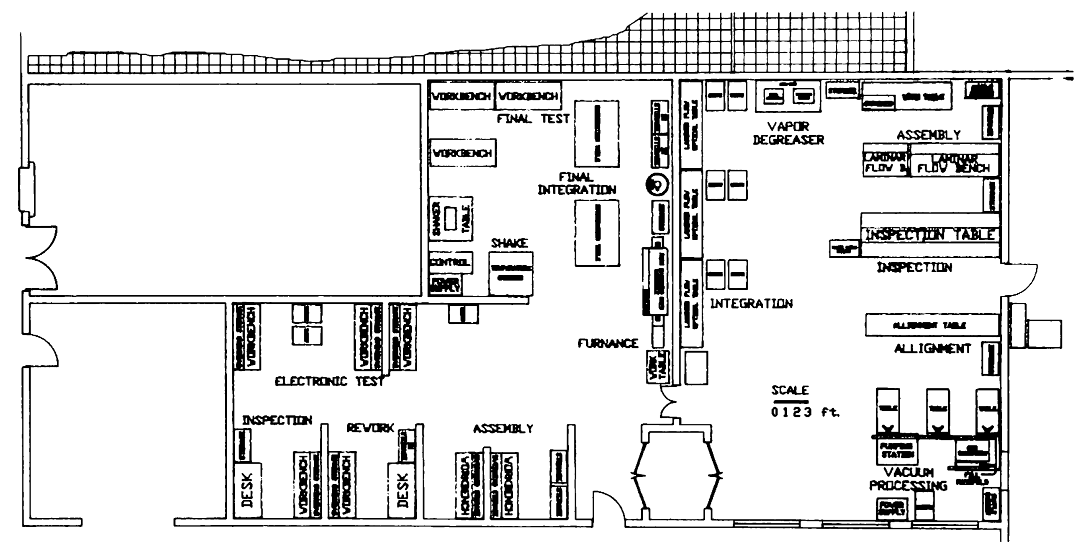

Figure 4: Production Facility Layout for Case 2

analysis that took into account labor, work-in-process, and capital costs indicated that within the allocated space, the selected combination of workers and facilities was optimum for the scheduled production requirements. The results (for Case 1) were based on staffing the facility for one, 8-hour shift, five days a week. Only in the production area would high work station utilization rates appear to be of concern. Figure 3 shows the proposed layout of work stations for Case 1.

Before the results of this (case 1) simulation analysis could be translated into reality, the situation was exacerbated when the space near the existing tool crib was removed from consideration for the use in the production of laser radar units. The simulation model, along with its associated economic model, were exercised again in an effort to identify how the prescribed production could be achieved in the smaller area. The results indicated that for the limited space available, a new combination of labor, work-in-process, and capital facilities and equipment, defined as Case 2 in Table 1, identified a scenario that provided the lowest operation cost for the forecast production rates. This could be accomplished by operating the Production Area during two, 8-hour shifts daily; however, the Clean Room could continue on a one-shift operation. Whereas the utilization rates for the work areas were reduced, the added shift for the electronics area allowed one assembly, one inspection, and three test work stations to be eliminated. The reduced equipment requirements now fit into the space finally allocated for the facility. This configuration is shown in Figure 4.

4. FINAL CONSIDERATIONS

The final arrangement of work space indicated by Case 2 was acceptable to UTOS and met all of their current production needs, and an accompanying economic analysis supported this approach. The simulation model and associate analysis was carried out in less than a month, permitting UTOS to begin construction and renovation on time. The study also provides UTOS with the ability to quickly evaluate changes that could affect the current and future capabilities of the new Laser Radar Facility.

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Programs in which Mr. Lehman and Mr. Davison have participated span those of interest to numerous Corporate divisions as well as several under Government sponsorship.