NWS EXHIBIT G

The Case for Paradigm Shift

An assessment of project delivery risk against the backdrop of industry practice.

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Definitions

A/E Firm – Architectural-Engineering firm; Typically structured to provide only facility and process designs for construction. Also often referred to as the *Design Authority*.

Construction Engineering – a professional discipline dealing with design, planning, construction, and management of infrastructure (utilities, buildings, highways, airports, etc.); skill sets include both engineering design and construction management abilities.

Design-Build Contract – a contract between the project Owner and Design Authority whose responsibility includes both facility/process engineering design *and* construction services. A Design-Build contract will often result in the Design Authority taking Construction Management responsibility while hiring a pure Construction/General Contracting firm to execute the "Build" portion of the contract while retaining overall control and fiscal responsibility for the project.

Design-for-Construction – is a synonym for comprehensive engineering-level site, process, and facility design; this is in contrast to Component Design, Product Engineering, or Equipment Design. One hallmark of this type of design in the US is that that most, if not all, construction drawings are sealed by a licensed architect or professional engineer.

EPC Contract – Engineer, Procure & Construct; refers to a turnkey performance contract whose scope includes the entire range of engineering design, commodity and equipment acquisition, facility erection, equipment installation, startup training and turnover activities.

EPCM Contract – Engineer, Procure & Construction Management; A performance contract similar to the EPC whose scope retains the *control* associated with Construction Management but subcontracts the Construction elements.

FOAK – Fist Of A Kind

Introduction

An Outside Perspective

When I joined Westinghouse in 2009, I was inspired to be joining Nuclear Power Plants as part of the latest 'nuclear renaissance.' I wasn't entirely sure what to expect, but I was expecting that the NPP organization possessed more experience in design, construction, and project delivery. What I found was an organization experiencing growing pains. No problem. I was looking for opportunity and challenge. However if the reality of a fine-tuned Design-Build firm doesn't yet exist, then maybe here is the opportunity to create it. This paper presents an recent outsider perspective and assessment of risk factors affecting NPP against the backdrop of industry practice. The intent is to understand the root causes of current project delivery risk; compare them to industry practice; and consider organizational alternatives to achieve project delivery success.

Assumptions

One of this paper's basic assumptions is that the NPP organization has effectually undertaken a Design-Build effort on behalf of our China and Domestic AP1000 customers. The contractual details of those efforts are not available to me, but observation and experience indicate these contracts bear the hallmark performance requirements of a Design-Build effort.

Another basic assumption is that an organizational structure more closely resembling that of a Design-Build organization would give current and future Westinghouse Project Delivery contracts a better chance for success.

The final assumption is that NPP wants be a Project Delivery organization and thus control the construction process as part of an overall Standard Plant Delivery strategy. This final assumption provides the ultimate thesis for this paper: *A paradigm shift from product organization to project organization is needed in order to achieve the goal of creating a Project Delivery organization that can successfully deliver AP1000 and similar construction-based programs.* All of the discussions presented in this paper tend to circle back to these basic assumptions and support the case for a construction-oriented Project Delivery organization.

A Project at Risk?

There is a general feeling that the AP1000 projects are at risk. Understanding that risk is an essential first step to mitigating it. By decomposing several fundamental issues (and asking "*So What?* and *Now What?")*, perhaps some lessons can be learned and success options uncovered. The risk issues I chose to focus on are

- Design Completion
- Industry Standardization
- Organizational Paradigm

There are certainly other interrelated risk factors, but I believe this risk group can trace their roots back to organizational experience, structure, and culture rather than any particular individual or design failure. Thus they may support the case for paradigm shift and subsequent organizational change.

Design Risk

The **AP1000 Design** is not complete, although it is currently under construction. This virtually assures large numbers of changes will occur to both systems and structures. *So what?* The **DCP Process** is inefficient for typical facility design efforts because it does not provide the quick issue resolution needed to support Design-for-Construction. Design-for-Construction in A/E firms often proceeds at a blistering pace – even where drawings are sealed prior to issue, the design process is evolutionary, integrated and *fast*.

