

M-UBER: UBER-TYPE ASSIGNMENT FOR DISTRIBUTED OPERATOR MACHINING OPERATIONS

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INTRODUCTION

Because computer numerically-controlled (CNC) machining is largely automated with only periodic tasks that require operator intervention, such as tool changes, part loading/unloading, etc., it is common practice to have an operator that oversees more than one machine simultaneously. The approach is to assign one operator to two (or perhaps three) machines in a cell. S/he is then responsible for serving only those machine interventions within his/her cell to ensure that the machines produce quality parts at the highest possible rate.

As an extension to this paradigm, a new approach, realized in a mobile software application, is proposed that enables Uber-type oversight of all machines in a production facility by a collection of operators, none of which are assigned to a particular machine or group of machines. It is referred to as Machining-Uber, or simply, M-Uber. In this scenario, each machine will send an alert when operator intervention is required. These alerts will be digitally distributed (e.g., by text message) to the assigned operator. This operator selection will depend on:

- geographic proximity to the machine in question (and, therefore, the travel time)
- other pending interventions
- the estimated time for the selected intervention
- the operator skill sets.

The objective function used to assign the operator to a selected intervention will be a global maximization of the cumulative time that all machines in the factory are engaged in part production (i.e., chip making in machining operations). To track operator location, radio frequency identification (RFID) tags can be embedded in a name tag, for example. The operator skill set will be archived in a database that is part of the software application. The operator availability will be set by monitoring his/her status through responses to other queries. Similar to Uber, the most feasible “driver” (operator) will be requested and the call will either be accepted or rejected. If rejected, the next best operator will be contacted. In

this way, operator efficiency can also be tracked and reported.

ADVANTAGES

In the M-Uber approach, operators will not be limited to a single group of machines. This eliminates two scenarios that decrease factory efficiency:

- no machines in the cell require intervention
- more than one machine in the cell requires intervention.

In the first case, the operator is not needed at that time (operator idle). In the second, both machines will be idle and one will be idle longer than necessary because the operator can only service one at a time. With the conversion to a “floating” operator concept and the support of a “smart” assignment tool, we believe that M-Uber will offer the potential for improved responsiveness to machine stoppages, a corresponding increase in machine usage, and optimization of the number of required operators.

The economic impact of M-Uber, once matured, will be significant. It can be implemented in any manufacturing facility that uses CNC equipment; the domain includes aerospace, automotive, medical, heavy equipment, etc. It will minimize operator costs through its personnel optimization capability, while simultaneously enabling a quantitative method for assessing operator productivity. It will increase machine usage, which will result in higher part counts and, therefore, greater productivity and profit. Further, by continually monitoring machine status, it will serve as a “big data” resource that will contribute to preventative maintenance through trends in machine performance.

MOTIVATING EXAMPLE

The advantage of the M-Uber concept is demonstrated in Figs. 1-3. In Fig. 1, the traditional approach of one operator-to-two machines is depicted for six total machines (three operators). In Fig. 2, the M-Uber concept is implemented, again with three operators. In Fig. 3, after the distributions of machine usage have been studied, the optimized

result was found to be two, rather than three, operators. In the figures the machines are red and hatched if an intervention is required. They are green without hatching if operational (making chips). The operators' spatial location is identified by the position of the indicator (circle with operator number). The indicator is unfilled if the operator is idle and filled if engaged.

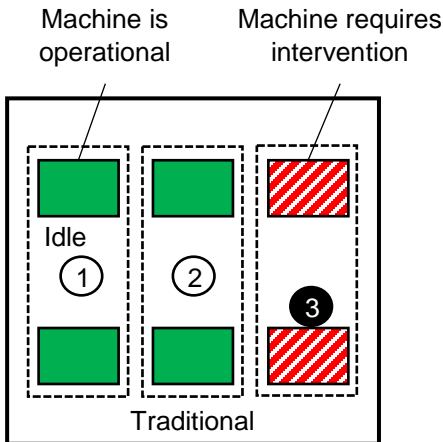


Figure 1: Traditional one operator-to-two machines setup. Operators 1 and 2 are idle and operator 3 is able to service only one of the two required interventions.

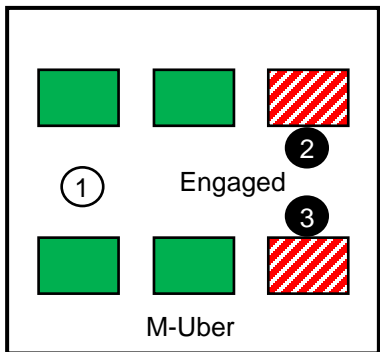


Figure 2: M-Uber setup. Operator 1 is idle, but operators 2 and 3 are able to service the two required interventions.

