

Book Review: Schedule for Sale: Workface Planning for Construction Projects by Geoff Ryan

Glenn Ballard¹ and James Choo²

Schedule for Sale: Workface Planning for Construction Projects, was published in 2009 by Geoff Ryan³. The idea behind the title is that productivity can be improved through better management, and that poor productivity causes projects to have longer durations. The book proposes a method of production planning and control designed specifically for megaprojects in the process industries.

According to the book's preface, the method of workface planning was developed by Ryan with Lloyd Rankin, who intends to publish a companion piece *You Can Have It All*, which is to provide instruction how to do workface planning, while Ryan's book provides the concept, the 'what' versus the 'how'.

"Work must be achievable before it is released to installers." (p. 57) This is the main principle behind the design and execution of Workface Planning. The goal is to increase labor utilization, which Ryan equates with labor productivity. Framed in terms of Taiichi Ohno's seven types of waste⁴, Workface Planning tries to eliminate the waste of workers waiting on work, but does so by increasing the waste of work waiting on workers. For example, on page 5, it is stated that the size of FIWPs (elemental work packages) is based on foremen estimates of best results, plus 10% so "you don't run out of work". Despite the book's title, schedule is systematically sacrificed to labor utilization through the creation of buffers of inventory and time larger than needed to absorb variation in flows and larger than needed to force continuous improvement.

What's more, opportunities for productivity improvement that go beyond labor utilization are not pursued. But before expanding the critique of Workface Planning, we describe it in the following section.

The Method of Workface Planning

Key to workface planning is the work breakdown structure, which divides the construction phase of the project into:

¹ Research Director, Project Production Systems Laboratory. ballard@ce.berkeley.edu or (415) 710-5531

² Senior Consultant, Strategic Project Solutions, PO Box 2835, San Francisco, CA, 94126-2835, (415) 362-3200, jchoo@strategicprojectsolutions.com

³ Ryan, Geoff. *Schedule for Sale: Workface Planning for Construction Projects*. AuthorHouse, Bloomington, IN, 11/23/2009.

⁴ Taiichi Ohno, *Toyota Production System*, Productivity Press, Portland, OR, 1988.

- Construction Work Areas: “geographical cubes of work”, each <100,000 labor hours (LH), multi-trade⁵, with no one trade having >40,000 labor hours
 - Construction Work Packages: <40,000 LH, single-trade, each coincident with a single Engineering Work Package
 - Trade 1
 - Trade 2
 - Trade n
 - Field Installation Work Packages: <1,000 LH (approximately one week’s work for a crew)

The sequence of Construction Work Areas is shown in a Level 2 schedule⁶. The units in Level 3 schedules are Engineering/Construction Work Packages for each discipline and trade. Level 4 is not used in the work breakdown structure or scheduling hierarchy. Level 5 schedules consist of Field Installation Work Packages.

Field Installation Work Packages (FIWPs) consist of documents that include (p. 10):

- A cover page that shows a 3D picture of the scope, a one line definition of the scope, the FIWP number, and the Planned Value of the work hours
- A table of contents
- A constraint page that shows the status of each constraint.
- A scope of work matched in level of detail to the experience level of the workforce.
- Safety planning
- Quality planning
- Trade coordination—includes risks and mitigation strategies from Workface Planner to Foreman
- Material confirmation—including a complete Bill of Materials, a copy of confirmation from the Workface Planning Material Coordinator that the materials have been hard allocated against the FIWP (meaning no one else can access them)
- Scaffold confirmation
- Construction Equipment confirmation
- Timesheets and cost codes
- Drawings and model shots

Each FIWP is assumed to have the following constraints and to have met the corresponding requirements (p. 11):

- Construction Work Package—must be issued for construction (IFC)
- Sequence—The work must be aligned with the Path of Construction; i.e., in accordance with the Level 3 Schedule
- Engineering Data—Drawings must be issued and available
- Prerequisite Work—must be complete
- Materials—every component must be identified and confirmed onsite
- Scaffold—must be identified, ordered and built for purpose at least 1 week earlier

⁵ Except for conduit, cable tray, and underground utilities, which are dealt with in a total project package.

⁶ The 2nd level of breakdown in the work breakdown structure; in this case, just below “Construction Project”.

- Construction Equipment—must be identified and confirmed fit for purpose
- Tools—there must be clear access to a reliable supply of the right tools
- Resources—Qualified trades people must be available with all of the appropriate site training requirements
- Quality documentation—how the inspection and test plan will be applied to the FIWP scope of work
- Safety Planning—There must be a program that will support the Foreman's safe application of the work
- Access to the work face—The permits required and congestion from other activities/trades must have been identified

Workface planners, 1 per 50 craftworkers, are responsible for assembling work packages, and get their information from people responsible for specific constraints: materials, construction equipment, scaffolding, and so on.