The DCP process appears to have been originally intended to control equipment and product configuration and was co-opted to support Facility Design. Its flaw may be that FOAK Design combined with the Fleet Design paradigm implies a One Time Only /Get It Right the First Time design approach which is necessarily either an iterative process, or an extended design process. NPP appears to have inadvertently engaged in an extended design timeline. *Now what?* This is a tough call. The DCP process needs be retained for AP1000, but as future DCDs are developed for other programs like SMR, less design detail should be issued with those DCDs, allowing room for design flexibility that can reduce design and construction costs. Well-documented Design Reviews that are part of an *Integrated Design* process could be used to meet licensing needs. (Integrated Design is discussed later.)

Issuing an incomplete design CFC to the field virtually assures a lot of **Construction Change Order Requests (CRX)** which are likely to result in Delay Claims and Liquidated Damages (LDs). *So what?*

Anecdotally, power generation facilities fix their liquidated damages at $1M/day. Nearly any post-construction design changes are likely to be linked to schedule and result in delay claims which will be difficult to defend. Assuming one of every ten DCPs result in a schedule delay of at least one day, the total cost of DCPs could be as much as $300M in delay claims (3000 DCPs x 1/10 x 1day delay per DCP x $1M/day) Plus the actual design and construction cost of the Change Order (CO). *Now what?* NPP has organized a Claims Management group to identify claims risk and develop strategies to mitigate and defend against that risk. At this stage of the AP1000 programs, NPP should evaluate E&DCRs and DCPs for their potential to generate claims and seek ways to redirect any of that potential liability to other parties including the NRC.

Industry Standardization

Construction Packages

In general, the AP1000 **Construction Packages** differ from typical construction industry standard packages. The division of responsibility (DOR) in our contracts implies a product- or system-based approach versus traditional construction contracts which use a performance-based contracting approach. The typical performance-based contract provides **Engineering-Level** design information (along with **Standard Details**) to the Constructor along with a **Master Specification** list and redirects the liability for meeting those design requirements from the Design Authority to the Constructor. The DOR approach potentially blurs the lines of responsibility for various contact requirements between the Design Authority (WEC) and the Constructor (Shaw) resulting in claims on both sides. Figure 1 illustrates the typical content of a Construction Package or what are often referred to in the industry as the "**Contract Documents**."

The **Front End** documents typically include a copy of the agreement, project scope, general conditions, special conditions, project manual, bid instructions, etc. The AP1000 Front end documents were not reviewed in detail for this paper, but the cost risks associated with potential DOR errors, omissions, and uncertainty regarding agreement on Scope and Responsibility can be significant. *So what?* There is a direct correlation between Contractual Responsibility and Cost Liability and these form the basis for claims litigation.

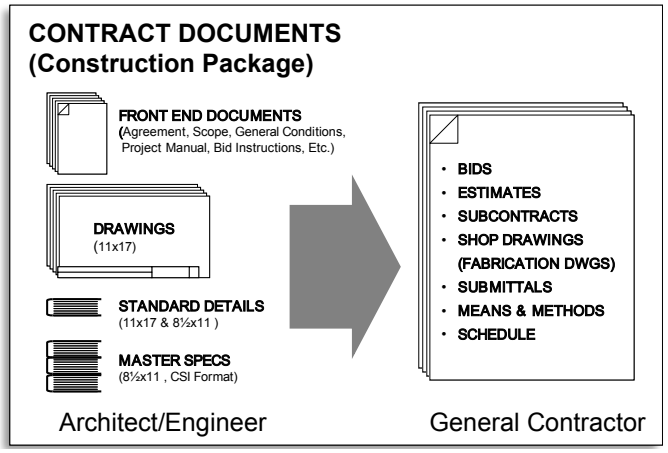

Figure 1. Integrated Project Delivery

Construction Drawings

The AP1000 **Construction Drawings** are organized and executed in a product- or system-oriented fashion (much like the DOR). From the Design-Build perspective, construction drawings (sometimes referred to as 'Engineering-level drawings' or simply 'Engineering drawings') typically provide only sufficient detail for the facility to be constructed in a manner that meets the intended performance or design criteria. The AP1000 design generally provides far more documents than the typical A/E design. This is primarily because the level of detail is greater than typically needed for construction. The drawings contain many Fabrication-level or Shop-level Drawings whose scope, detail (and liability) normally belongs to the Constructor. The **Quantity** and **Detail** of AP1000 construction drawings has prolonged the design schedule, and will likely result in more fabrication questions than might normally result from Engineering-level design drawings. It has also resulted in drawings being issued with *Open Items* and *Holds* which can be used by the constructor to justify delay claims. (I have personally never seen either *Open Items* or *Holds* in a construction package before joining WEC.)

