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P. DONNELLY, AspenTech, Bedford, Massachusetts

Capital projects are making a comeback, but are EPC firms ready?

After several years of cutting costs to align to the reality of fewer and smaller capital projects, engineering, procurement and construction (EPC) firms are now forging ahead as the industry recovers. However, with smaller, less-experienced teams and key personnel often distributed across several offices and time zones, one might be wondering: Are EPC firms ready to scale back up as the volume and size of projects increase?

As I have traveled across Asia, Europe and the Americas over the past year, meeting with a wide range of EPC firms spanning the full spectrum of services offered, I have begun to see new initiatives emerging, geared toward improving internal operations. This trend is corroborated by a survey[1] of 123 industry executives in March 2018, where more than two-thirds of respondents said they were improving, or planning to improve, their engineering processes.

Time of transition. Many EPC firms have historically operated as confederated states comprising previously acquired firms, strong regional offices, and/or areas of domain or project expertise. Following a downturn in which experienced people, departments and entire offices have been eliminated or reconfigured, the approach to organizing and executing project work is being reexamined.

More than half of the industry survey respondents said that information sharing across offices needed to be improved. Increasingly, both small and large firms are seeking to standardize their workflows and technology platforms to enable more work sharing, cross-office collaboration and a "follow the sun" project execution approach for conceptual design, front-end engineering and design (FEED) and detailed engineering work. This trend is increasingly relevant, as some firms have been adding engineering capabilities in new locations by going through mergers and acquisitions or by scaling up their resources in lower-cost countries, such as India.

A senior vice president of engineering at a mid-sized, domestic EPC firm recently told me that "efficiency is the name of the game." Following a recent merger, he is 4 mos into a process reengineering program designed to get the company's teams working more effectively across offices, and he stated that this program is a matter of survival. His firm's near-term goal is to get everyone on the same playing field—with common nomenclature, templates, libraries and standards. The company wants to ensure that its teams are working with the latest models and data, and that deliverables from the different offices are consistent.

Essentially, firms want to connect virtual islands of personnel, departments and offices by using new work processes that allow firms to harness their collective talent and bandwidth to execute on the opportunities they view as the best fit for their capabilities and that offer the most financial reward. By breaking down the silos between divisions, regions and offices, they are building organizations and technology platforms that will allow them to execute project work more efficiently.

Drew Dietrich, Engineering Systems Administrator at WorleyParsons, sums it up nicely: "Today's projects are executed across multiple locations and with extremely aggressive schedules. The ability for the whole team to be working with the current data is key to making timely engineering decisions."

EPC firms are also pulling key project stakeholders closer together earlier in the design process, where their collective decisions have the greatest impact on project outcomes. Specialists work together, in parallel, to deliver designs that are better optimized as holistic systems to lower required capital expenditures (CAPEX) *and* perform at the highest levels during operations. As a result, their designs better meet their customers' needs, thus increasing satisfaction and positioning them for repeat work.

A similar shift is occurring at the project pursuit level. According to the industry survey, 65% said that generating new bids is a difficult and slow process. Instead of key personnel working sequentially to gather information required to submit a profitable and successful bid, leading companies are now bringing needed expertise together earlier in the process and using common, collaborative tools for creating accurate estimates quickly to be more responsive to customers, bid more jobs and ultimately win more work.

Why change is necessary. According to these industry survey respondents, the top reasons for needing to improve processes include:

- Too many silos
- The need to streamline workflows
- Constant changes during FEED
- Too many different software packages
- Technology misalignment.

Consider a typical bid situation where process engineers, mechanical engineers, safety experts, estimators and others

have required inputs. Each member creates a set of relevant engineering data that must be incorporated into the overall concept, and the data from one specialist often has an impact on the work of the others. When working sequentially, the opportunities for early collaboration and sharing are lost, and every change introduced can result in a reset of the process. The bid is essentially done when the team runs out of time, not when the best alternative and estimate are developed.

The same situation occurs during execution of FEED, when the design and engineering disciplines work in a sequential engineering process. Approximately half of the survey responders indicated that sharing data across disciplines results in errors. Data is isolated in spreadsheets or disconnected tools, and is not available to inform the work of others (FIG. 1). When incorporating data from another specialty, it is often entered manually, which may introduce errors or omit valuable information. Instead of overall project wisdom increasing, it is often lost or left behind and not available to inform a broader, more systems-based approach to the design.