For the traditional approach (Fig. 1), it is observed that operators 1 and 2 are idle for the selected intervention state; operator 3 is only able to service one machine, while the other machine must wait until the first intervention is completed. For M-Uber (Fig. 2), operator 1 remains idle, but operators 2 and 3 are free to serve the two required interventions. After optimization (Fig. 3), M-Uber has matched the number of required operators to the intervention rate

(on average) and productivity is increased. While this example is limited to six machines, the final solution will be implemented across the entire factory so the complexity is increased together with the potential for efficiency improvement.

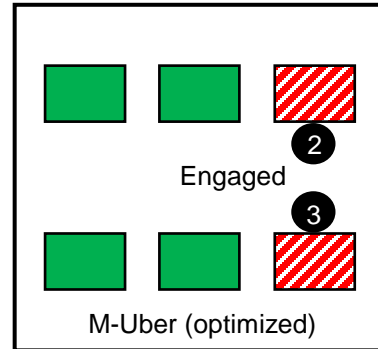


Figure 3: Optimized M-Uber setup. Based on machine usage data, the number of operators is optimized. Now two operators service the six machines.



Figure 4: Simulation software that compares the traditional (dedicated) and M-Uber assignment techniques.

INITIAL RESULTS

An initial simulation has been programmed and demonstrated using data from a representative production facility; see the screen shot in Fig. 4. The interactive simulation shows the operators assignments graphically for four potential interventions:

1. tool change
2. anticipated maintenance
3. unscheduled maintenance
4. part complete, new setup.

The traditional (dedicated assignment) and M-Uber approaches are shown side-by-side. For the dedicated assignments, one person is assigned to two machines (12 operators, 24 machines). For M-Uber, eight operators are free to float between the 24 machines.

The simulation enables the cumulative worker idle time, machine down time, and number of parts produced to be compared over a fixed time period (24 hours is shown in Fig. 4). Based on initial simulations, it is shown that eight operators in the M-Uber approach are more productive than 12 operators using the traditional assignment strategy.

- targeted start time
- estimated completion time.

Using the application, the operator will be able to accept or reject the assignment (similar to an Uber driver). The application concept is displayed in Fig. 5.

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CONCLUSIONS

This paper provides a description of the new M-Uber approach to operator assignment in machining facilities. In this approach, an operator is not limited to servicing a single group of machines (e.g., a dedicated operator is assigned to two specific machines). A floating operator concept, where the operator is free to service any machine intervention in the facility, is combined with an Uber-type assignment tool to provide improved responsiveness to machine stoppages. The result is a corresponding increase in machine usage and an optimization of the number of required operators.

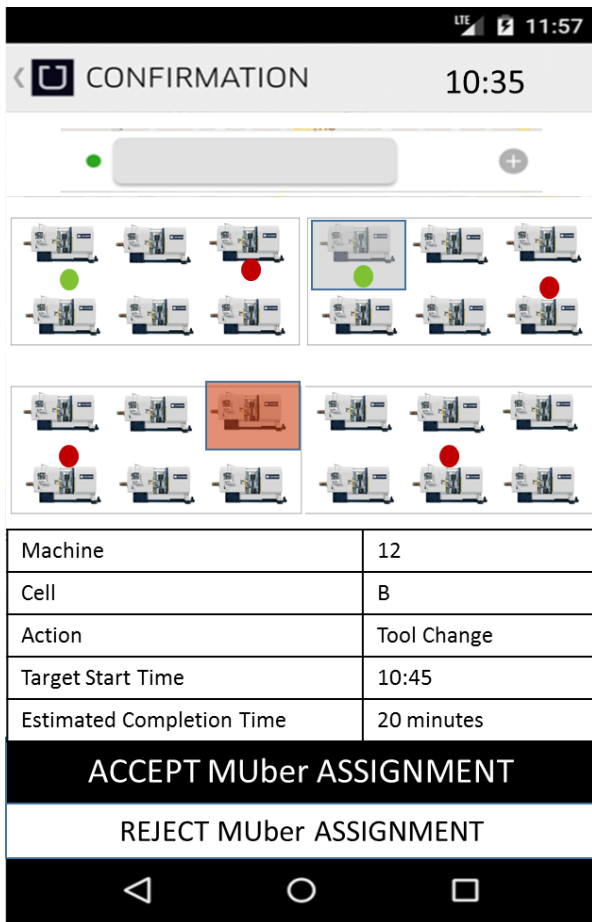


Figure 5: M-Uber assignment application. The assignment request will be delivered to the best operator via a handheld device.

As noted, the best operator is alerted when an intervention is required. This message will be sent via a modal device and include the following information:

- machine number
- cell number
- action required (intervention type)