The **Format** of the AP1000 design drawing could be improved to support project delivery goals: drawing numbering could be simplified, ANSI B drawing sizes are more readable and portable than ANSI E (especially when reduced to 11x17), and CAD Standards could be, well, standardized. (Multiple design agents employed by WEC have contributed to this lack of standardization.) While seemingly minor, these changes, in aggregate, greatly improve the bid-ability of the package and the clarity of design intent,

thus resulting in lower construction bid costs, construction costs and fewer RFIs.

Standard Details

The Construction Packages contain design drawings which utilize what are called 'standard details,' but they have not been collected in a ready-to-reference **Standard Detail Library**. For illustrative purposes, consider a standard AP1000 HVAC duct support detail whose design is common for many sizes. Most A/E firms will collect their standard details, number them, place them into either 11x17 or 8½x11 binders, and include that reference number on the HVAC layout drawings. The numbered details drawings might include a 'pick table' that covers all referenced duct sizes. In this way, one standard support detail can replace dozens of support drawings. Reducing the number of support details reduces the overall number of construction package drawings, simplifies the Constructor's bid process, and should reduce construction bids and bid review costs. *Now what?* There is not much that can be done for the AP1000 program, but this knowledge can be used to improve other designs like the Small Modular Reactor (SMR) program.

Master Spec

Similarly, the AP1000 construction documents do not currently include a **Master Spec** (also referred to as a Master Construction Specification). The Master Spec typically consists of a complete, bound package of all the specifications needed to procure, construct, store, maintain, prepare, or install all the equipment and commodities necessary to construct the facility. The specifications follow the Construction Specifications Institute (CSI) Format model which has been the accepted standard for the US design and construction industry since 1948.

The AP1000 design specifications that currently exist do not conform to these standards making it difficult for our construction partners and their procurement organizations to identify and supply the correct material. Part of the confusion appears to be related to WEC document naming conventions which do not appear to distinguish between **Design Specifications** and **Construction Specifications**. This is an issue because in A/E space, the Design Specs are typically referred to as Design *Criteria* and are intended to provide direction to the Engineer on the performance requirements of the part, product, system or structure, but are rarely provided as a contract deliverable to the Owner, and never included in the Bid/Construction Package. Construction Specs, however, provide information to the Constructor regarding what specific material and equipment to procure and how to store, assemble, fabricate, or construct; The Constructor is not concerned with Design Criteria since he is responsible for Construction, not Design.

As an illustration, WEC has 1,890 documents in EDMS that contain the words *specification*, *spec*, and *specs* in their title. Of that number, WEC has identified approximately 500 specs that apply to the design. *So what?* By incorporating industry accepted specification format and numbering standards into our drawings and construction packages WEC could receive significant flow-down cost savings associated with 1) Improved design clarity: drawings which reference specifications do not have to be changed when the spec changes (currently many design drawings include material and construction notes that are typically included in a material or construction spec); and 2) Improved bid package clarity tends to streamline the procurement process and result in lower bids and fewer Requests for Information (RFIs) from the field;

Now what? As a nascent Design/Build entity, NPP should consider adopting industry-accepted construction and design standards and processes which are proven to contribute to lower and more accurate design, bid, and construction costs. There may still be time to develop good AP1000 specs for Domestic programs and future programs could benefit. Adopting the CSI Master Format (or at least its industry-accepted numbering convention) is one step toward this goal. Typically, the project engineers (functional groups) are responsible for developing the construction specifications. This is often accomplished with the assistance of vendor-supplied documentation and compiled with the assistance of the a document production staff. However, there are companies that specialize in writing specifications that can be subcontracted to help develop or convert specs to CSI format.

Sealing Drawings

One hallmark of Design-for-Construction in the US is that most, if not all, construction drawings are sealed by a professional engineer. The A/E, Design-Build and EPC community typically utilize projectized management methods combined with licensed professional engineering involvement in the management of design efforts to ensure that virtually all of their work is sealed with a professional

engineering stamp. This method achieves several goals: it drives Design projects to scheduled completion; it ensures a peer-reviewed, constructible product; and provides a baseline for configuration management activities.

