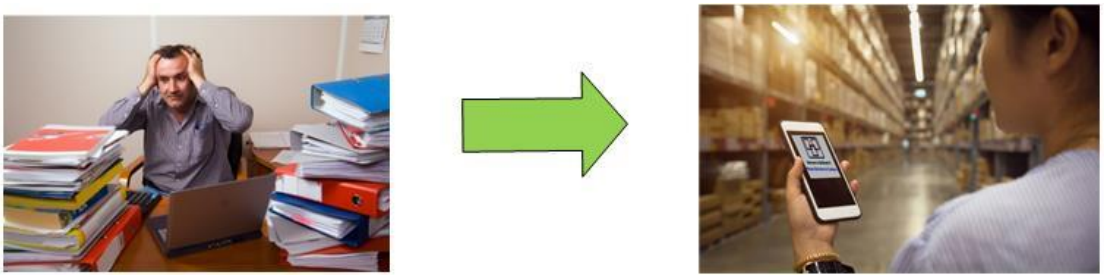
What are Decision Support Systems for Industrial Operations Management?

Introduction

Wikipedia defines a Decision Support System as:

A decision support system (DSS) is an information system that supports business or organizational decision-making activities.

DSSs serve the management, operations and planning levels of an organization (usually mid and higher management) and help people make decisions about problems that may be rapidly changing and not easily specified in advance—i.e. unstructured and semi-structured decision problems.



In manufacturing and industrial distribution organizations, a KnarrTek Decision Support System for Operations Management performs the following functions

1. Provides production and materials managers with the real-time status information they need to efficiently run their operations
2. Assists production managers to schedule materials handlers and equipment operators to ensure customer orders get delivered on-time.
3. Assists materials managers to dynamically replan materials purchases and reschedule jobs as new orders arrive and production issues arise
4. Prevents mistakes by providing timely warnings before mistakes occur
5. Captures job cost, materials traceability, and manufacturing process performance data for subsequent analysis.

Decision Support Systems are a paradigm shift from ERP and accounting systems, which provide people with stacks of reports about what went wrong yesterday, to providing these same people with the real-time information they need, when they need it, to efficiently do their job without making mistakes.

Instead of thinking about what data an IT system can collect and report on, in an Operations Management Decision Support System we think about what information people need and when, to efficiently do their jobs.

A Simple Example

It is useful to contrast the simple case of:

1. An Inventory Tracking System that can produce reports/screens of the quantity of inventory of each material in stock along with a desired minimum inventory quantity.

2. An industrial operations management DSS that sends a text or Email message to a materials manager when materials need to be reordered, taking into account the inventory in stock, the expected delivery of materials on open purchase orders, and the expected consumption of materials on upcoming jobs.

In the former case, a material manager will have to expend a lot of time figuring out what materials to order. Often this is based on a minimum inventory quantity for each item, which was entered long ago, and bears little or no relationship to the current demand for each item.

For example, an Inventory Tracking System may show 16 items in stock, with a minimum inventory level of 2 items. But, if jobs are due to run next week that need 23 of these items, then the item is out of stock and needs to be reordered immediately.

For the materials manager to manually track this, for each item in stock, especially in a make-to-order manufacturing plant, where the demand for specific raw materials parts may vary dramatically from week to week, is an overwhelming task.

As a result, we often see organizations using simple Inventory Tracking Software, or those organizations using their ERP or accounting systems to track their inventory, having excess inventory of some parts and stock-outs for others, at the same time.

This problem can be solved by a DSS periodically monitoring the physical inventory of each part in stock and comparing it with the quantities needed for upcoming jobs less any materials already on order from suppliers.

Then, instead of the DSS presenting this information in terms of a report, it can simply send the materials manager a text or Email alert when they need to reorder materials based on expected lead times and when those materials are needed for jobs.

