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Quality Management System

Material Placement Trial For Material Handling Device

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Prepared For:

Student Engineering Contest

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Detect the Difference

1. Overview

Sensis Corporation is evaluating the feasibility of using automated material handling equipment to aid in product assembly. As part of this evaluation, Sensis is soliciting proposals for the design, construction and demonstration of a material handling device.

This device will be used to move delicate components from a starting point to any number of predetermined points on an Assembly Area. Since this device will be used as an aid in product assembly, the speed at which it can accurately move components is a critical performance attribute.

The component Assembly Area may be used to assemble components that are chemically volatile; therefore, there are certain constraints on the materials used to build the material handling device. Sensis has provided a catalog of materials that can be used (see Appendix B: Material List) and each vendor must construct their version of the device from materials on this list.

Sensis Corporation will evaluate the ability of each prospective bidder to design, construct and demonstrate a material handling device that satisfies performance requirements. Sensis will therefore sponsor a competitive evaluation program prior to awarding the procurement contract. All prospective bidders are required to participate in this evaluation program.

2. Program Overview

2.1 Evaluation Program

Each participating bidder shall:

1) Participate in the Preliminary Design Review (PDR).
2) Design and build a prototype material handling device capable of satisfying the performance objectives delineated in this specification. This device shall be built exclusively from the list of materials specified by Sensis Corporation. It is not necessary to use all of the materials on thelist.
3) Demonstrate the ability to accurately move delicate components to specified locations within an Assembly Area.

2.2 Performance Objectives

Each prototype device will be evaluated based on its ability to satisfy the following performance objectives:

1) **Accuracy** – The ability to place the component on or near a target point.
2) **Speed** – The number of components placed on a target point per unit time.
3) **Load Failure Rate** – The ratio of the number of damaged components to the number of components attempted to be moved.

3. Preliminary Design Review

Each participating bidder shall participate in a PDR of their device. The purpose of the PDR is to provide the prime contractor (Sensis Corporation) with an opportunity to evaluate the progress of prospective bidders, discuss technical and organizational challenges and provide feedback to prospective bidders on the strengths/weaknesses in their technical approach.

At the PDR, each prospective bidder shall provide a verbal presentation (PowerPoint or view graphs) designed to convince Sensis that you are the prospective bidder that should ultimately be awarded this contract. The bidder shall address the following points in your presentation:

1) Demonstrate that the bidder understands the problem by explaining the problem in your own words. Identify the constraints that you will have to overcome.
2) An initial list of the materials which will be (or were) used in the prototype and experimentation phase of the material handling device design. This list shall identify the items and quantities sufficient to allow experimentation with different design alternatives.
3) Present results from any prototype testing by describing the experiments performed and the conclusions reached. In particular, explain how the experimental results influenced the design to date.
4) Present the prototype design approach. Display and/or demonstration of a prototype is recommended. Include a description of alternate designs considered thus far. It is permissible to change the design after the PDR if subsequent testing demonstrates the design requires revision.
5) An overview of the bidder's management structure (how are you managing the work).
6) A discussion of problems encountered and how the bidder will overcome them.

4. Performance Contest

Each bidder shall participate in a contest where they will demonstrate the degree to which their device satisfies the performance objectives delineated above. The contest is described in the remainder of this document.

4.1 Assembly Area

Each machine will be evaluated in a model of the Assembly Area against the Performance Objectives. The Assembly Area is shown in Figure 1: Assembly Area Layout. The layout consists primarily of two (2) folding tables of standard construction with some separation. The surface of the tables shall be considered the work surface. An area described by a rectangle three (3) feet by two (2) feet will be designated as the Carriage Region. The machine shall make contact with the work surface only within the Carriage Region. Four (4) Target Areas will each be designated by twelve (12) inch diameter circles. Each Target Area will have three (3) scoring zones (see Figure 2: Target Area Diagram). Points for the Trial will be determined by the smallest scoring zone that completely contains the component. Each scoring zone will be interpreted as right cylinders projecting vertically from the Target Area. Target A sits on top of an obstruction. An additional Target Area (Target D) will be specified at the time of the demonstration. This target may be located anywhere within the work surface. The component shall begin each Trial at the Start Point in contact with the work surface.

Table 1: Assembly Area Coordinates

Assembly Area Item	X-Coordinate (in)	Y-Coordinate (in)	Z-Coordinate (in)
Carriage Region Extent	$-12 < x < 12$	$-6 < y < 30$	0
Center of Target A	0	-24	0
Center of Target B	42	-24	0
Center of Target C	42	24	12
Center of Target D	TBD	TBD	TBD
Component Start Point	0	0	0
Obstruction Volume (approximate)	$36 < x < 48$	$18 < y < 30$	$0 < z < 12$
Work Surface 1 (approximate)	$-16 < x < 16$	$-36 < y < 36$	0
Work Surface 2 (approximate)	$28 < x < 56$	$-36 < y < 36$	0
Work Surface Plane	---	---	0

The Assembly Area will be located in a facility with approximately 12 foot ceilings. The machine should be less than eight (8) feet in height relative to the work surface to assure ceiling clearance. Access to the Assembly Area is limited to 34 inch by 7 foot doors. The machine should facilitate disassembly and/or articulation to allow for easy transport.

