THE CHALLENGE OF CHANGE
All plants and facilities are subject to continual change as technologies evolve, turnarounds are executed, and modification and upgrading projects take place. Yet, the facilities themselves and the information that describes them is often inconsistently updated in line with these changes, creating challenges for the effective and safe operation of the facility. Often, owner operators can lose the ability to track changes—through the review and approval process, what has been done, what are the consequences of these changes, and where is the information related to the change stored.

A recent study by Intergraph showed that some of the biggest challenges met by owner operators include the inability to find the necessary information for executing projects and being able to determine whether or not this information is accurate and up-to-date. This is often due to a lack of change management and traceability as the companies do not have an integrated approach to engineering information management. If there is 30 years’ worth of plant documentation in paper format scattered across the facility, it is no wonder that change management becomes a burden.

Safety issues
Currently, many owner operators have a manual and paper-based change management process in place, which poses a major security risk for facilities. A paper-based approach does not allow tracking and prevention of unauthorised changes, making maintaining an integrated information asset difficult. In addition, safety issues are often linked to poor management of change, which has too often been a direct or indirect cause of major incidents, claiming lives, destroying facilities, and adversely affecting the local plant environment while damaging the company reputation.

These issues have led to a growing focus from regulatory authorities on the management of change processes, while demands for demonstrable compliance with audit traceability are continuously increasing. In addition, existing facilities are often being operated longer than originally planned due to technology advances and decreased appetite from owners to invest in new capital facilities. In the worst case scenario, extended lifetime combined with poor traceability and insufficient processes in place can lead to an increased risk of losing ones’ license to operate.

Furthermore, there are other real-life problems arising from the lack of management of change (MOC). Many owners face extended turnaround times as well as heightened overall cost of maintenance and operations, as time is lost in searching for correct documentation and information about the facility. Surveys have shown that up to one-third of the cost of modifications can be attributed to finding and verifying engineering information.

Challenge of efficient change management
Managing change in an operating plant is a complex, safety critical work process, where continuous changes have to be managed. These changes often have to be controlled in parallel, if the same equipment is impacted by several changes. This can quickly become complex, as multiple alternate solutions to the proposed changes need to be managed simultaneously, changes might be cancelled prior to implementation, or postponed for future turnarounds.

Rainer Pittnauer, Intergraph® Process Power & Marine, Austria, discusses the challenge of change management, and how modern engineering technology can assist.
A manual change process is a time-consuming and error-prone activity. It requires collecting information and documentation, which is often only available in silos, scattered around the facility, and sometimes even in paper format. These documents would need to be maintained properly and shared with the people and departments involved during the different stages of the change management process, typically involving the following components:
- Change risk analysis.
- Review and approval.
- Testing and implementation.
- Post-implementation review.
- Update as-built documentation.

Executing the above-mentioned parallel activities in a manual, document-centric process can easily lead to erroneous decision-making that is based on incorrect or outdated data. The implications of this include extended plant downtime during implementation of changes. This can also lead to risky or dangerous events taking place due to a change in a plant that relies on wrong information, e.g., bypassing the wrong safety function in the emergency shutdown system (ESD).

**How can software technology help?**

In order to address these challenges, owner operators are searching for tools that offer the capability to maintain the dynamic engineering design basis and integrate with other information systems. An example of such a solution is Intergraph PP&M’s SmartPlant® Enterprise for owner operators, which provides a preconfigured work process and out-of-the-box integrations with operating systems to provide improvements for management of plant operation changes.

This integration between operating systems and engineering information management allows for maintenance of the digital representation of the plant in an efficient and consistent way. Comprehensive solutions for capturing both unstructured and structured data, as well as data validation, ensure the transition from an existing manual, document-driven change process to an electronic change process.

These types of solutions supporting an electronic-driven change process provide rigorous MOC of engineering information with full traceability and audit trail. The technology provides a change impact analysis capability that presents the user with possible documents and tags impacted by a change based on an initial assessment and, by examining these impacted tags and documents, shows other ongoing changes with which there may be potential conflict and synergies. This ensures that change requests are properly considered in the context of other changes and that the impact of a change on all relevant tags and documents are identified. The preconfigured MOC process includes an electronic workflow for managing the review, authorisation, design, and approval of changes in the engineering design basis, and, optionally, the notification of maintenance to perform changes by creating notification records in the plant maintenance system (SAP PM).

**A digital twin of an existing asset**

As aforementioned, the existing engineering information and 3D plans of the existing facility might often be insufficient or completely missing. This makes any brownfield project challenging, as there is no way to ensure that the planned changes or upgrades will fit into the existing piping and space. To facilitate this, owner operators are increasingly using laser-scanning technology to capture the as-built information of their assets.

The whole process starts with surveying the plant with a laser scanner. Each scan takes approximately five minutes and captures millions of data points, while it simultaneously captures high-definition photographs of the scanned area. The equipment is highly portable and can be moved quickly between scanning stations to cover the whole plant. The laser’s range means there is no need to get close to hazardous equipment and working at a height can be minimised.