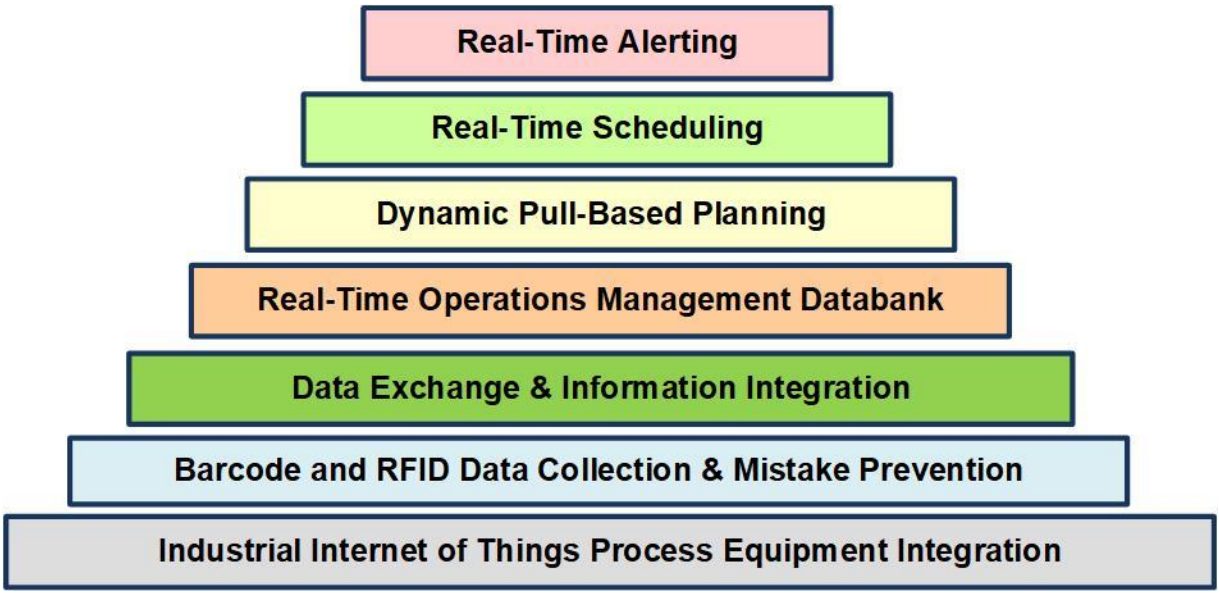
The alert Email can contain details of the materials to be ordered, and, if required, the DSS can send this order information to the purchasing system, as an unreleased purchase order, ready for the materials manager to make any final changes before releasing the PO to the supplier.

As a result, the materials manager does not have to expend large amounts of time figuring out what materials to order and when. But it is important to keep the material manager involved and not simply to automatically order the required materials.

The reason for this is that the materials manager may have general knowledge, which the DSS, with its specific built-in knowledge does not. For example, the manager may know that he is able to get a lower price by ordering a slightly larger quantity. The manager may also know that the supplier recommended by the DSS is unable to deliver the required parts as their plant caught fire last night, and so forth.

This is why we call them Decision Support Systems and not Automated Decision-Making Systems. The function of a real-time DSS is to provide the needed information when and where it is needed in a format that makes it as easy as possible for each person to do their job.

Layers in a Decision Support System for Industrial Operations Management



A Decision Support System for Industrial Operations Management may have a number of layers. The most important layer, which is always implemented first is the real-time data collection layer, as without accurate real-time information about the status of jobs and materials and projects, making accurate operational decisions is not possible

This data collection layer may be integrated with shop floor equipment, such as weighing scales, barcode labeling equipment, and process control equipment. It may also be integrated with data from ERP and accounting systems, as well as CRM, CAD, and E-Commerce systems.

This data is collected in near real-time, into a Real-Time Operations Management Databank, which contains an accurate real-time view of the status of customer orders, purchase orders, jobs, materials and projects at all locations, throughout the organization.

This Databank, also collects operational history data, including the materials traceability history of what materials went into each job, what materials were shipped to which customers, and when, the cost of each job, and lots of other operational performance data, such as rework and scrap.

