Project Scope Document

# Project Name

Advanced Artificial Intelligence Techniques for Slot-Die Coating Process

## Location of Document

Chicago, IL, USA

# Team Composition

## Sponsor

Argonne National Lab – Dr. Zhengchun Liu(Data Science and Learning) , Dr. Yuepeng Zhang(Applied Material Division)

## Illinois Tech

Illinois Institute of Technology – Dr. Shlomo Argamon , Mrinalini LNU

# Project Background

## Sponsor’s Line of Business

## Argonne National Laboratory is a science and engineering research national laboratory operated by UChicago Argonne LLC for the United States Department of Energy. The facility is located in Lemont, Illinois, outside of Chicago, and is the largest national laboratory by size and scope in the Midwest.

## Description of Sponsor’s Problem

Establish a smart manufacturing project which aims to use Machine Learning techniques to automatically optimize the slot die coating process. We have a physical model of the slot-die machine in the material’s laboratory. We have created a digital twin for this machine to apply Machine Learning and optimize output by hyper-parameter tuning. We need to integrate the data from the physical machine into the digital twin and get real-time classification outputs.

# Project Objectives and/or Goals

1.Research methods to extract, load and transform data from the High-speed camera.

2.Using Machine Learning and Computer Vision techniques such Convolution Neural Networks to predict image outcome (i.e., defects classification).

3.Tune hyperparameters to optimize results of the experiment and cross validating our Hypothesis with physical experiment.

4. Create a Data Acquisition system to feed images to the ML algorithm and interpret them (classifying defects) in real time.

# Project Deliverables

## Type of Deliverables

1.Images captured by Edgertronic SC2+ camera is not good enough for our experiment so we have to research on additional techniques, lenses or cameras that can satisfy the data requirement.

2. Extracting usable data from the raw output of images.

3. Identifying the most effective ML technique to interpreting the quality of roll-to-roll die coating process via optical camera.

## Expectation on Deliverables

1. Images are clear, show the defects clearly and can be transformed quickly and easily into the ML model for inference.
2. Create a high-quality dataset for machine learning model development to classify defects of roll-to-roll slot coating process.
3. Our digital twin ML algorithms provide good accuracy for classification on the actual data.

# Project Risks and Constraints

## Risk

1. Even if we order a super expensive lens or camera, we might not get the quality of data that we need for our ML algorithm. This will cause delay to the entire experiment.
2. We might require a lot of preprocessing and manual labeling to convert raw data into usable format for the ML model development.

## Constraint

Budget and time constraint to test out hypothesis.

# Project Execution

## Strategy

1. Getting the data with desired quality.
2. Labeling data manually for ML model training.
3. Transform and Load data into ML model in real time for inference.
4. Compare accuracy for different ML algorithms and choose the best one
5. Use that model on live data, provide feedback to the die-coating machine

## Agile Development: Epic, Story, Task

Epic is a sub-project, Story is a collection of related tasks, and Task is the tangible work that you are going to complete.

1. Epic - Getting the data

Story – Get the correct camera to capture the required data

Task –Current images are not usable for ML analysis.

a. We try the reverse adapter method with the Edgertronic SC2+ with a Nikon AF Nikkor 50 mm f/1.8D lens. For the second overhead video camera, we purchase a goPro.

b. If it doesn't work to create the images, maybe we can try generating a video. And extract frames from that video.

c. If we are not able to zoom in post editing for the SC2+, we need a lens with higher (zoom + autofocus) and use it with the 50mm.

d. Consider an optical microscopic camera if the target is too small and if nothing else works out.

1. Epic -Labelling the data correctly for training set

Task - Manually checking each image and labelling the type of defect, so that we can generate a large training dataset for our Machine learning algorithm.

1. Epic - Transform and Load data into ML model in real time for inference.

Task – Write python scripts to convert the raw data into usable format for image classification.

1. Epic - Compare accuracy for different ML algorithms and choose the best one

Story – Use 3-4 different algorithms and different hyper-parameters to find the best combinations.

Task-

a. Algo 1 with different Hyper-parameter tuning

b. Algo 2 with different Hyper-parameter tuning

c. Algo 3 with different Hyper-parameter tuning

1. Epic – Use model on live data

Task – Streamline process to convert live data to usable format and run through the algorithm

## Timeline

Assign a number of days to each task, then add them up to estimate the expected finish day of each story, epic, and eventually your project.

Estimated number of days:

1.a – 3 days (29 June 2021)

1.b - 4 days (5 July 2021)

1.c -3 days(8 July 2021)

1.d -4 days(14 July 2021)

2. 5 days(21 July 2021)

3. 4 days(27 July 2021)

4.a – 3 days(30 July 2021)

4.b – 3 days(4 August 2021)

4.c – 3 days(9 August 2021)

5. 4 days(13 August 2021)

# Document Revision History

6/24/2021 – Mrinalini – Initial Version

6/25/2021 – Sponsor – Sign off or approval.