Figure 1: Assembly Area Layout

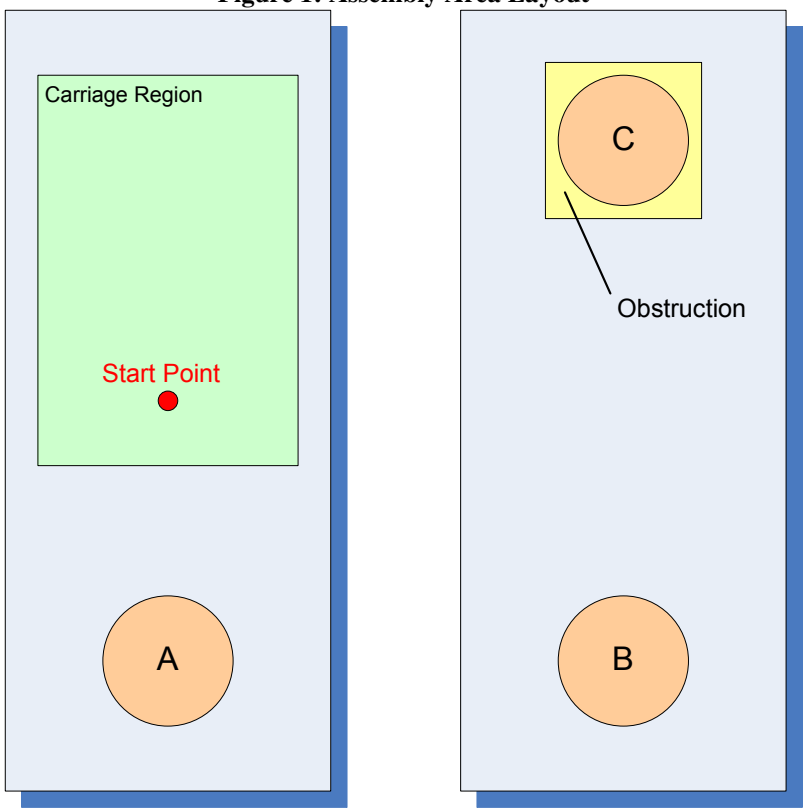
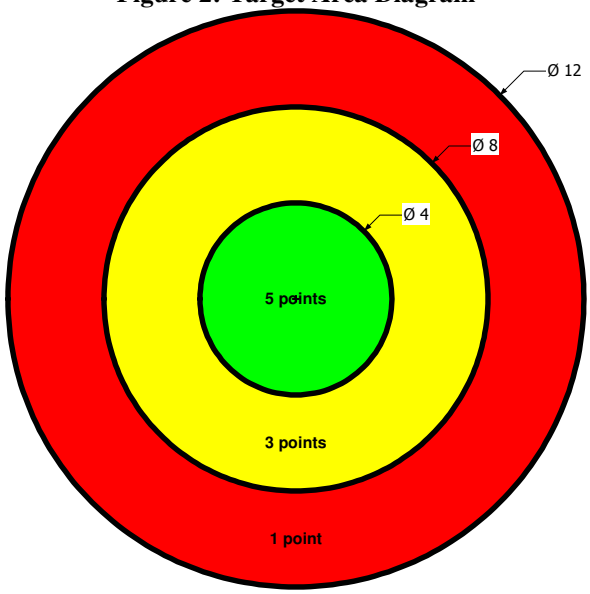


Figure 2: Target Area Diagram



4.2 Trial Procedure

The testing will be divided into four (4) Trial Periods. All Trial Periods will be the same length. The exact amount of time will be decided at the test event, but is likely to be 10 to 15 minutes. Between Trial Periods the bidder shall be permitted to make repairs or adjustments to their machine. A single Target Area will be designated by the referee at the start of each Trial Period. During the Trial Period, the bidder shall use their machine to make as many successful Trials as possible to the designated Target Area. Each delivery attempt will be considered a single Trial.

For the purpose of this evaluation, the Payload shall be modeled by an uncooked egg. An egg is an appropriate model because it has mass approximately equal to that of the components of interest, it is delicate and it is a challenging shape to control while being moved. Each participating bidder shall demonstrate the ability to accurately move an egg to specified locations within an Assembly Area. Only one (1) component shall be loaded into the machine per Trial. Each bidder shall receive no more than 12 components per Trial Period. Intact components may be reused by the bidder within the same Trial Period for additional Trials.