The Professional Engineer (PE) seal represents a personal and professional guarantee that a design has been produced by a recognized and licensed engineering expert (and often implies that it has been vetted by peers and experts in the field via the Design Review process). It also represents an acknowledgement by the Engineer of Record that he/she is willing to certify the safety and reliability of the design. It has been rumored that the AP1000 design may not seek or require a professional engineer's seal based on the Supremacy Clause of Article VI of the US Constitution:

> *The Supremacy Clause has been interpreted to come in effect only when the Federal Government has acted in a given field. In the case of Edgar v. Mite Corporation, 457 U.S. 624 (1982), the Supreme Court ruled: "A state statute is void to the extent that it actually conflicts with a valid Federal statute." In effect, this means that a State law will be found to violate the supremacy clause when either of the following two conditions (or both) exist:*
>
> *Compliance with both the Federal and State laws is impossible, or*
>
> *"...state law stands as an obstacle to the accomplishment and execution of the full purposes and objectives of Congress..."*

The ostensible rationale being that if the NRC (a Federal agency) approves the design via the licensing approval process, then Federal design approval supersedes any state design approval requirement. *So what?* The project risk register should include the risk that this approach could result in a legal challenge whose outcome is uncertain. That observation notwithstanding, in light of the recent crisis in Japan and renewed public scrutiny of the nuclear industry, Westinghouse may want to reconsider sealing future design drawings to achieve several objectives:

1. Define Design Completion
2. Initiate (or 'Baseline') the configuration management process
3. Certify conformance with code and safety requirements
4. Identify the responsible engineer-in-charge, and
5. Reinforce public confidence in our designs.

Organizational Paradigm

Growth and Structure

The Westinghouse NPP organizational structure is a natural outgrowth of the Nuclear Services and Nuclear Fuels businesses that have successfully sustained the organization for the past thirty years. Perhaps it should be noted that those organizations owe no small part of their success to the fact that they have serviced and fueled a relatively captive market: Simply put, Westinghouse products require Westinghouse fuel and services. This vertical market integration and capture is what all good product organizations strive for because it makes sales and profit targets significantly easier to achieve.

Not surprisingly, at its inception, NPP appears to have adopted what it perceived as a successful operating model: a highly-matrixed, highly-proceduralized organizational structure which relied heavily on the existing Services and Fuels talent pool for staffing and management. This provided an undeniably talented staff, but one whose talents lay within the bounds of their experience of designing, producing, installing, servicing, and fueling *Products and Equipment.*

It would be unusual if this successful core management group had possessed the architectural-engineering or design-build experience that would have enabled them to envision *all* of the integrated engineering, design, documentation, procurement, contracting, scheduling, construction, and management processes for delivering a turnkey nuclear power generating *Facility Construction Project.*

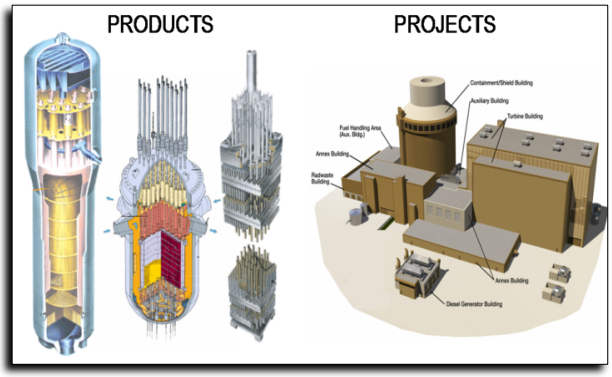

Figure 2. The Product vs. Project Paradigm

The AP1000 design process placed its primary emphasis on Nuclear Island component and system engineering aspect rather than on an integrated design

approach to project delivery that emphasized construction. Thus engineering efforts proceeded in the accepted product-engineering, silo-ed information fashion. The effort would not have met the definition of a typical A/E integrated engineering effort, and schedules were developed and missed because the organization lacked the experience or understanding of the timelines and work products required to support a turnkey Design-for-Construction program.

Design-Build and A/E firms deal primarily in Design-for-Construction programs and the documents required to safely permit, construct, and operate a *facility*. Thus they seal *all* their construction engineering drawings, including spec books and calc notes to ensure that the facility meets all applicable local codes and design standards. Alternatively, the design engineering function at most product-based companies tends to focus on the technical performance of the product and the detail needed to fabricate or manufacture the product (like a n electric motor, cell phone, or child car seat). The product manufacturer then guarantees safe performance of the product so long as it is used within product application guidelines/specifications through the use of certified engineering (ASME-stamp) or third party certification such as CE or UL. Westinghouse NSSS components, systems, and drawings appear to follow this model.

