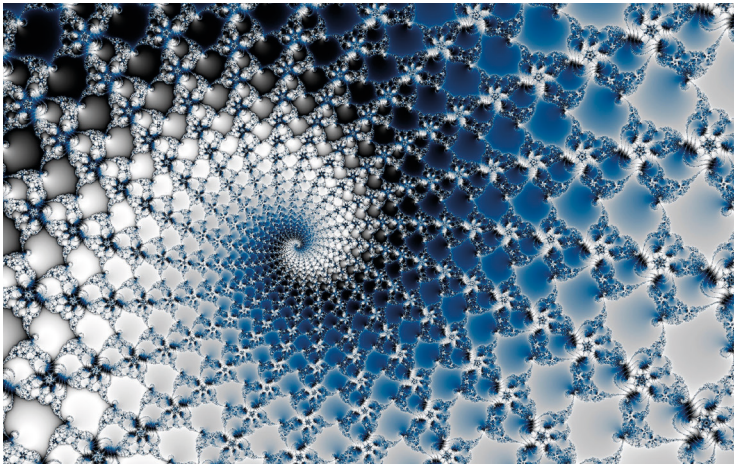


# Project Management

## Driving Complexity PMI® Italian Academic Workshop

edited by

Fabio Nonino, Alessandro Annarelli, Sergio Gerosa  
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## Driving Complexity

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## 11. Investigating project complexity from an organisational learning perspective: a multiple case study

*Alberto F. De Toni, Elena Pessot*

Complexity – and its growth at a faster rate than the capability to cope with (Maylor and Turner, 2017) – has been recognised as a major topic of discussion in project management research and practice. Dealing with the interdependency, uncertainty and change of contemporary projects and their dynamic environments poses new challenges (Cooke-Davies et al., 2007) and requires a more contingent approach in managing projects, beyond the conventional linear systems and the “Tayloristic one best-way approach” as a reference model to apply to any type of project or industry (Blindenbach-Driessen and van den Ende, 2010; Shenhar, 2001).

This connects with the specific challenges encountered by organisations when capturing and embedding new knowledge and learning from the management of single projects at the overall organisation level (Bresnen et al., 2004; Prencipe and Tell, 2001). Project teams need to deal with the interfaces between the temporary and permanent organisation they belong to (Stjerne and Svejenova, 2016) and the ways of working constrained by tight schedules and optimisation towards the achievement of the single project goals, resulting in distributed knowledge and working practices (Bresnen et al., 2004).

This work aims to investigate how organisations are facing the complexity of their projects based on the reflections and perspectives of the learning gained by the project management teams at the organisational level. We build on 1) the dimensions of project complexity identified in the project-oriented literature, i.e. diversity, interdependency, dynamicity, uncertainty, and 2) the key organisational processes of organisational learning in projects environments (Pren-

cipe and Tell, 2001), i.e. knowledge creation through experience accumulation, knowledge acquisition (from other sources or contexts), knowledge codification. In order to answer the following research question:

*How do organisations understand and face project management complexity within their projects from an organisational learning perspective?*

## **Design/methodology/approach**

Aiming for sense-making and increasing the understanding of the features of complexity and organisational learning processes in projects, this study employs a qualitative methodology and an exploratory approach (Yin, 2013). Moreover, it follows the need to take into account the organisational context within which projects are embedded and interact, extending the contingency-based approaches (Shenhar, 2001). Therefore, we conducted a multiple case study where the cases have been a sample of projects managed and delivered by the same organisation, i.e. a large, leading company of the shipbuilding industry. We selected a population of 7 cruise ships' projects showing complex multivariate conditions (Yin, 2013), with a variance on the criteria (Eisenhardt, 1989; Shenhar and Dvir, 1996) of: size of the ship, technological newness, shipyard (production site), delivery date (therefore corresponding to different timings in the development process), customer (highlighting the features with an impact on the design and production phases, i.e. newness of the customer to the firm and to the market, type of relationship, customer segmentation, innovativeness).