Four causes of low engineering productivity

1. **Poor handling of information.** Information is at the heart of what an EPC firm delivers and is the lifeblood of a design, yet key design and engineering information that was hard-won in one phase of the project often ends up trapped in multiple Excel files, handed off manually (often introducing errors) or possibly not passed on to the next phase or discipline at all.
2. **Giving only "lip service" to collaboration.** Mechanical and safety engineers wait for process engineering data that seems to never be finalized, and the estimating team often orbits the core design process—only getting fully plugged in too late, resulting in a scramble to meet the deadline, which, in turn, causes accuracy to suffer and risks to increase.
3. **Pretending the project scope and schedule will not change.** Sequential, siloed work processes and disconnected data mean that personnel will always be scrambling and working overtime to accommodate the inevitable requests for changes to the project scope and schedule. Response times to customers and the quality of the design suffer as a result.
4. **Waiting until the end to see the result.** We have come to accept disintegrated engineering processes that do not provide useful guidance until the pieces are put together at the end. By then, it is too late to change key design and equipment parameters, and you may be locked into a suboptimal design concept.

A new way of working. As internal and external forces come together to disrupt this industry, forward-looking firms are implementing initiatives to make process and technology improvements that will fundamentally change the way they work. In pursuing these initiatives, some common objectives include enabling virtual teams comprising experts from across the organization—in different departments, locations and time zones—to leverage the full breadth of the firm's capabilities. To support these objectives, EPC firms are looking for a design and engineering platform with these common qualities:

- **Model-based and data-centric.** A consistent project data model/repository is used across all parties and disciplines involved in engineering and design for the project. Updates are propagated automatically, and people work with the most up-to-date information. Information is preserved, and collective project knowledge consistently increases over time and across disciplines and project phases.
- **Simultaneous.** Different disciplines work on the project in parallel. Early insight into information developed by others is available to the broader team, and this early feedback shapes the overall direction toward a better outcome. This process shortens cycle times, allows more options to be considered and reduces bottlenecks.
- **Collaborative.** True collaboration occurs when the disciplines work together with tools tailored to their specialty, while sharing the same consistent set of project data. Information is not trapped in siloed spreadsheets or lost in handoffs, and changes are more easily and quickly seen and accommodated.

Another good example of such improvement initiatives is the ongoing efforts underway at a Calgary-based EPC firm.[2] The company is in the fourth phase of a long-term initiative to improve its project execution. In the current phase, the EPC firm is working to create a robust data model across the engineering disciplines, following a previous phase in which the company established digital project hubs for storing all project information and integrated its design authoring tools. Next, the EPC firm will be tackling workflow optimization. All these initiatives have helped the company to shorten cycle times and improve communication with its customers.

Benefits. Generally, benefits of reengineering work processes

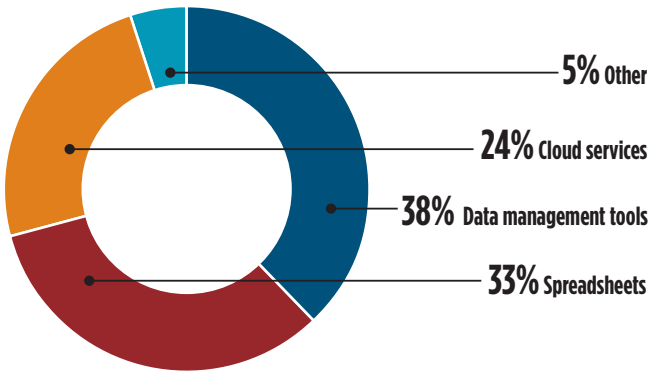

FIG. 1. An industry survey of EPC firms[1] shows the current methods for managing design and engineering data.

typically fall into three areas: better design outcomes, preservation of project knowledge and the ability to accommodate change.

Better design outcomes. It is generally accepted that a design team's ability to impact final costs and the functional capabilities of a process plant decrease with time (FIG. 2). A senior cost estimator at an EPC company[3] said, "A critical success factor for EPC firms and owner operators is the ability to maximize efficiency early in the design phase." Early decisions—such as where the plant is located; which design concept to pursue; and the number, size and type of major pieces of equipment—essentially lock in the design approach at the initial stages and limit subsequent alternatives.