Program Management and Integrated Project Delivery

World-class Project Delivery and Program Management companies like Bechtel, Flour, and URS have refined the practice of Design-for-Construction and Construction Management over the better part of the last century. Other companies like CH2M HILL entered the Design-Build market as recently as twenty years ago for the same reasons Westinghouse apparently did: it is where the profit margins offer the greatest potential reward (and risk!).

Many successful EPC firms evolved from Design firms by either playing 'take-away' from the traditional Constructors, or merging with them to become self-performing EPC firms. Others effected similar change by becoming Design-Build or EPCM firms who retained CM control but subcontracted the *risk* back to the general contractors. They mitigated the risk posed by subcontracting by engaging in rigorous due diligence prior to engaging subs and by executing tightly controlled *performance* contracts.

By choosing to lead a consortium, NPP embarked on a Design-Build Project Delivery effort as a Program Management organization. Whether they knew it or not. Using the PMI definition, a Program Management organization is able to manage multiple interrelated Projects. To succeed Westinghouse NPP must be able to effectively integrate and manage the Pursuit, Contracting, Design, Licensing, Construction, Procurement, Start-Up, Turnover, and Close Out activities associated with delivering that turnkey project. Figure 3 is a simplified illustration of a Program Management organization and its supporting projects.

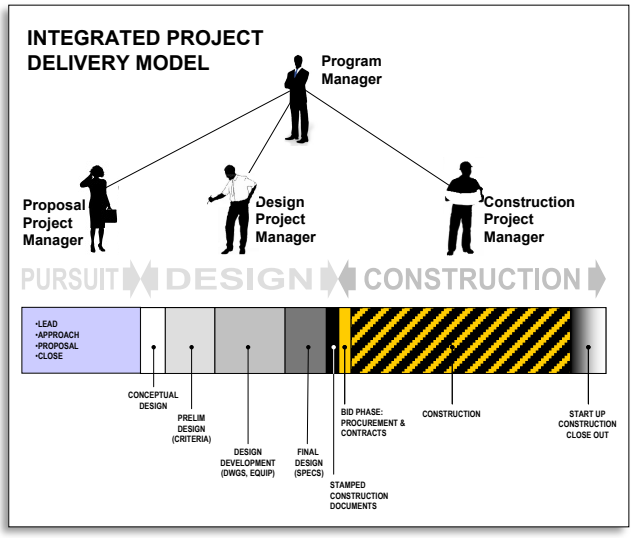

Figure 3. Integrated Project Delivery

So what? Given that AP1000 Final Design is nearly complete (and hopefully won't change much) the Construction, Procurement and Start Up activities represent the bulk of the remaining NPP Program Management and execution effort. Although Shaw currently owns the Construction lead for AP1000, WEC needs to have the capability to replace Shaw at any given moment on domestic and future projects. To do so, WEC must know and understand the Construction scope better than Shaw knows it and be prepared to act on it wherever the next opportunity presents itself. *Now what?*

Construction Program Management

NPP already possesses the nucleus of a Construction Program Management Team: The Construction-Engineering Integration group provides Westinghouse with a seasoned, collaborative, results-oriented 'Go-To' team of Construction Management, Engineering, and Project Delivery professionals with broad

experience across the EPC/EPCM/Design-Build spectrum including

- Engineering Design (for Construction)
- Field Construction Means & Methods
- Estimating and Budgeting
- Construction Management & Documentation
- Integrated Project Scheduling
- Commercial Contracts and Contract Management

This existing organization currently possesses the capability to provide the following resources and services:

- In-depth analysis of Design and Design Changes as they affect construction sequence and impact cost, as well as their potential for resulting in construction claims.
- Independent schedule analysis of construction contractor erection plans and schedules as a means of verifying compliance with, or departure from, contract requirements.
- Act as primary source of construction expertise to interface with foreign and domestic construction partners and thereby communicate WEC construction strategy and schedule.
- Construction estimating expertise to develop baseline cost information that can be used to price EPC/Design-Build/EPCM proposals and confirm bids from others for Procurement, Construction and Professional Services subcontracts.
- Counterbalancing construction expertise to promote, protect, and defend WEC interests during contract discussions and change order negotiations with Owners, Construction Contractors, and Suppliers.