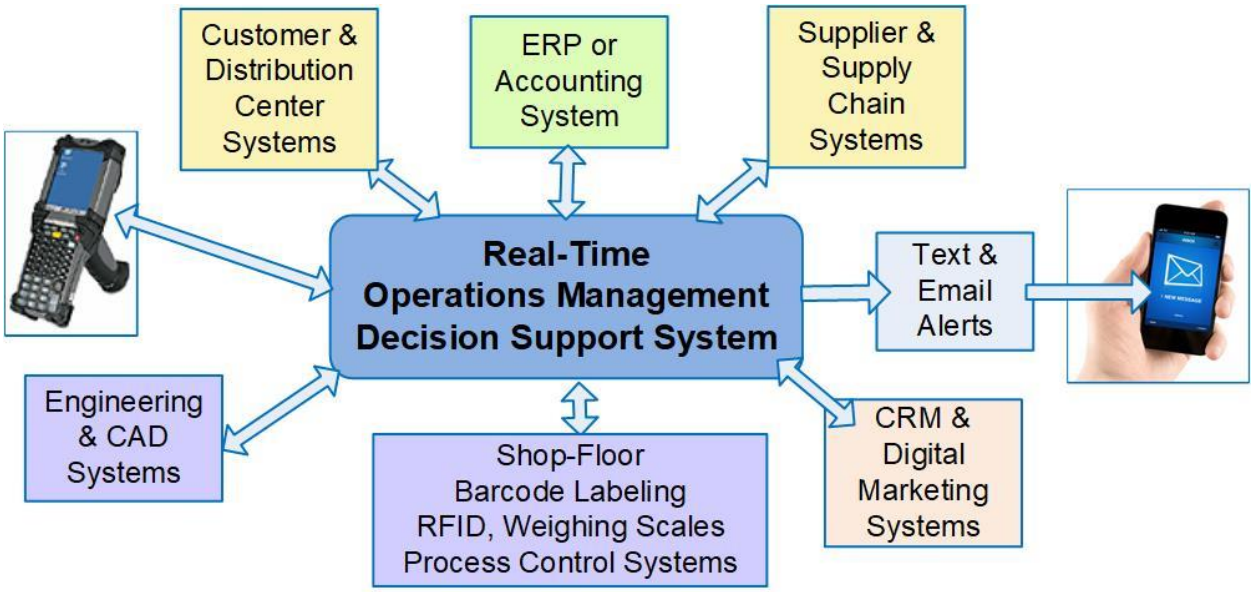
This Databank, can be used to provide an integrated, real-time view, of operations to managers and other employees, wherever, and whenever they need it ,over the Internet. It can be used to

feed data to other systems, which need this data, and can also be used as the basis for Business-Intelligence reporting.

This information can then be used to advise materials managers as to what materials need to be ordered and made. It can also be used for dynamically scheduling jobs to help ensure that customer orders get delivered on time.

Finally, changes in the Databank can be monitored by intelligent agents to generate Alerts, by text message or Email, for managers and other employees, when they need to take some action.

Information Technology Infrastructure for Operations Management



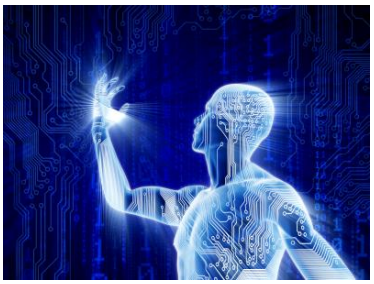
A Decision Support System (DSS) for Industrial Operations Management does not exist on a stand-alone basis, except in very simple circumstances. Typically, a DSS automatically exchanges information with a number of other systems, such as those shown above, as well as sending alerts and warnings to managers when there are events that they need to pay attention to.

This is to ensure that people have the information they need to make decisions appear automatically, in the systems they use on a regular basis, as their primary source of information. In this way, when they receive a text or Email alert message, they do not have to go looking for the backup information they need, in a variety of systems.

The DSS can help assure that they are presented with just the information they need to quickly make critical decisions and are not overwhelmed with extraneous data.

A DSS can also prepare data to be sent to other systems, pending approval by the manager, or even send the data to the other system in an unreleased state, pending approval, which can further save the time of operations managers and their staff and prevent mistakes.

Is an Industrial Operations Management DSS an Artificial Intelligence System?



Yes and No. In its base data collection layers, a DSS may be using 20-year-old data collection technology. In its higher functions, such as monitoring and alerting, and especially in real-time planning, a DSS, such as those from KnarrTek, uses the latest Real-Time Artificial Intelligence (AI) methods.