Changes that are introduced after these initial decisions have been made can upset the schedule and be very expensive to implement. Therefore, it is imperative that these early decisions are made with all available inputs and information, from as many stakeholders as possible. By enabling collaboration and input across the key disciplines early in the process, using a concurrent engineering approach, these early decisions are better informed, improving project outcomes. Since working concurrently is a more efficient and productive process, design cycle times are shortened, and more design options can be considered.

Preservation of project knowledge across disciplines and phases. When design teams are connected by a common engineering and design environment, information from one discipline is available to the others instead of being locked away in isolated spreadsheets or stand-alone tools. Manual data transfer and replication are reduced, and typical errors and omissions are avoided. Collective knowledge about the project as a system continually grows. Handoffs between project phases are smoother and adjacent teams no longer feel like they are starting from scratch (FIG. 3). The use of consistent models and data across the project lifecycle also allows for critical information to persist beyond handover and to be used to help hone operational performance.

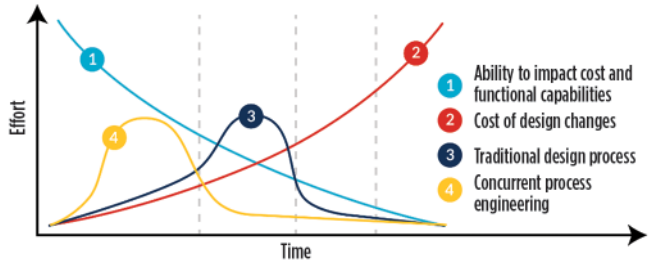

FIG. 2. The design team's ability to impact final costs and plant capabilities decrease over time (the MacLeamy Curve).

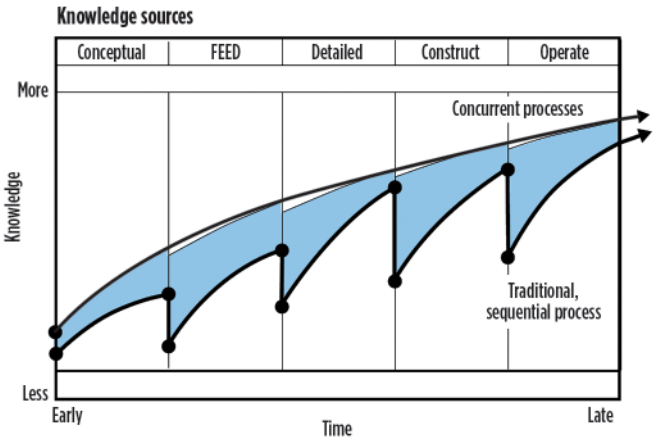

FIG. 3. Design teams using a consistent modeling and data environment preserve project knowledge across disciplines and phases, which improves productivity.

Accommodation of project changes. Changes on large, complex projects can be both costly and disruptive. Yet, change is inevitable, and a firm's ability to adjust quickly and efficiently can save considerable time and money for both the project owner and its engineering firm. When teams collaborate around a common engineering environment and set of project data, members can be made aware of the changes and quickly understand the impact to their deliverables. Changes can also be propagated through the common engineering data platform to all parties and will be reflected in dependent deliverables such as equipment lists and data sheets.

Benefits in action.

Many parties are involved in the process of delivering a design for an upgrade or a new plant, with thousands of deliverables that are created and updated, and multiple key decision gates to navigate across the lifecycle of the project. Improved engineering processes and supporting technology can have an impact throughout the conceptual and basic engineering.

The ultimate beneficiary of improved engineering performance is the project owner. More collaborative projects can generally achieve the desired result with a lower overall CAPEX, and are inherently safer and more profitable to operate. The ability to provide a single, integrated set of project data for use in detailed engineering, costing, commissioning and operations will continue to pay dividends over the life of the asset.

In addition, the ability to quickly and efficiently accommodate owner requests for changes during the design process is a significant and easily understood benefit.