Before the Trial Period the bidders will have an opportunity to setup the machine at the Assembly Area assigned to them. At the end of this setup period, the machine shall be in the Initial Configuration awaiting the first Trial of the upcoming Trial Period. The Initial Configuration shall be essentially the same for each Trial within all Trial Periods. The position of pins, screws, gears, pulleys, strings or other minor mechanical devices for governing the motion of the machine after the Trigger events shall be permitted to vary from one Initial Configuration to another.

A delivery attempt shall be defined as a Load, Charge, one or two Trigger events and a Reset event, in that order. The machine shall be in a Static State before and after the Load, Charge and Reset events. A single Load event, a single Charge event, a maximum of two Trigger events and one Reset event are allowed for each Trial. During each Trial the bidder may perform each event through Manual Action.

The machine shall be in the Initial Configuration before each Load event. At the end of the Load event, the component shall remain at the start point in contact with the work surface until the Trigger event. Once the Charge is complete, the machine shall be in a Static State before the Trigger event to allow personnel to clear the Assembly Area for safety reasons. A bidder shall Trigger the machine to cause the machine to enter a Dynamic State. A bidder may Trigger the machine a second time at any time between the first Trigger event and the Reset event. The machine and component shall reach a Static State in order for the referee to establish the location of the component. The component shall be unloaded from the machine for inspection as part of the Reset event once the final location has been established by the referee. The unloading may be performed through Manual Action. The machine shall remain within the volume directly above the Carriage Region during the Initial Configuration and until the first Trigger event in each Trial.

A Successful Delivery will be defined as follows but the referee will always have final scoring discretion:

1) The component shall be stationary.
2) The component shall be in contact with the Work Surface.
3) The entire component shall reside within the boundary of the Target Area.
4) The component shall be free of visual signs of damage (cracking, leakage, etc.).
5) The component shall be provided for inspection in its original condition (i.e. without adhesives, machine components or other apparatus)

Machine design should consider that the referee must verify the above conditions to properly score the Trial. Mechanisms which significantly block the view of the component and the Target Area may result in erroneous scoring.

4.3 Scoring

Trial performance will be rated according to the following formula:

$$score = \sum_{p=1}^{4} TotalPts_p \times \frac{SuccessfulDeliveries_p}{Trials_p}$$

where:

TotalPts is the number of points awarded for successful deliveries in each Trial Period (p)

SuccessfulDeliveries is the number of Trials resulting in undamaged components delivered within a Target Area. in each Trial Period (p)

Trials is the number of component delivery attempts made in each Trial Period (p) regardless of outcome

Appendix A: Definitions

1) **Assembly Area –** See Section 4.1, Assembly Area.
2) **Carriage** – That part of the machine that is in contact with the Work Surface prior to and during machine operation
3) **Carriage Region** – See Section 4.1, Assembly Area.
4) **Charge** – Action taken to add potential energy to the machine for use in machine action -- a single Charge event may add energy to any number of energy storage devices on the machine.
5) **Dynamic State** – Machine state characterized by presence of motion (i.e. kinetic energy).
6) **Initial Configuration** – A Static State that occurs at the start of each Trial.
7) **Load** – Action taken to place the payload in/on the machine
8) **Manual Action** – Action taken by a human to change the state of the machine.
9) **Payload** – The material the device is designed to move and deliver
10) **Reset** – Action taken to return the machine to its Initial Configuration.
11) **Static State** – Machine state characterized by a lack of motion (i.e. kinetic energy).
12) **Target Area** – See Section 4.1, Assembly Area.
13) **Trial** – A single attempt by the machine to deliver a component
14) **Trial Period** – A length of time when repeated Trials are performed to demonstrate performance
15) **Trigger** – Action taken to initiate a machine action
16) **Work Surface** – See Section 4.1, Assembly Area.

Appendix B: Material List

Item
½ inch dia. x 8 ft. long PVC pipe
½ inch dia PVC 90^0 elbow
½ inch dia PVC 45^0 elbow
½ inch dia PVC "T"
PVC adhesive
surgical tubing
assorted rubber bands
string
2 x 4 softwood lumber
½ inch diameter (or smaller) wooden dowels
duct tape
wood glue
empty soda bottles
wire coat hangers
hinges
nylon mesh 3 ft. x 3 ft. (≥ ¼ inch mesh opening when measured on the side)
1 lb coffee can
tennis balls
ping pong balls
balloons
metal fasteners (**Note**: Any number or size of nails, nuts, bolts and washers may be used; however, a detailed list of your requirements must be provided in your material list.)
Graphite lubricant
Petroleum jelly
Paint or ink (for cosmetic purposes only, may not perform a function)