RoboLive® Valuation Description: For Manufacturers

Intro

RoboLive is a toolset that improves robot programming efficiency and provides insights for manufacturers utilizing industrial robots. These characteristics are achieved through;

- automation of programming tasks
- increasing the capabilities of computer simulated environments
- producing insights through real-time data analysis
- organizing and distributing information seamlessly, in highly intuitive and actionable formats.

As implied by the name, RoboLive provides this information frequently enough to be considered a 'live' monitor of the robot systems; rather than an analysis tool which processes backups that are subject to obsolescence if changes occur after their creation. The system includes a server and client application used to view the information produced, as well as additional optional applications. The RoboLive server runs on a virtual machine deployed in a data center on the same network as the robot systems it analyzes, and the information produced is widely distributed to all users through an application installed on Windows PCs.

Value Proposition

In order to ascertain the value of RoboLive to a manufacturer, five categories which contribute to profitability are analyzed on an annual basis. Their individual contributions are quantified and summed to produce a total valuation. Return on investment can then be computed based on the RoboLive price.

Internal scrap cost reduction - S

RoboLive contributing elements: Process Visualization

Defects resulting from programming problems can be substantially reduced through RoboLive utilization. The difference between these costs and the cost to employ a RoboLive user constitute this valuation component. A scrap rate is determined for which programming problems are the root cause. The cost of each unit scrapped (including labor) is also determined. The anticipated reduction in scrap resulting from programming problems enabled by RoboLive is finally estimated. Using these three measures and the annual production quantity provides the **scrap cost reduced** through RoboLive as;

$$S_S = (scrap\ rate\ from\ programming\ problems) * (annual\ production) * (average\ cost\ per\ unit\ scrapped\ including\ labor) * (reduction\ rate\ of\ scrap\ from\ programming\ problems)$$

Due to the high level of usability and intuitive design, user costs for RoboLive can be kept very low. These depend on each manufacturer's frequency of analysis and time required per analysis, but because RoboLive provides explicit problem identification and filtering, a routine model analysis is expedient. The **cost increased for employing a RoboLive user** is given by;

$$S_R = (RoboLive\ user\ wage\ per\ hour) * (RoboLive\ user\ time\ required\ per\ day) * (Production\ days)$$

Finally, the **internal scrap cost reduction value** can be found by subtracting the RoboLive user cost from the scrap cost reduced.

$$S = S_S - S_R$$

Utilization improvement – U

RoboLive contributing elements: Process Visualization, Robot Path Calibration, Vehicle-0 Determination, Robot Documentation

Factory utilization is affected by RoboLive through its ability to reduce downtime. The annual number of downtime hours expected to be reduced by RoboLive are multiplied by the hourly downtime cost to provide the **utilization improvement value**.

$$U = (annual\ downtime\ hours\ reduced) * (downtime\ cost\ per\ hour)$$

Relevant hours and the cost rate should be based on a buffer empty condition.

Wage reduction – W

Operating costs are reduced through RoboLive's ability to reduce hourly needs for workers performing tasks of: quality checks, rework, programming corrections, and equipment commissioning. Overtime premium reduction is also considered in this component.

Quality wage reduction

RoboLive contributing elements: Process Visualization

An expected quality check time reduction provided by RoboLive is estimated as a percentage, and the quality check time currently required is determined. Based on these measures and the hourly wage of a worker performing these tasks, the **quality check wage reduction value** is determined.

$$W_Q = (quality\ check\ time\ reduction\ \%) * (quality\ check\ hours\ per\ unit) * (quality\ check\ units\ per\ day) * (production\ days\ per\ year) * (worker\ hourly\ wage)$$

Rework wage reduction

RoboLive contributing elements: Process Visualization

Rework time reduction can also be achieved by RoboLive through its ability to reduce the number of parts requiring rework. The reduction percentage expected is determined along with the annual rework time required and worker wage. Combining these provides the **rework wage reduction value** as follows;

$$W_R = (rework\ time\ reduction\ \%) * (rework\ hours\ per\ unit) * (rework\ units\ per\ year) * (worker\ hourly\ wage)$$

Programming correction wage reduction

RoboLive contributing elements: Process Visualization, Vehicle-0 Determination

Programming correction time is another wage reduction subcomponent enabled through RoboLive's provision of exactly the required information and program banks with

prepared corrections. The **programming correction wage reduction value** is computed similarly;

$$W_P = (programming\ correction\ time\ reduction\ \%) * (programming\ correction\ hours\ required\ per\ correction) * (programming\ corrections\ required\ per\ year) * (worker\ hourly\ wage)$$

Robot commissioning wage reduction

RoboLive contributing elements: Process Visualization, Robot Path Calibration, Vehicle-0 Determination, Robot Software Overview, Device Logic Insertion, Robot Documentation

Robot commissioning wage reduction is a unique subcomponent because it occurs once per model (at startup before SOP), not annually. The robot commissioning time reduction percentage through RoboLive use is determined and multiplied by the total robot commissioning time required. With the hourly labor rate for robot commissioning, the total cost saved is found, and this cost is amortized over the model life. The result is the annualized **commissioning wage reduction value**.

$$W_C = (robot\ commissioning\ time\ reduction\ \%) * (robot\ commissioning\ time\ per\ line) * (quantity\ of\ production\ lines) * (robot\ commissioning\ hourly\ wage)/(model\ life\ in\ years)$$