The phase of data collection employed multiple sources to enable triangulation (Yin, 2013) and lasted for more than one year. The sources of evidence were interviews, field notes, qualitative questionnaires, documents and archives. A database was prepared for each case, including primary and secondary sources, and data were analysed following a two-step procedure, involving a within-case analysis and a search for cross-case patterns (Eisenhardt, 1989) in terms of dimensions of project complexity and organisational learning processes.

## Findings

Results of the study show how project teams understand and face the complexity of their projects and determine further insights on studying organisational learning as an emergent process. Table 4.1 summarises the main mechanisms carrying to specific sub-processes of learning when dealing with different complexity dimensions in the analysed projects.

**Tab. 11.1. Complexity dimensions and organisational learning in projects**

COMPLEXITY DIMENSIONS	ORGANISATIONAL LEARNING PROCESSES		
	EXPERIENCE ACCUMULATION	KNOWLEDGE ACQUISITION	KNOWLEDGE CODIFICATION
DIVERSITY		<ul style="list-style-type: none"> <li>• common knowledge base</li> <li>• innovations and advancements</li> </ul>	
INTERDEPENDENCY	<ul style="list-style-type: none"> <li>• trust mechanisms</li> <li>• on-site training</li> </ul>	<ul style="list-style-type: none"> <li>• economies of repetition</li> <li>• collection of feedbacks</li> <li>• cross-fertilisation of competences</li> </ul>	<ul style="list-style-type: none"> <li>• systematisation of interfaces</li> <li>• improvement of standard procedures</li> <li>• organisational redesign</li> </ul>
DYNAMICITY	<ul style="list-style-type: none"> <li>• focused meetings</li> <li>• fluidity of informative process</li> </ul>		<ul style="list-style-type: none"> <li>• specific management tools</li> <li>• systematic reviews</li> </ul>
UNCERTAINTY	<ul style="list-style-type: none"> <li>• informal procedures</li> <li>• overcoming of "cultural gap" for knowledge sharing</li> </ul>		

In general, dealing with the management of complex projects results in a considerable level of organisational learning, taking place in

the project teams.

Focusing on the levels of single dimensions of project complexity, we can observe the prevalence of single processes of experience accumulation, knowledge acquisition and knowledge accumulation. For instance, a higher level of both interdependency and dynamicity results in a higher knowledge codification, to be promptly shared in the emergent knowledge communities. Beyond the experience of the project team members, dealing with several interfaces (e.g. customers, suppliers, subcontractors, other functional units) and pace of the projects (e.g. introduction of several changes during the implementation phases or strict regulations) allows for a better learning at organisational level to be translated in common knowledge repositories. A higher diversity mainly results in the need to acquire knowledge from the external sources, especially from the previous projects, the past experiences of the team members and also the competences of the main stakeholders, when properly shared. The dimension of dynamicity results in both knowledge acquisition and codification, mainly addressing issues that are specific of the ongoing project at the operational level. Finally, higher uncertainty requires relying on the ongoing experience-based learning.

Overall, the complexity of projects tends to bring to informal mechanisms of knowledge acquisition and codification, to be properly shared and transferred in the upcoming projects.

## **Originality/value**

This study contributes to the stream of literature on project complexity by enriching it with an organisational learning perspective. It can be situated at the interface between project management and organisational studies, offering insights for a theory building aimed at studying organisational learning in project environments as an emergent process of complexity.

The findings are likely to advance knowledge on the issues of managing projects characterised by a certain level of complexity, by acknowledging the importance of considering the emerging mechanisms of experience accumulation, knowledge acquisition and knowledge codification of project management teams when they face the complexity of their projects.

## **Practical implications**

This research can provide some useful indications for the management of projects with reference to the definition, assessment and management of project complexity. The complexity dimensions proposed in the study may help project managers and other project stakeholders to better understand the complexity of the projects they are working on. Moreover, the perspective of organisational learning would support them in positioning their projects in terms of emerging patterns and their fit with the knowledge management strategies actually promoted within their organisations. A dedicated evaluation would provide project management teams with a basis to eventually adjust their project management practices and/or organisational learning processes accordingly, especially when they develop more projects to realise the company's strategic objectives.

