Hexagon Metrology Inc.
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Workflow Optimization for Industrial Software Applications

Background:

Hexagon Manufacturing Intelligence, formerly known as Hexagon Metrology, is the world leader in quality control solutions for manufacturing. Solutions include hardware, software and services in a broad portfolio of products ranging from stationary coordinate measuring machines (CMMs) for the manufacturing floor, high accuracy optical measuring systems for the lab and portable measuring systems, such as laser trackers, for large structures.

One of the key areas of focus lie with the development of new software solutions for improved manufacturing through measurement. Software needs to be able to collect large amounts of measurement data, analyze that data and then enable the manufacturing process to act on it. This software must be flexible enough for engineers to implement customized CNC controlled data sampling strategies and analysis reports while still easy enough for operators to use in a manufacturing setting. Therefore, the software has at least two main modes of use: (1) engineering mode and (2) operator mode. In addition to having these two modes of use, the software must also be versatile enough for use on multiple measuring system platforms that utilize a wide range of sensor types and support the analysis and reporting requirements for different key industries.

Problem Statement:

Hexagon's legacy software products suffer from having obsolete menu-driven interfaces and development environments which are difficult for new users to adapt to their own unique applications. The goal of this project is to investigate the workflows for various applications and design new interfaces that can reduce the number of steps or otherwise simplify the implementation of solutions through the software.

Proposal:

This research project investigates the workflows needed for several key applications and tests their implementation using existing software products. Existing software products include Hexagon's own PC-DMIS and QUINDOS, and several others found in related industries. For example, related industries may include CAD/CAM software in addition to Metrology software. The investigation stage of the various software products will be used to gain perspective and establish some rule bases for how software is typically used in this industry as well as similar industries, thus providing critical information about how to link and combine various steps for the most simplified approach.

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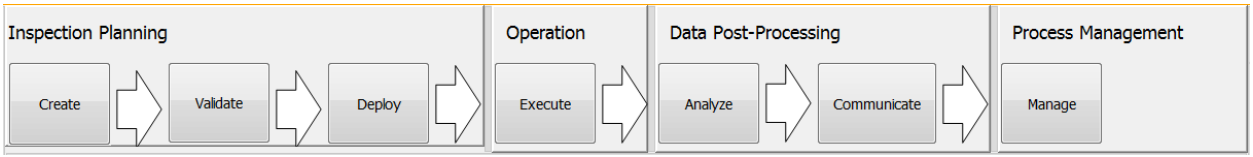
In the following diagram the general workflow for software in the Metrology Industry is shown:



There are four main stages in the general workflow. The first stage shown is *Inspection Planning* and includes the creation of measurement routines for various CMM systems. The blocks within this stage include defining machine specific attributes, motion/tool paths for various sensor types, the validation of those motion paths using CAD and then deployment on a measurement system. The second stage shown is *Operation* and allows a user in a manufacturing environment to walk up to a measurement system and run routines written in the previous Inspection Planning stage. *Data Post-Processing* is where the acquired measurement data is organized and analyzed, then communicated through various output methods such as graphical and text file reports. Finally, *Process Management* is where the results are used to make corrections to the manufacturing process and archived.

The most critical aspects of the workflow can be divided into two main parts and investigated by two students. The first part, Inspection Planning can be investigated in its entirety, where the second part can include Operation and Data Post-Processing while omitting some of the Analyze part. Improvements in Analysis are not the focus of this project since algorithm optimization is beyond the scope of our present resources.

In the following table, the two areas of investigation and development are shown:

<table>
<tr><th>CS Engineer 1: Inspection Planning</th><th>CS Engineer 2: Execute and Communicate</th></tr>
<tr><td rowspan="2">GUI for creating automated measurement routines and validating them.
Knowledge of CNC path programming, machine interfaces is helpful
Knowledge of CAD and how models can be used for CNC simulation
Knowledge of error condition handling and response.</td><td>GUI for operator execution
Knowledge of modern look-and-feel GUIs
Platform independent GUIs of interest</td></tr>
<tr><td>GUI for communicating results
Scientific data representation
Graphical forms for display data
File formatting methods
Data export in various standard formats such as PDF, CSV, SQL etc.</td></tr>
</table>

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Deliverables

The end product is a GUI example model for each of the three described development areas (refer to table). The goal is to be able to provide evidence of the improvements in efficiencies and ease-of-use compared to the existing software and then demonstrate how it might be implemented through the GUI example models. It would be beneficial to support the proposed improvements with objective or measured data. For example, documented user interactions, number of mouse clicks to get through a task, time it takes for a novice user to perform a task, comparison with alternative software, etc. The working example models only need be a functional user interface and not necessarily linked to any algorithms or devices.

More advanced GUI example models might also be proposed whereby the steps of the investigated workflows of a software may be stored by the software and then used to optimize subsequent workflows. In such as design described, the UI would be adaptive to the current and/or most frequent usage of the software. The software could learn how it is being used and adapt its functionality based on a specific use case. For example, specific tools in the software may be used often and might be promoted to the top level menu of the UI if used with enough frequency. Another example is that menus could be made self-guiding and redundant entries in successive dialog boxes could be updated automatically. In any case, any number of suggestions could be made and implemented in a working example model for the purpose of demonstrating the basic principles prior to making a larger investment in software development.