PROJECT SUMMARY

Overview:

The most hazardous and challenging times for process operations occur during plant start-up and shut-down. While manufacturing plants have extensive protocols for each operating unit, and the coordination among process units, a desire for more rapid start-up/shut-down can lead to one or more protocol deviations. Also, the complexity of these systems can lead to steps not being completed in the proper sequence. Further, abnormal situations, including effects of severe weather and unanticipated events can put the operations at a higher safety risk level. The major goal of this proposed approach is to use Big Data based techniques and Cognitive Computing to learn from prior events (start-up/shut-down and abnormal situations) and to improve real-time decision-making in process operations.

A rigorous dynamic simulation of a vinyl acetate monomer (VAM) plant will be used as a case study for start-up, shut-down and abnormal situations. Different simulated cases, as perturbations from a nominal start-up, for example, will be used to demonstrate the effect of various faults, incorrect operator decisions and other uncertainties. Reduced-order models will be developed and used as the basis for fault detection and operator decision support. The "big data" techniques will make use of the process history from previous start-ups to more rapidly detect problems and assist operators with decisions to complete a successful start-up despite the uncertainties and faults. The Cognitive and Immersive Systems Laboratory (CISL) at RPI, including a "situation room," will provide extensive audio-visual and computing facilities to demonstrate how cooperative human-computer decision-making can be used to improve process operations during start-up, shut-down and abnormal situations.

Intellectual Merit:

The proposed effort makes fundamental contributions to how start-up and shut-down procedures can be supervised via the use of a "situation room" that supports the decision making process via cognitive computing. This situation room can be viewed as a hybrid of a chemical plant operating room and a futuristic "holodeck" where computers monitor plant data as well as human decisions (be it by their actions, words, or gestures) and automatically provide information that are deemed critical for the next few decisions. While simulators have been used for operator training for quite some time now, we are not aware of a single effort that focuses on improving start-up/shut-down procedures by supporting human-machine (in the form of past data/experience) interactions. The already existing CISL infrastructure at RPI, which makes use of cognitive computing, offers a unique opportunity for performing this work.

Broader Impacts:

The use of a situation room for supporting decision making processes via cognitive computing and interacting with the group of decision makers is a new concept that can find applications in a number of areas outside of plant start-up/shut-down. For example, corporate board meetings can be supported in such as fashion as can pathology laboratories where critical decisions by a small group of people need to be reached. The proposed work is the first in the area of supporting chemical plant operations, but many of the concepts will carry over to other settings. We believe that the use of such situation rooms has the potential to revolutionize how computers can support decision-making processes.