## **Research limitations/implications**

The research has been completed in February 2018. Major limitations are linked to the choice of the research design, i.e. the case study and the qualitative data analyses performed, that limits generalisability. Despite this, this explorative study allowed to reveal possible patterns, and a statistical analysis on a wider sample would sustain a better formulation of the hypotheses and operationalisation of the variables.

Moreover, the selection of the cases and the boundaries established in the design of the research limited the scope of the study. Therefore, the investigation of multiple projects from different organisations, also on a multi-sectoral basis, would allow to extend and refine the lessons learned here. A further interesting direction for future research concerns the selection of managerial and organisational practices to foster organisational learning with different levels of diversity, interdependency, dynamicity and uncertainty.

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## 12. Facing project complexity by Advanced Work Packaging: an application in Benetti Yachts

*Davide Aloini, Elisabetta Benevento, Annamaria Diprima,*

*Francesco Ricci*

Project complexity is a critical topic in construction project management (Bakhshi et al., 2016; Lu et al., 2015). Researchers have increasingly recognized the importance of complexity, particularly in large-scale projects (He et al., 2015; Davies and Mackenzie, 2014), as one of the factors affecting expected project outcomes (time, cost, quality, etc.) (Bosch-Rekvelدت et al., 2011; Dao et al., 2016).

Project complexity involves dynamism and uncertainty, which are mainly manifested in technological and organizational complexity (Baccarini, 1996; Lu et al., 2015). Accordingly, mega construction projects are usually characterized with high technological complexity, such as building type, overlapping of design and construction works, dependency on project operations, and uncertainty of the production process or customer demand (Bosch-Rekvelدت et al., 2011; He et al., 2015). In addition, the nature of complexity in such projects is related not only to their scale, but also to organizational/coordination issues. Indeed, complex projects are conducted by a network of organizations which includes various teams, project staff, multiple organizational structure and, thus, is often hard to manage (Davies and Mackenzie, 2014; He et al., 2015).

Due to poor coordination and integration between the various project participants, Engineer-To-Order (ETO) manufacturers – such as industrial constructor – typically face low levels of work productivity and project predictability (Gosling and Naim, 2009). Such deficiencies in productivity and predictability of outcomes can notoriously be turned around through a proper early planning approach that involves and coordinates the engineering, procurement, construction

and project controls areas with a supply chain orientation (Yeo and Ning, 2006).

In the very last few years, Advanced Work Packaging (AWP) methodology (CII RR 272-2, 2013) has been emerging as a successful planning methodology within the industrial construction environment. AWP is based on the concept of breaking the project scope into smaller portions with planned and managed installation. The project is divided into Construction Work Packages (CWPs), which are large sections of the project construction activities, and Engineering Work Packages (EWPs), which are deliverables from engineering activities. The CWP/EWP designations are then merged together, iteratively decomposed and issued to the field for completion (Figure 12.1).

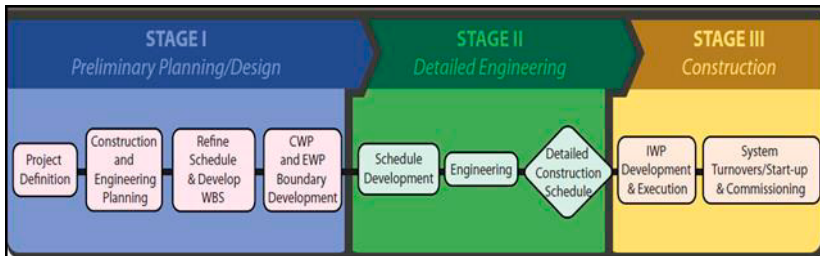


Fig. 12.1. Advanced Work Packaging diagram flow (Source: CII RR 272, 2013)

Besides few explorative experiences within the industrial construction sector, the implementation of Advanced Work Planning technique is still embryonic in other ETO industries. Also, to the best of our knowledge, there is lack of empirical research aimed at testing and validating the AWP methodology directly in the field. Particularly, no empirical contribution has provided quantitative measurement of the performance resulting from a proper implementation.