These real-time AI methods, which were originally developed for the US military, are different from most AI systems which attempt to come up with the best possible solutions in essentially unlimited time. Instead, the goal of real-time AI systems is to quickly come up with warnings and good (but possibly not the best) recommendations, based on specific knowledge programmed into the real-time AI system and then let managers use their general knowledge to make the final decision. In this way, a DSS behaves like an army of tireless staff workers sifting through mounds of computer data to come up with recommended actions for their manager.

As such, the higher-level reasoning in a KnarrTek DSS is done using the paradigm of collaborating intelligent agents. Some intelligent agents may incorporate techniques such as rules, decision trees, model-based reasoning, and/or simple mathematical algorithms to analyze data retrieved from a variety of systems. Yet other agents may fetch the latest updates to data in one or more systems and turn it into information to be sent to other agents or other systems. Yet other agents make decisions about who to send alerts and warnings to.

The important concept here is the timely delivery of information and warnings, when action needs to be taken. The other very important concept is to have the system quickly provide advice and not make the final decision, as people are much better at understanding the overall needs of their organization and the constraints it operates under. This enables decision support systems to be much simpler and be quickly implemented as they do not have to contain rules or other algorithms covering every possible situation.

Commentary

If you study the crashes that happen with self-driving cars, as I do, you quickly see the difference between advisory systems, like a DSS, and fully automated decision systems. In cars, this is the difference between a system that warns the driver when they are drifting out of their lane or about to back into an obstacle and a self-driving car which encounters a situation for which it has not been programmed, which can lead to a crash.

In one case, an automated self-driving car mistook the side of a white semi-trailer pulled across the road for the sky. As a result, it drove right under the semi-trainer, decapitating the driver, and then drove a further one third of a mile to its planned destination, with a headless driver.

Even advisory systems can get it wrong. I have to deliberately turn the backup warning alarm off on my Jeep when I am coupling it to my boat trailer. Also, a lane-drift warning may not be appropriate if the driver is executing a sudden maneuver to avoid a large pothole.

Finally, a story from my early years in this business. I was working for an early-stage hi-tech company which had just acquired its first business computer (which was the size of a good-sized truck and had much less computing power than my mobile phone has today).

After several months of hard work, we succeeded in implementing a set of programs to capture and analyze operational data, such as the status of jobs, inventory, and projects, for the organization.

We then met with the CEO, who was a very bright MIT educated engineer named Larry (who was also a very good business man) and showed him all the reports that our wonderful new computer could produce on a daily basis, detailing every aspect of his operations.

Larry stared at the pile of reports on his desk, pushed them away with a scowl, and said "This is not what I wanted at all". Instead, Larry informed us that what he wanted on his desk each morning was a single sheet of paper with a list of the 6 most important things he needed to pay attention to that day.

Well, here we are, many years later and we are getting much closer to Larry's goal but have not yet fully achieved it. In between I have worked for a number of high-tech early-stage companies, including one that developed a real-time AI super-computer, performed DARPA funded AI research at MIT and USAF funded research at WPI into real-time AI methods, and, in recent years, applied these methods to hundreds of manufacturing and industrial distribution organizations.

But, if I were to meet Larry today, I would tell him that we are getting very close, but that we are not quite there yet in achieving his vision.

Author

This white paper was written by Dr. Peter Green, who serves as the Technical Director of KnarrTek Inc. and Milramco LLC. Dr Green obtained his BSC (Hons) in Electrical Engineering and his Ph.D. Degrees in Electronics and Computer Science from Leeds University in England. Subsequently Dr. Green was a senior member of technical staff at Massachusetts Institute of Technology and a Professor of Computer Engineering at Worcester Polytechnic Institute. He has also been a member of the senior management team of eight high-technology start-ups or early-stage companies.

Dr Green is an expert in implementing operations management Decision Support Systems within manufacturing and industrial distribution organizations. He is a systems architect and led the team which developed the BellHawk job and materials tracking software and MilramX decision support software. Over the past decade Dr Green has also led the implementation of over 100 systems, based on BellHawk and MilramX, to use Industrial Decision Support Systems to assist manufacturers and other industrial organizations to improve the efficiency of their operations and to increase sales through improved customer satisfaction.

For further discussion, or to send comments, please contact the Author at peter.green@Milramco.com.

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