3D models are centrally positioned as the primary database.

Batch Sizes, Lead Times and other Rules

Readers accustomed to the world of Just-in-Time will note the large batch sizes specified in Workface Planning. All things else being equal, project duration increases with batch size.

- Batch sizes:
 - Engineering issues drawings in discipline-specific Engineering Work Packages for approximately 40,000 installation labor hours, or 40 crew-weeks.
 - Construction progresses through counting the hours earned in completed Field Installation Work Packages sized to require approximately 1,000 installation labor hours, equal to approximately one week's work for a crew.
 - Transfer batches between trades-The size of these transfer batches dictates the degree of concurrency or overlap between the work of successive trades. If piping must have completed an entire Construction Work Package before that CWP is released to instrumentation, then the CWP is the transfer batch.⁷
- Lead Times:
 - Scaffolds must be constructed, ready for use, at least 1 week ahead of scheduled start
 - Materials are to be delivered to the point of installation (or agreed staging area for the responsible crew) at least two days prior to scheduled installation
 - All materials must be allocable to the FIWP 4 weeks prior to its scheduled start
- Triggers:
 - Workface Planners dissect CWPs into FIWPs once the EWP (the engineering work package corresponding to the construction work package) is released to fabrication

⁷ Rules regarding the number of crews per CWP are not provided in the book, but for illustration purposes, two crews per CWP means the batch would be transferred in 5 calendar weeks; 4 crews per CWP—2.5 calendar weeks.

- FIWPs are entered into the 4 week lookahead once all material constraints have been satisfied⁸

A Blast from the Past

Workforce Planning looks very familiar to us. It has some lean elements, specifically the principle to deliver materials, information, and tools to the point of installation; the idea behind work packaging. But what makes it so familiar, so much a blast from the past, is its focus on productivity improvement and on local optimization; i.e., improving the productivity of each crew and assuming that doing so optimizes project cost and time.

Work Packaging

Work Packaging is hardly a new idea.

- DuPont's farm wagons—⁹ heard about these when I started working as a pipefitter's helper for Brown & Root in the middle 1970s. I don't know when the practice was used, but DuPont was famous for having loaded farm wagons with all the piping materials and drawings needed to erect a piping isometric. When a fitter-welder-helper crew completed installation of an isometric piping drawing, they returned the wagon to the materials yard and got another one, all cued up and ready to go. This was work packaging defined by the unit of installation, which typically could be done in one or a few days. The amount of time to install the work package did not define the work package. The drawing did.
- STNP - Work packaging was done on the South Texas Nuclear Plant when I⁹ worked there for Bechtel as an internal management consultant in 1984. These work packages were folders filled with documents, like the packages described in *Schedule for Sale*. The quality of the piping work packages was discovered to be very poor; a consequence of the responsible managers' push for production and neglect of quality. As with DuPont's farm wagons, work packages were defined in terms of drawings to be installed, not by an amount of labor hours to be expended and earned.
- Zachry - In the late 1990s, Zachry joined the Lean Construction Institute. At that time, they were using work packages sized to what a crew could install in a week. Presumably this influenced the decision in *Workforce Planning* to do the same. Zachry's motivation was primarily to improve progress accounting and to stop attempts to game the system. No credit was given for work packages until they had completely passed QC inspection. This eliminated the problem of overreporting progress and removed an incentive to do work out of sequence; e.g., to erect pipe spools using temporary hangers in order to claim credit for erection, despite having to return later to install the permanent hangers at the cost of more labor hours.

⁸ What counts as 'satisfying material requirements' is ambiguous, but if that means materials are on site, then all materials for the FIWPs to be installed in the next four weeks, plus all materials to be installed in some number of weeks after that date, depending on the rate of FIWP installation, must already be on site. This is clearly not a rule consistent with the principle to do work, make decisions, deliver materials and information at the last responsible moment, the intent of which is to reduce the waste of work waiting on workers and to use all available time and resources to generate better work products.

⁹ First author

There is more to the history of work packaging than we know, but it is interesting to speculate that Zachry's innovation was adopted in the industry not for its original reason, but because it was more convenient for project management to batch work by quantity of labor hours than by the unit of installation. This also was consistent with traditional project management's lack of attention to detailed work planning of operations, which has always been left to the craft.