Due to above-mentioned research gaps, this paper aims at investigating the suitability of AWP methodology to the shipbuilding context. In addition, the research aims to provide preliminary evidence of the potential benefits related to the AWP implementation.

## Design/methodology/approach

The AWP implementation was conducted in Benetti Yachts, one of the largest yacht-builder in the world. The case study methodology goes through the following six main steps:

1. **Project order selection.** A mega-yacht (60 mt.) order was selected in order to test the AWP implementation. The choice was determined by a lower design and production complexity of the mega-yacht orders respect to giga-yachts and the availability of historical data for setting up AWP and assess comparisons (more than 20 mega-yachts were built by Benetti). A set of indicators was also identified in order to evaluate improvements due to AWP application.
2. **Modelling and analysis of actual construction process.** Meetings with process participants, extensive document analysis, and accurate direct observation of work activities were conducted to identify the main phases of the shipbuilding cycle and map the construction process. A BPMN model was built which includes the planning and production activities along with various project participants.
3. **CWA plan development.** By the process model and the work breakdown structure (WBS) of past mega-yacht projects, we developed a CWA plan with the collaboration of the project team. Specifically, we broke the entire project into different geographical construction work areas (CWAs). Each CWA has different size (boundaries) depending on the logical association of work and the activity type. Sizing of CWA is aimed at estimating and monitoring the progress of the project.
4. **CWP plan and EWP plan development.** For each CWA, we identified a set of construction work packages (CWPs), with the support of the construction management. Each CWP is fed by one or more engineering work packages (EWPs). An EWP is produced by the engineering team and provides CWP with technical documentation, such as drawings. After that, constraints and dependencies between a CWP and the related EWPs were identified by interviews with engineers. In addition, where relevant, CWP and EWP development also allowed to define Procurement Work Packages (PWPs).

5. **IWP plan development.** Each CWP was finally divided into several installation work packages (IWPs). Each IWP contains all elements necessary to complete the installation of a scope of work in the field. Figure 12.2 shows the relationship between CWA, CWP, EWP and IWP.

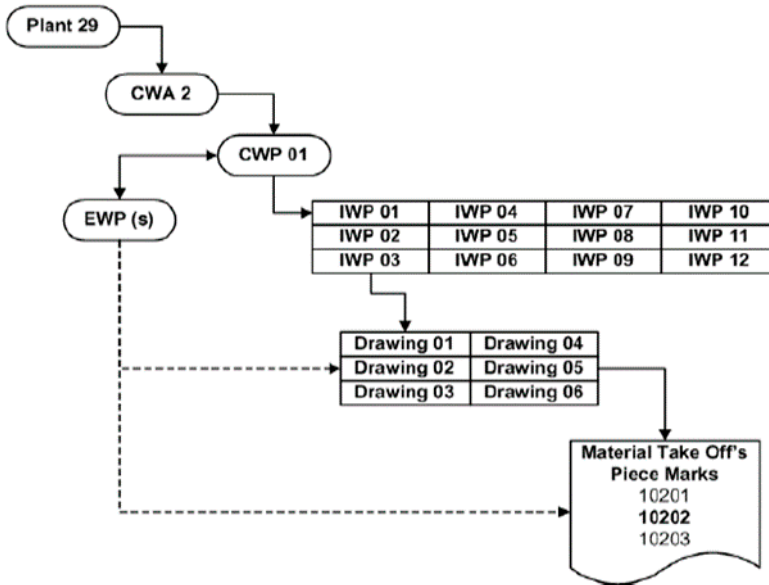


Fig. 12.2. AWP structure

6. **Project implementation and AWP test.** The mega-yacht project will be executed and monitored following the AWP project plan as defined in the previous steps and project data will be collected by an appropriate AWP sw tool. Then, project performance will be evaluated and compared with previous project orders to check the potential benefits of the AWP. Periodical meeting with project team will be also planned to identify possible shortcomings of the AWP methodology and define directions to refine it accordingly.