This group is ready to accept a lead role in Project Delivery as NPP transitions from a product- and services-based organization to a Project Delivery and Program Management organization. Westinghouse NPP is not an expert A/E, Design Build, or EPC firm. Yet. But it possesses many of the resources needed to create the framework and create a plan for success in that market.

Summary

From a Constructor's perspective the nuclear construction business is a square peg they have to fit into a round hole. Consider this: there are only two suppliers of nuclear power generation equipment in the United States – Westinghouse and GE; However, the 2009 ENR lists 48 construction firms with revenues over $1B, and 27 design firms with revenues over $500M. While any nuclear construction contract would be a plum, most of these constructors (like Shaw, Bechtel and Fluor) recognize that plum comes with some significant baggage that will eat into their margin – like nuclear certifications for fabrication, construction and safety, for instance. And so they budget for that uncertainty. Therefore, anything WEC can do to become less of a square peg for the Constructors and their suppliers is likely to result in lower Construction bids and thus more attractive WEC proposals.

NPP can begin mitigating Project Delivery risk by acknowledging the existence of an organizational paradigm that presently does not distinguish between Product engineering and delivery methods and Project engineering and delivery methods. This is not to imply that one method is better than another - *both* have applicability within the appropriate organizational setting. But simply recognizing *that there is a difference* clears a psychological hurdle and sets the stage for discussing programs to improve project delivery performance by engaging in initiatives such as

- Updating specs to CSI Format
- Updating Construction Package Standards (CAD, Specs, Format)
- Revising DCP policy and procedure
- Developing Construction Cost Estimates
- Developing Baseline Project Schedules
- Creating Performance Contract Templates

A Paradigm shift from Product Delivery to Project Delivery will require senior executive support and a clear vision of what the organization needs to look like when transformation is complete. There are consulting organizations that have experience facilitating organizational change who can, and should, be enlisted to assist us and identify and implement industry Best Practices. However, the Construction Engineering group offers a foundation to build on.

Depending on sales and market strength for new nuclear products, WEC may want to expand the scope of such change to consider creating a parallel organization: Nuclear Plant Construction (an EPC/EPCM focused group). An even more radical alternative may be to create an entirely new limited liability entity (LLC) that could give NPP some protection from claims. Such an EPCM-style LLC contracting arm might be similar to the Nuclear

Services organization, but with full procurement and contracting authority that could help insulate the parent organization. There are additional ways to contractually limit organizational liability, but the intent here is to raise the option for consideration.

In theory, Paradigm change doesn't seem difficult. However, in practice, there are some factors and guidelines that are worth assessing. Several generally accepted key factors are included below for reference:

Six Key Factors in Organizational Change Management [1]

1. Clarity of Roles

Who should be at the table, planning the change? Are the right people at the table? Who ultimately decides? Who are other key stakeholders? What is the decision-making process?

2. Clarity of Vision

What does success look like? Why is the status quo not acceptable? What is the vision? How will people or society benefit if the change is achieved? How does the vision translate into specific benefits or costs?

3. Strong Champions

Are the leaders of the organization involved? Do those leaders champion the change even when the going gets tough? Are other people with broad influence also championing the change?

4. Sufficient Resources

Is there sufficient time for people to meet and resolve the issues that need to be resolved? Is there enough money to hire consultants to guide and facilitate the process? Once the plan is approved, are there resources with which to implement it?

5. Engagement

Are staff and others who will implement the change engaged in examining options and developing recommendations? Are key outside groups and stakeholders also engaged?

6. Communication

Throughout the process, are people informed about what is going on? Does everyone have a clear idea of the steps in the process and people's decision-making responsibilities? Is the communication proactive – not reactive?

Paradigm shift is worth considering for its potential to refine strategic goals which may result in schedule, process, and cost savings that benefit the entire organization.

Mr. Eveges is an engineering and project management professional with over 26 years of practice spanning a variety of industries: product manufacturing; government consulting; process operations; architectural-engineering design; finance; and construction. His specific experience includes: Planning and execution of design-build projects; Estimating, bidding, contracting, and procurement; Process-mechanical system design and automation; Industrial information management systems; Construction and Contract management; Construction claims analysis; and Customer sales/service. He has owned and operated a general contracting business, holds a bachelors degree in Mechanical Engineering, a master's degree in Industrial Engineering, and is a licensed Professional Engineer in Pennsylvania and Virginia.

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[1]http://www.leadingresources.com/learning/tools/changemanagement/organizational/