Like the productivity improvement programs from the 1970s-early 80s, the goal of Workforce Planning is to improve craft utilization. The motivational assumption seems to be the same as in the 80s; namely, to take away excuses from foreman and crew, and hence increase the pressure to perform to productivity targets. Local optimization is the strategy, bolstered by big buffers between specialists (disciplines and trades) that allow them to operate as if independent.

Same/Different from Last Planner^{®10} and Lean?

From the book, we see Workforce Planning to be partially consistent, completely consistent, or inconsistent with these lean principles:

1. Partial: *Plan in greater detail as you get closer to doing the work.* Work is broken down into smaller components, but the level of detail does not include the design of operations¹¹, required in Last Planner[®]; and operations are not what are assigned in the Workforce Planning system, also required in Last Planner[®]. The planning system never moves from what is to be constructed to how. The unit of assignment is the Field Installation Work Package, which includes all the operations to be performed within the specified part of the process plant. The sequence and design of operations is 'below' the formal planning and control system of the project, just as in traditional construction project management.

Since the FIWP's contain 500 to 1000 hours of work for a single trade, which amounts to 1-2 weeks worth of work, all sub-week or sub-day coordination is left to traditional means, e.g., radios (page 3). Unless all the FIWP's are fully coordinated and executed with 100% reliability, this would leave the re-coordination and negotiation of the day-to-day shared resources, such as cranes and lifts, to be done informally. The FIWP's solution of the shared equipment variability built into the plan is to add a 30% capacity buffer (page 81) to absorb the variation rather than reduce planning batch size.

2. Partial: *Produce plans collaboratively with those who will do the work.* Workforce Planners are encouraged, though not required, to sequence FIWPs with craft supervisors. The book also states that the industry is migrating toward a solution where a detailed planning function is moved closer to the

¹⁰ Last Planner[®] is a registered trademark of the Lean Construction Institute. The trademark imposes no restrictions of the term or associated methods unless used in trade, as opposed to used to manage your own projects.

¹¹ Projects are composed of phases, phases of processes, processes of operations, and operations of steps. Steps are assigned to individuals or small teams within the work group responsible for executing the operation (Ballard, "Last Planner Update". Int'l. Group for Lean Construction, Virginia Tech, 2003; available at www.iglc.net).

work face by developing planners who understand the work. Definition of FIWPs and the work breakdown structure above them is done by higher level supervisors and does not involve the crafts. As noted above, the sequencing and design of operations is not addressed in Workface Planning.

3. Consistent: *Reveal and remove constraints on planned tasks as a team.* In Last Planner®, the front line supervisors are responsible for removing constraints within their control; e.g., labor, special tools, construction equipment, safety, quality control. In Workface Planning, responsibility for removing constraints lies with the various support groups such as materials management, safety, and QC. This may reflect the fact that construction is done direct hire on process industries megaprojects, as opposed to being subcontracted, or the subcontractors function only as labor brokers. In these cases, the management functions that would be performed by full-fledged subcontractors are performed by personnel from the project manager.
4. Inconsistent: *Make and secure reliable promises.* In Last Planner®, those who are directly responsible for production, the foremen, request and make promises one to another regarding the release of work and removal of constraints. This occurs first in scheduling, at least at the level of construction phases, and sometimes at the master schedule level as well. Each phase of the project is to be planned and scheduled collaboratively with supervisors from the trades that are involved in each phase: site preparation, foundations, equipment setting, structural steel, piping, etc. Ultimately, daily and weekly works plans are coordinated through the exchange of promises between front line supervisors of the various trades.
5. Unclear: *Learn from breakdowns.* Learning is certainly encouraged in the book, but there is no explicit process requirement and no methods are provided.
[These first five are the principles of the Last Planner® system of production planning and control¹². The remaining are principles for process design developed by Ballard in 2009 for the California Prison Receivership Project, unpublished; available upon request]
6. Inconsistent: *Select critical, new and repetitive operations as starting points for rethinking work structure—how work is divided into pieces, who does what work, in what contractual relationships.*

As previously noted, Workface Planning does not address construction or engineering operations.

7. Inconsistent: *Use virtual and physical prototypes to design operations in preconstruction. Use first run studies (or only the crew planning part of first run studies for non-repetitive operations) to do detailed design of*

¹² Ballard, Nickerson & Hammond, "Production Control Principles", Int'l. Group for Lean Construction, 2009; available at www.iglc.net.

operations during construction. See #6 above.