Findings

A new project plan related to the 60-meter yacht was defined accordingly to AWP methodology. The project plan was also implemented in a Microsoft Project application in order to support project execution and monitoring phases. Specifically, we identified:

- 22 CWAs, 66 CWP's and about 200 drawings for the outfitting phase;
- 27 CWAs, 27 CWP's and about 140 drawings for the hull and superstructure construction phase.

Figure 12.3 shows, as an example, a CWA and the related CWP's, EWP's and PWP defined for the low deck of the vessel.

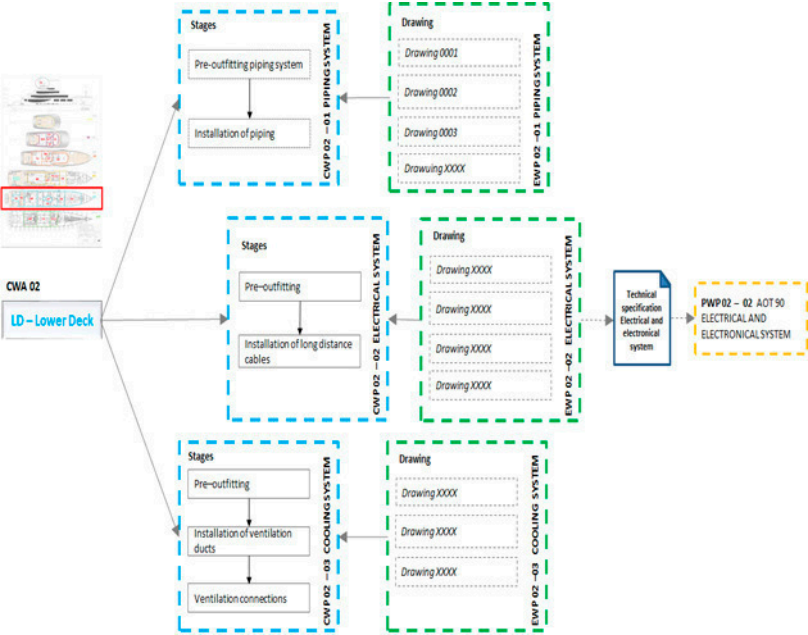


Fig. 12.3. Relationship between AWP, CWP, EWP and PWP for the low deck of the vessel

Expected results from the AWP implementation mostly concern with the increase in labour productivity and alignment with the planned schedule, both of them resulting from fewer reworks and improved alignment among project participants. Indeed, an early identification and mitigation of constraints should allow achieving

reduced project over-time and extra-cost, which are also estimated with more reliability and robustness. These expected improvements are also related to a set of ancillary benefits in other areas, such as improved project flexibility, enhanced accountability and measurability.

In Table 11.1 we show selected indicators to quantify and compare improvements by AWP methodology.

## Originality/value

To our best knowledge, this is a first attempt to implement the AWP methodology and test its feasibility in the shipbuilding context. In addition, the research also aims at providing early empirical evidence of the expected benefits theoretically related to the AWP implementation.

## Research limitations/implications

The empirical test of the AWP methodology is limited to a single case (project order) which is still in progress. Consequently, reported evidence is still partial and results will not be generalizable. Nevertheless, this work could be a valuable starting point for replication in other cases/industries.

**Tab. 12.1.** Performance indicators

Dimension	Metric	Formula
Time	• Schedule Variance Index	$\frac{\text{Actual Schedule}}{\text{Planned Schedule}}$
	• On-time Engineering	$\frac{\text{Average delay in drawing releases}}{\text{Average delay in drawing releases}}$
	• Overall Project Completion	$\frac{\text{Actual days for project completion}}{\text{Actual days for project completion}}$
Cost	• Cost Variance Index	$\frac{\text{Actual Cost}}{\text{Planned Cost}}$
	• Rework Savings	$\frac{\text{Rework Cost Reduction}}{\text{Rework Cost Reduction}}$
Quality	• Engineering Rework Factor	$\frac{\sum \text{Drawings with Reworks}}{\sum \text{Drawings}}$
	• Production Rework Factor	$\frac{\sum \text{Token with Reworks}}{\text{Total Token}}$
	• Total Field Rework Factors	$\frac{\sum \text{Reworks Costs}}{\text{Total Production Cost}}$

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