Using the free Leica Truview software, the scan data is presented as a point cloud, in which each pixel has X, Y and Z co-ordinates. This means that even without building a new 3D model, the point cloud can be used for measurements and comparisons with existing computer-aided design (CAD) models of the plant.

Together with the photographs, the captured brownfield data and the point cloud data makes it possible to perform a virtual walkthrough of the plant, from one scanning station to another, and to take measurements. Based on this information, a digital twin of the physical asset can be created, enabling owners to execute a data-centric approach to change management, and overcome many of the...
challenges related to manual processes: inaccuracy, lack of traceability, and frequent errors.

**Synchronising changes**
An aspect of change management that is often not considered is how changes to the engineering design are reflected in operational systems such as maintenance, reliability, inspection, and a host of other systems that consume engineering information. Most owner operators either rely on manual processes or cumbersome batch transfers, in order to ensure that systems are updated in line with changes to the engineering data and documentation. The problem with such approaches is that they are error-prone and can result in operational systems being incorrectly updated. The consequences can include equipment not being maintained or inspected correctly, or errors in the procurement of replacement equipment and parts. To eliminate such issues, Intergraph PP&M has implemented solutions to automatically update consuming systems, such as SAP, with new or updated tag details.

**Improved MOC: project example**
Intergraph PP&M recently implemented an electronic change process for an owner operator in Germany. This customer was already efficiently maintaining the existing plant information in a central repository, but change management was still a manual process.

This manual change management process was inefficient and severely lacked transparency. Furthermore, certain changes had not been documented properly, causing a lack of traceability. The solution was to implement an electronic workflow that represented the exact steps of the change process.

The plant information, such as tags and documents, were already available in the system electronically. This way, once a change is filed in the system, all affected tags and documents can be linked to the change. During this time, the system defines which stakeholders are required for a particular change by using checklists. Depending on this information, the system automatically selects the proper workflow. This electronic workflow manages the automatic distribution of information, the review, and approval tasks related to the change for all involved stakeholders.

This way, all the required departments are now either notified automatically, in case action is required, or informed that the changes have been made, even if no action needs to be taken. By implementing this comprehensive change work process, the customer increased efficiency of change management, as all changes are handled in a consistent process, ensuring better visibility and full traceability. Moreover, this enabled the possibility of a rich reporting and change impact analysis, which is used to maintain an accurate overview of events in the facility.

**Future of change management**
Mobile technology and augmented reality (AR) solutions will become key for efficient and safe change management in the near future. The technology needed for this improvement is already there, but the industry has not yet acknowledged its full potential. There are still a number of companies working in document-centric environments, or managing their plant documentation as hardcopy. The prerequisite to leveraging such immersive technology as virtual reality (VR) and AR is the availability of data-centric solutions, which provides a ‘digital twin’ plant representation.

Mobile technology will enable engineers on the field to execute changes more safely and efficiently, as they can bring the digital twin of the asset with them to the field. The traditional approach today is to provide hardcopy printouts of relevant documentation and information. Paper printouts are not only labour-intensive to produce and maintain, but also cumbersome and difficult to use in the field. Furthermore, mark-ups made in the field are often difficult to interpret back in the office, which causes further delays in transcribing data into relevant systems.

Having mobile technology in place enables access to accurate information throughout the execution of change. The required data and documents can be taken offline to the field on a mobile device. In addition, it is possible to capture notes or photographs, etc. in the field quickly and efficiently. Later on, modifications, media capture in the field, as well as red-marks, can be uploaded to the system. This eliminates delays and errors in transcribing notes from paper mark-ups.

In addition to mobile technology, AR and VR solutions will shape training and change management execution. For example, having a HoloLens or an AR helmet available means engineers can perform a dry run of the change before it takes place, testing all the possible scenarios that could go wrong.

During the execution of a change, VR/AR devices will guide the engineer through the different work steps:
- Indicating the personal protection equipment and tools, which are required to perform the task.
- Describing the exact procedures including sub-procedures that define the work steps.
- Identifying the proper equipment linked to the change, such as through quick response (QR)/radio frequency identification (RFID) scanner.
- Viewing of the documents and drawings linked to the change.
- Providing photos and 3D real time animations for steps that need to be performed.
- Evaluating the real time process values.

**Conclusion**
The key reason change management is so challenging comes down to the availability of existing engineering information. Plant information required to assess, plan, and execute a change is often only available in silos and very often in paper format. In addition, poor reporting measures are in place, and there is often no way to evaluate the impact of a change. This can be improved by creating a digital twin of the physical asset, which helps to overcome many of the challenges related to manual MOC processes: inaccuracy, lack of traceability, and frequency of errors. Mobile, as well as AR and VR solutions, will further enhance and shape the way change management will be executed in the near future.

**Reference**
1. Intergraph Research on Intergraph Information Management/Owner Operator Solutions.