8. Partial: *Develop a site production management system to reduce demand variability, and to pull from logistics. Extend the window of reliability so more product types can be pulled to installation. Screening work packages for constraints prior to committing to execute them should reduce variation between the site's expressed and actual need for information, materials and resources.*

However the use of pull mechanisms is not addressed in Workface Planning, although in fairness, the requirement that constraints be removed before FIWPs can proceed to execution is an application of pull.

9. Inconsistent: *Send pull signals for made-to-order (fabricated) products as far upstream as possible; e.g., detail reinforced concrete structures 'just-in-time' for scheduled installation.*

As stated above, pull mechanisms are not part of Workface Planning. Neither are 'just-in-time' deliveries.

10. Possibly consistent: *Deliver today what is to be installed tomorrow.* The intent of this principle is to deliver to the point of installation today what is to be installed tomorrow. This specifies the timing target for just-in-time deliveries.

The book requires materials to be delivered to the point of installation, or perhaps to an agreed staging area, two days before installation. Perhaps the intent of the two day lead time is the same as for my one day lead time; namely, to develop confidence in the installers that materials will be available when ready to install, after which lead times can be further reduced until we discover variation that must be eliminated in order to continue reducing lead times.

11. Consistent: *Have installers first touch materials when installing them; provide materials at the point of use.*
12. Inconsistent: *Optimize the amount of material based on the demand, lead-time, replenishment cycle, supply reliability and consumption rate.*
 - Maintain small inventories of made-to-stock materials (small, high volume, consumables) on site and replenish through vendor managed inventory (VMI) or frequent milk runs from inventories held at logistics centers or from supplier depots.
 - Maintain small inventories of made-to-stock materials (large, inexpensive) off site, and kit into work packages for JIT delivery.
 - Deliver fabricated products JIT.
13. Unclear: *Manage all deliveries to site: specify time windows and offloading areas; preassign labor and equipment.*

The book does not specify how site deliveries are managed.

The terminology “removing constraints” could have been taken from Last Planner® and may suggest to the unwary a similar mindset, but what’s really going on is the much older effort to reduce delays. That’s part of Last Planner®, also, but subordinate to the goal of improving work flow reliability. The importance of work flow reliability may not be so evident in large, horizontal projects where sequential dependency between volumes is less than in multi-storey buildings. In addition, the need for reliable release of work from trade to trade is seemingly reduced by placing buffers between them sufficiently large to conceal variation.

Delivering work packages directly to installers is a part of lean logistics, but other principles of a lean logistics system appear to be absent from Workface Planning; e.g., minimizing the amount of materials on site, just-in-time deliveries, replenishing inventories using pull mechanisms.

The goal looks to be compliance from the trades rather than collaboration and commitment, although there is some mention of collaborative definition and sequencing of FIWPs.

Focus of optimization is on individual trades rather than on work flow reliability between trades. There is little focus on inter-craft coordination. Large transfer batches between trades make it reasonable to focus attention on how to most efficiently produce the transfer batches, prior to release to the following trade. If transfer batches were shrunk, that would increase concurrency and accelerate schedule—if the batches were properly defined and released reliably. It would also create a need for reducing variation between planned and actual task durations.

Workface Planning’s work breakdown structure is a form of location breakdown structure, which sequences trades through locations so each can do their work unimpeded by other trades. The size of locations dictates the speed of project execution. Suppose a Construction Work Area was a crude vacuum unit. Every trade must do its work in the crude vacuum unit before it is complete. Suppose it takes each trade four weeks to do its crude vacuum unit work and there are four trades. The cycle time for the crude vacuum unit is 16 weeks (48 ten hour days). Now suppose the crude vacuum unit is divided into items of process equipment and the associated controls, power, and piping, and that there are 8 such subdivisions, each taking each trade 2 days to complete—a simplification for purposes of illustration. The cycle time for the crude unit would shrink from 48 to 20 days. Crafts are still working alone in each location and craft productivity remains the same, but the locations are subdivided to increase pace of completion. This strategy places a higher premium on coordination and active collaboration at the craft level.

In addition, Workface Planning methodology does not seem to focus on optimizing the project delivery system for “time-to-market” which is more often than not, one of the most critical success factors for a typical process-based project. The mandate of building of large inventory buffers (e.g., four weeks of material inventory) and time buffers (e.g., scaffolding done one week in advance) would force the supplier to start producing and delivering sooner. This in turn would put pressure on engineering and all front-end phase to start sooner. Since there is a limitation on how early we can get started, time-to-market date would have to be delayed.