Overtime wage reduction

RoboLive contributing elements: Process Visualization, Robot Path Calibration, Vehicle-0 Determination, Robot Software Overview, Device Logic Insertion, Robot Documentation

The final subcomponent considered is the overtime wages reduced as a result of RoboLive use. Overtime premiums paid to employees that are reduced through the efficiency improvements provided by RoboLive are quantified by the **overtime wage reduction value**.

$$W_O = (annual\ overtime\ hours\ reduced) * (overtime\ premium)$$

The value of total wages reduced is computed by the addition of the subcomponents.

$$W = W_Q + W_R + W_P + W_C + W_O$$

This calculation assumes hours reduced can result in cost savings from workers being productive performing other tasks or being unscheduled.

Opportunity cost reduction – O

RoboLive contributing elements: Process Visualization, Robot Path Calibration, Vehicle-0 Determination, Robot Software Overview, Device Logic Insertion, Robot Documentation

Opportunity cost reduction quantifies the value provided by improving SOP readiness timing. The anticipated improvement in SOP readiness is specified in days, and the daily production rate provides the number of additional vehicles available due to the improved readiness. This quantity is amortized over the life of the model, because this valuation is annualized and this event occurs once per model launch. Based on the vehicle's average sale price and profit margin, the **opportunity cost reduction value** is determined.

$$O = (SOP\ readiness\ timing\ improvement\ in\ days) * (daily\ units\ produced) * (vehicle\ sale\ price) * (profit\ margin)/(model\ life)$$

The timing improvement expected must consider whether or not RoboLive improves the duration of tasks on the critical path for SOP. The value of improving non-critical path task durations should be considered in this value, but discounted appropriately.

Recall risk mitigation – R

RoboLive contributing elements: Process Visualization

Based on U.S. National Highway Traffic and Safety Administration (NHTSA) recall data (nhtsa.gov), commissioning problems preventable by RoboLive, resulting in manufacturer recalls, were categorized as "improper processing," "mis-located processing," and "missed processing." Assuming average costs for vehicle repair, part replacement (replacing part of a vehicle), and using the starting MSRP for a full vehicle replacement, preventable costs are estimated for the U.S. auto industry. Because safety standards have increased since 1970 when relevant records first appear, an applicable period for analysis has been chosen from 01 January 1990 to 18 July 2019 (the data retrieval date). 126 addressable recalls occurred during this period with an average total estimated cost of $22,751,148 per year. A manufacturer's annual production output can be divided by the total U.S. market size of 17.552 million vehicles (U.S. Bureau of Economic Analysis) to attain its market contribution percentage. Using the annual market recall cost and a manufacturer's contribution percentage to the market, the **recall risk mitigation value** can be found as follows;

$$R = (annual\ market\ recall\ cost) * \frac{(manufacturer's\ annual\ units)}{(market\ units)}$$

Any brand damage occurring from a recall is not considered in this valuation. This calculation assumes all industry manufacturers are equally likely to incur the recall costs deemed addressable.

RoboLive would likely have prevented a recent recall by Subaru of its 2019 Ascent SUV which had missing welds. 293 vehicles were affected, all of which were entirely replaced. With a starting MSRP of $31,995, an estimated cost of this recall is $9,374,535, without accounting for any brand damage.

Final Metrics

Annual valuation and ROI

The **total annual valuation of RoboLive** is given by;

$$RoboLive\ Value = S + U + W + O + R$$

Because the RoboLive price structure involves a price per server deployment, price per product implementation, and a time-based optional service price, the **RoboLive price amortized** is calculated.

$$RoboLive\ price\ ammortized = \frac{(Server\ implementation\ price)}{(Server\ life)} + \frac{(Product\ implementation\ price) + [(Options\ price) * (Product\ life)]}{(Product\ life)}$$

The **return on investment** (ROI) is calculated as;

$$ROI = \frac{(RoboLive\ value) - (RoboLive\ price\ amortized)}{(RoboLive\ price\ amortized)} * 100\%$$

The RoboLive server and options are not limited to any number of products. These costs can therefore remain constant while the value of RoboLive is scaled to an unlimited number of implemented products.

Unquantified Benefits

Many improvements which cannot be shown to materially affect profitability are unconsidered in this valuation. Elegant tools like RoboLive can improve morale among workforces, leading to increased productivity, among many other possibilities. Seeing innovation embraced and implemented can inspire further innovation, providing a viscous cycle of benefits potentially extending far beyond the quantified value.

Efficiency improvements in robot commissioning during the new model startup phase have substantial unquantified benefit potential as well. Robot programming

requires other work in common areas to be halted, and is often a major component on a project's critical path. Even without an SOP advancement, improved efficiency in this area can provide increased time available for other lower priority work or refinements, which can result in reduced downtime, better performing equipment, and improved morale. The ability to have accurate vehicle-0 frame data in a very large percentage of processing equipment without laser measurement time and costs can also yield significant additional value. Possible long-term benefits can be realized such as reduced staffing needs and reduced costs for contracted services benefiting from RoboLive.

Dressler Automation's mission is to positively affect humanity using automation to enable widespread availability of beneficial resources and experiences. RoboLive is one method we've created in pursuit of that end.