Economic feasibility studies. When evaluating the feasibility of a project, the owner can create an economic model that can be further developed during the conceptual, FEED and detailed design phases. The estimate becomes richer and more detailed as more information is added, and then it is easily passed to the owner's EPC firm.

Process engineering. The process model serves as the basis for the rest of the design and is available to the equipment designer, safety engineers, regulatory authorities, project owner and other stakeholders. Process engineers can work with estimators to build templates for quick, accurate financial evaluation of different concepts.

Estimating and bidding. Estimators work closely with design team members to ensure they have the latest information and can adjust for changes in the process, equipment, sizing, site plans and other variables that are subject to change.

Mechanical equipment design and rating. From the process model, the mechanical engineers, heat exchanger specialists and column specialists can begin developing more detailed engineering data and equipment specifications. Equipment lists and data sheets are stored in a central location and can be updated by all, making key project data available to others.

TABLE 1. Maturity models to help chart a path for productivity-driven process changes for plant engineering and design

Maturity level	Target	Selected best practices
1	Use of a common data model	Consistent source of project data for process engineers and estimators
2	Interconnected design tools	Specialized tools for each discipline, with a shared, consistent underlying data model
3	Shared information asset	Updates automatically shared with entire team
4	Process redesign with a focus on collaboration	Early, cross-discipline sharing and coordination for the best outcome

Safety system engineering. Engineers developing the plant's flare and blowdown systems have the right guidance, so they can precisely size their systems. This helps ensure safety while also minimizing the tendency to over-design, which can significantly lower CAPEX costs for the owner. For example, a North American EPC firm[4] more efficiently conducts safety studies (including pressure safety valve sizing; flare system design and rating; and dynamic analysis for startup, shutdown, emergencies and compressor surge), all while using simulation data from its integrated process design tools.

Getting started. Based on direct experience with hundreds of EPC firms, the author's company has developed maturity models to help chart a path for productivity-driven process changes for plant engineering and design (**TABLE 1**). The first step is to implement a common, consistent data model for process engineers and estimators. The second step is to provide an integrated engineering environment where each team member has discipline-specific tools that are connected to the single, consistent project data model. Finally, work processes can be designed to bring the parties together for early collaboration around a shared information asset, thus helping to ensure that changes by one are seen by all.

The importance of people. No lasting improvements come without buy-in from the stakeholders. At a joint EPC-owner/operator seminar on digital transformation in Paris in June, the head of onshore-offshore engineering for an Italian contracting company[5] stressed the need to keep people at the forefront during these times of change. Describing critical success factors on a recent digital initiative, he stated that a people-first approach was critical to their success and counseled others undertaking similar initiatives to ensure buy-in from top management, invest in human capital and development, and drive a culture of innovation and technology adoption.

This is echoed by the previously mentioned senior vice president of engineering during a process-reengineering project on the heels of a recent merger. He said they began their initiative with local workshops at each office (including stakeholders from executives to users) to provide details about the project and to get their input early—a solid investment when you know you will be asking some of them to change the way they have done things for decades.

Takeaway. Initiatives underway at many EPC firms to improve how they organize and execute project work are fundamentally reshaping the industry. These firms view the ability to coordinate work across functions, offices and geographies as a prerequisite for competing as the industry recovers. The net beneficiaries are the owner-operator companies, which will realize better designs and more profitable operations.

The success of these initiatives will not only depend on supporting technology for concurrent engineering, collaboration and data management, but, most importantly, on the people involved. In a recent *Forbes* article[6] on digital transformation, a senior vice president for the author's company summed up this notion perfectly. He stated, "We know from decades of experience in operational excellence that culture is king when it comes to transforming organizations. That is why we say that success is only achieved when capability and culture come together." HP

NOTES

[1] AspenTech's Concurrent Process Engineering survey, February 2018.
[2] Vista Projects
[3] SK Engineering and Construction
[4] Linde Engineering North America
[5] Saipem
[6] Venables, M., "Are people the biggest challenge in digital transformations?" *Forbes,* September 2018.

PAUL DONNELLY is the Industry Marketing Director for Engineering and Construction at AspenTech. Mr. Donnelly has more than 25 yr of experience in engineering, construction and supply chain management positions with global business responsibilities. He earned an undergraduate degree in geology and has an MBA from the University of Massachusetts.
paul.donnelly@aspentech.com