**Module 2 DISCUSSION 1**

**Identify business requirements in a Smart Manufacturing scenario**

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| Andon Lights or Stack Lights on Machines |

You are an independent consultant dedicated to helping businesses build a machine monitoring application customized to their needs. You are called in to help a small manufacturer build a web application that will monitor 50 CNC machines in their facility with an annual revenue of $15M per year serving the aerospace and medical device industry. The company’s current OEE is at 40%. This web application will need to collect machine status information through collection of signals from each machine’s Andon Lights. RED=Failure, Yellow=Warnings, GREEN=Normal Machine Operation. The application will collect manually entered by the operator and also automatically collected data from the machines. The data will be analyzed by specialized machine learning applications. Some of the machine learning analyses will be performed on the premise and some will be performed on a cloud infrastructure.

The application will collect data from the facility supervisor about target facility utilization metrics. Personnel will manually enter information with regards to the machine asset when they first start using the application. The app will continuously collect status light data from the internal machine control system. When a Yellow or Red Light comes ON, the machine operator is required to fill a simple form that gathers the timestamp and the reason for the light status. This record is also stored for analysis later. In addition, the app will collect energy consumed from the machine asset and stream that data to the company’s cloud infrastructure. The app will also collect data on work order # processed at each machine.

The primary use of this application to build a live machine monitoring dashboard that can be viewed by employees in-house, by production supervisors, and the administrative team within their offices or homes.

An additional intent for the facility owner is to use all of this data collected from the various machine assets to develop machine learning models that might help answer if there are any particular root causes that hinders the progress towards a more acceptable 70% OEE. Also, the company founder intends to use this information to develop an employee incentive scheme to help promote faster resolution of unplanned machine downtimes. This data analysis is also intended to better negotiate machine maintenance contracts with the original equipment vendors, particularly when machine stoppage is unrelated to the work order itself.

**CHALLENGE:**

1. Identify the business and technical requirements
   1. Business requirements:
      1. Build a web application that will monitor CNC machines in the target facility.
      2. The target facility utilization metrics should be collected from the facility supervisor.
      3. The collected data must be analyzable by specialized machine learning applications. ML applications should assist the administrative staff in progress towards 70% OEE.
      4. Machine learning analyses should be performed both on the premise and on a cloud infrastructure.
      5. The app should be represented as a live machine monitoring dashboard that can be viewed by employees in-house, by production supervisors, and the administrative team within their offices or homes.
      6. Create an incentive scheme to help promote faster resolution of unplanned machine downtimes.
   2. Technical requirements:
      1. The web application must monitor at least 50 CNC machines.
      2. The first type of collected data is Andon Lights with 3 levels: RED=Failure, Yellow=Warnings, GREEN=Normal Machine Operation. This data type should be continuously collected from the internal machine control system.
      3. The second type is data manually entered by the operator. The RED or YELLOW data type should be accompanied by the second type of data. The operator fills a form that gathers the timestamp and the reason for the light status.
      4. The third type of data is other data automatically collected from the machines. It is continuously streamed to the company’s cloud infrastructure.
      5. The fourth type of data is the work order # processed at each machine.
      6. The collected data has to have a special format for ML applications.
      7. Special ML applications should be able to run both on-premise and on a cloud infrastructure.
      8. The app should represent all the data on the dashboard.
      9. Access to the app should be available by authorized production supervisors from in-house, and by the administrative team from their offices or homes (remote monitoring).
2. Add your questions that you would ask the company administration as you develop the solution architecture.
   1. Is it a strict restriction to 50 CNC machines? Is it possible that the # of machines will be increased in the future?
   2. Is there any specific equipment on the factory floor that is used only for the aerospace and medical device industry?
   3. Do all the machines have Andon lights? Do they have a common way of sending this type of data (e.g. digital/analog signal, voltage, current…)
   4. Is there a specific form that operators should be using while filing a report?
   5. How many operators do you have?
   6. What information about operators is valid for this app?
   7. What other types of data should be automatically collected from CNC machines?
   8. What are the OS and computing capabilities of on-premise equipment and cloud infrastructure?
   9. How do the metrics entered by the supervisor look like? Is it structured data or not?
   10. What kind of data should operators fill in when they first start using the application?
   11. How frequent is the time stamp for the continuous collection of status light data from the internal machine control system?
   12. How long should the records be stored and where?
   13. Should there be a restriction on who can access the app?
   14. Should there be a mobile version?
   15. Who is going to develop ML tools?
   16. Are there any specific ML techniques preferred?
3. Can you draw the first draft of a diagram that represent the tables and the relationships between them to help implement this live dashboard app.

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| CNC machines | | | | | |
| Brand name | Model No. | Year manufactured | Type | Department | Machine ID |

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| Operators | | | | | |
| Last name | First name | Age | Department | Working since | Operator ID |

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| Andon lights status | | | | | | | |
| Machine ID | Timestamp | Work order # | Light Status | Operation | Power consumption | Operator ID | Report ID |

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| Operator Reports | | | | | | | | |
| Report ID | Machine ID | Operator ID | Light Status | Timestamp | Root cause | Parameter 1 | Parameter 2 | Parameter … |

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| Streaming data | | | | |
| Machine ID | Timestamp | Parameter 1 | Parameter 2 | Parameter … |