Concluding Reflections

Upon completing the book, the reader will likely have unanswered questions, some of which include:"

- Is there data on variation and batch sizing, results, breakdowns, impact on supervisory time, on spacing between trades?
 - Why are the batch sizes and lead times so big? Is the variation in workflow that great, and if so, why not attack the causes of workflow variation rather than increase the time and cost of projects to mask them?
 - A CWA is limited to 100,000 labor hours, composed of craft CWPs limited to 40,000 labor hours. Presumably you imposed this quantitative requirement in an attempt to keep workload relatively even for each craft from one work package to the next. How well has that worked out? How do crafts handle unevenness?
 - Are there any published case studies on Workface Planning? What results have been achieved?
 - Is there any data on learning from breakdowns in Workface Planning?
 - According to the book, there is an anticipated time release for general foremen and superintendents. What do general foremen and superintendents do with this time? Any data on supervisory time released by WFP?
 - Big process plants tend to have less sequential dependence between their parts horizontally; i.e., across different areas of the plant, at the same time. However, the vertical sequencing still tends to hold: site prep., underground utilities/foundations, steel and equipment, piping. Within limits, every 'area' of a plant could be built at the same time, in parallel with one another. This is quite unlike constructing buildings or bridges, though similar in key ways to linear projects such as pipelines and highways, on which all parts could be done simultaneously if there were sufficient resources. The number of areas done concurrently and the spacing between trades in each area determines the pace of project completion. Is there data on the optimum spacing and on the variation that limits the optimum?
- If the start of the Workface Planning approach began with Last Planner®, why did personal commitments and first run studies not make it to the approach?
- Does everything really have to be printed and physically signed when there is a constant mention of the technology being ready? What about tablet pc's?

It looks like the mentality is the old productivity improvement idea to increase time on tools by removing excuses. This local optimization strategy cannot be implemented without large buffers between sequentially dependent tasks. Productivity improvement comes at the price of projects longer than they need to be. That may not be immediately apparent because historical performance is so poor. Speeding the completion of work chunks may beat historical norms, but you're still leaving money (time) on the table

Production planning and control has two objectives: increase productivity and increase the rate of project completion. This can only be done by increasing work flow reliability¹³ because capacity utilization is determined for a given rate of project progress by the level of work flow reliability; measured, for example, by Last Planner®'s percent plan complete. But increasing work flow reliability by increasing batch sizes slows the pace of project progress. Work flow must be made more reliable not by piling stuff up but by making processes and systems better able to deliver just-in-time. So, it's predictable from fundamental principles of production management that Workforce Planning's goal to reduce project durations by increasing labor utilization will have only limited, if any, success.

Turning now to Workforce Planning's productivity improvement objective: Labor productivity is the product of two primary factors: 1) The percentage of paid labor time spent processing work product, and 2) the output rate of product per unit of productive time. The former, labor utilization, is itself a function of voluntary and involuntary delays (interruptions to work processing), hence the focus in Workforce Planning on removing constraints that either interrupt or slow the pace of work. Labor fruitfulness, the output rate per unit of productive time, is rather a function of design constructability, work methods design, skill levels, and technology. No consideration is given to improving these variables in Workforce Planning—at least not in the book. However, the design of construction (and engineering) operations has been a part of Last Planner® since its creation¹⁴. Better work flow reliability makes it worthwhile to invest in detailed planning of construction operations. If the work available for a work group (design squad or construction crew) one, two, or four work days from now is uncertain, it is the rare construction supervisor willing to spend time doing detailed planning. The strategy is rather to try to be prepared for whatever work happens to become available. Making work ready, free of constraints, should improve the percentage of planned tasks completed¹⁵, but Workforce Planning ignores the output rate per unit of productive time, and concentrates only on increasing labor utilization, the percentage of paid labor time spent productively. In other words, the opportunity to improve processing is ignored.

¹³ For the argument from queuing theory that shows how reduction in variation (e.g., increasing PPC from 50% to 70%) yields an increase in labor utilization and/or an increase in the pace of processing, depending on how the released capacity is invested, see Howell, Ballard & Hall's "Capacity Utilization and Wait Time", from the Int'l. Group for Lean Construction's 9th annual conference, in Singapore, 2009; available at www.iglc.net.

¹⁴ See the four papers by Gregory Howell and Glenn Ballard on Last Planner® in the 2nd annual conference of the Int'l. Group for Lean Construction, held in Santiago, Chile in 1994; available at www.iglc.net.

¹⁵ The Last Planner® System proposes four quality criteria for assignments: definition, soundness, sequence and size. Workforce Planning specifies soundness and sequence at the level of FIWPs, but none at the level of operations.