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How to include digital physical progress measurements in capital project control setups

Getting an accurate measure of physical progress is essential to maintain capital projects under control. New technology is getting deployed on projects based on advanced imaging (digital photography, 4D scans, drones) often associated with Artificial Intelligence (AI). This remains an emerging discipline and does not cover the full scope of the project. In this White Paper we explore the possibilities offered by this new technology and the challenges that must be overcome to include those digital measurements in the overall project control framework.

Introduction

A reliable measure of physical progress is essential data for knowing the current state of the project (where we are). Having this reliable foundation is also essential for any forecasting activity (where we are heading).

Measuring physical progress requires up-to-date reports on the status of certain indicators identified as representative of physical progress. Two practical problems arise:

- The relevance of the choice of indicators:
  - Their representativeness (ideally, they should be roughly linear with the effort to allow prediction by the earned value method - example of document progress problems at the end of the cycle with successive updates of documents approved for construction),
  - The level of effort with which data can be measured or capture
  - The granularity of the indicator (level of detail – which needs to be right, neither too detailed nor too general),
  - The promptness with which this measurement is available and transmitted for use (risk of time lag, problem of digital discontinuity with subcontractors and intermediate processing of the data),
- The accuracy of the data, which requires quality and reliability of the progress measurement.

Project professionals must recognise that this focus has to be included in project setup plans

What can digital technology bring to the field of physical progress?

Digital technology allows us to respond to the immediacy challenge of the availability of data. It can make it possible to significantly increase the data capture frequency. It also allows automatic processing of data (by aggregation, analysis, etc.) provided that it is correctly coded at its origin.
Digital can also enable data to be captured at a greater level of detail, closer to operations (e.g. by deploying tablets and phones on site, connecting to welding machines or non-destructive testing monitoring systems); and therefore to manage much more massive data sets than traditional approaches. Digital technology could therefore accelerate the provision of data at a greater level of granularity.

Current digital capture technology for physical progress

Many approaches are being deployed, of various maturity, some in various stages of actual development:

- Engineering
  - Document and drawing control systems (status: mature),
- Manufacturing facilities:
  - Material receipt, tracking and storage (status: mature technology, increasingly deployed)
  - Automated capture by automated production supervision systems (status: mature technology, dependent on the background automated supervision system),
  - Manual capture on digital interface for quality control and non-conformance management (status: mature including using portable devices, but not systematically deployed),
- Construction sites:
  - Manual capture by supervisors on a digital interface (portable reporting equipment), possibly linked with an underlying process description and proof capture using photography (status: mature technology using portable devices like phones and tablets, but not systematically deployed),
  - Sets of digital pictures from set points or 4D capture with a fixed 3D laser system, with some AI to interpret the physical progress data on the basis of the 4D model of the facility (status: working prototypes),
  - Image interpretation from drones moving around facility and comparing with 3D models (status: under development).

Using AI for physical progress measurement

The possible uses of AI, which exist today, concern

- Capturing progress data: Where it is difficult or expensive to measure physical progress data at the source, AI-based applications can enable it to be measured indirectly by 'intelligently' interpreting a more macroscopic observation of the project. This also allows capture at source without subjective interpretation or copying errors and avoids the cost of people capturing information manually. This approach is used in particular for construction activities where macroscopic observation of the site with fixed or mobile HD cameras (drones), interpreted by AI, makes it possible to derive a physical progress. Applications already exist today, particularly in the construction of office buildings (observation of the site from the outside which automatically measures the progress of the floors)
- Analysis of progress data: AI can also be used to develop more in-depth analyses of the physical progress data available (trends in time and space, identification of patterns, productivity measurements, cross-referencing with other effort-related data, etc.). This can therefore enable trends and correlations to be detected

- Management of difficulties related to the heterogeneity of data in terms of time, format, source, and availability; and identification of outliers, thus supporting data cleanliness.

What issues need to be overcome to fully benefit from digital capture of physical progress?

The following problems always arise irrespective of the source of physical progress data:

- The problem of measuring and identifying the right data to represent the physical progress at the desired level of detail. It is not always relevant to use raw numerical data which are not always representative of physical progress (e.g. welds: it only counts if the weld is validated after non-destructive testing!)
- Today, in industrial projects, a large part of the physical progress data is still not captured in digital form immediately at source, particularly during manufacturing or construction activities - whatever the level of granularity sought.
- Physical progress data is not necessarily coded correctly to assist in its analysis and aggregation (which goes back to the more general problem of more detailed coding of different parts of the installation - product and work bread down structures, etc)
- A certain amount of data easily captured digitally (cameras, AI, etc.) is not necessarily relevant and representative of physical progress. A selection is necessary, and data cleanliness needs to be ensured.
- Digital discontinuities in the value chain from the project owners and in the cascade of subcontractors do not help the transmission and collection of information and need to be overcome
- The frequency of availability of various physical progress information is not consistent: from instantaneous to monthly; project schedules are reviewed monthly, site data weekly or daily; and it is difficult to manage different time references
- There is still a lot of manually captured data that needs to be re-entered with possibility of mistakes
- A lot of physical progress data is lost in the projects, the history is not kept in a homogeneous way which makes it difficult to analyse transversally or on the evolutions over time across projects.

Overcoming these challenges is required first to allow the benefits of digitalisation to be realised. Coding of the data and adaptation to fit into the project control setup and needs of the project is an area where progress is often still needed. It is part of the project setup phase and is too often overlooked, as managers are sometimes hypnotised by new capture technology. This leads to situation where digital data is generated but not really used by the project.

Our experience is that integrating digital physical progress data requires a specific effort at the start of the project, and adequate benefits evaluation before implementing automated data capture. In addition, the major question of the digital discontinuity between the various project contributors must also be addressed by specifying early what data interfaces will be set up and used to transfer digital datasets across contractual boundaries. This area still requires a lot of focus and hopefully standardisation initiatives will be implemented to ensure that this setup work can be facilitated.

Summary

Many initiatives exist and some progress is made towards integrating digital physical progress data in project control setups. However, this requires a particular effort at project start-up as the amounts of data thus generated must be specified, coded, and checked to fit into the overall project control setup.

Project professionals must recognise that this focus has to be included in project setup plans and that this issue also needs to be addressed in the requirements to the specific contractors and subcontractors that will be involved in the project. Early consideration of such solutions is thus paramount to their successful implementation in projects.