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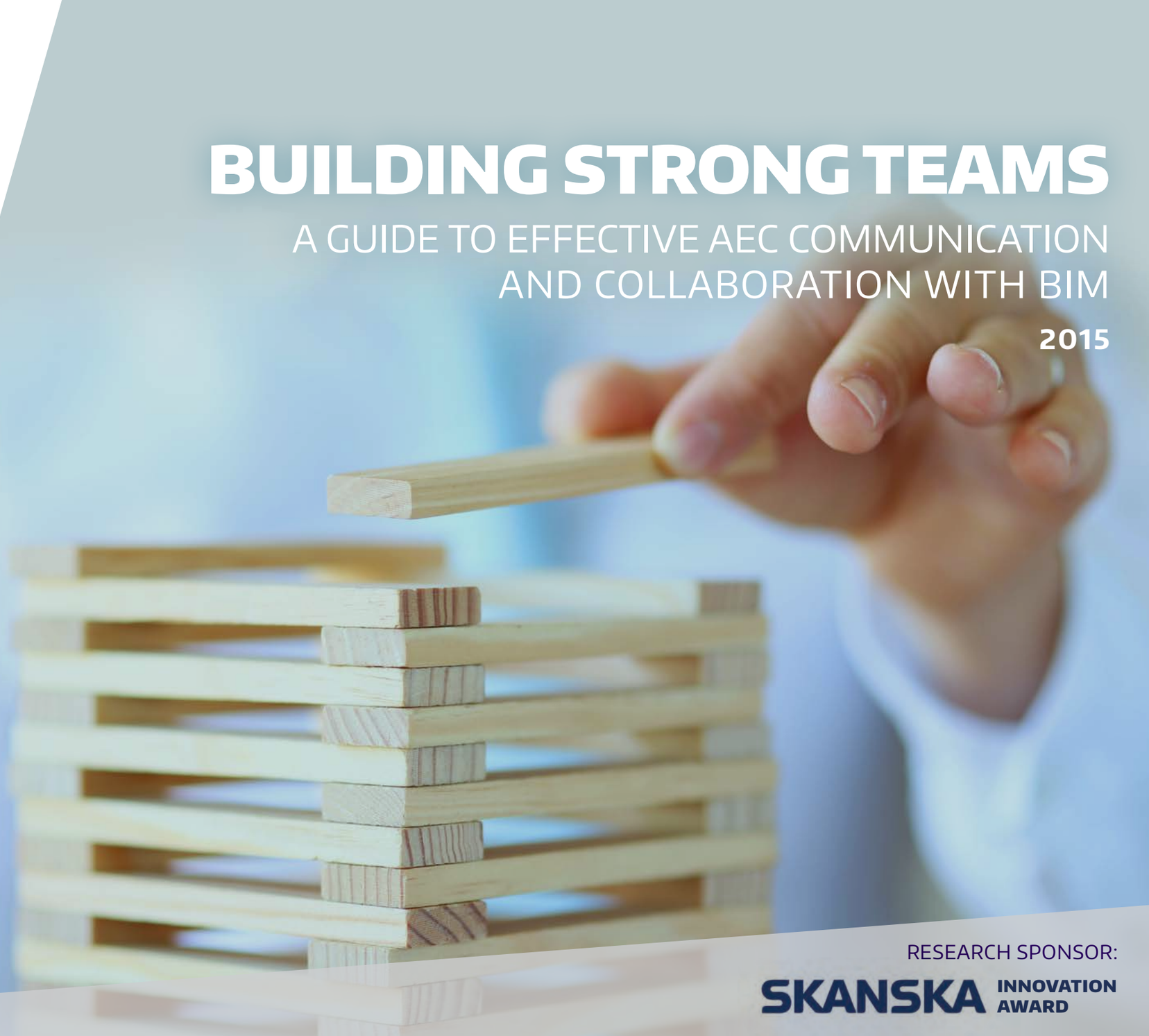
RESEARCH IN CONSTRUCTION
DEPARTMENT OF CONSTRUCTION MANAGEMENT

BUILDING STRONG TEAMS

A GUIDE TO EFFECTIVE AEC COMMUNICATION AND COLLABORATION WITH BIM

2015



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The Center for Education and Research in Construction (CERC) is a locus of research, scholarship and discovery in the UW's Department of Construction Management and allied disciplines of architecture, engineering and real estate. Focused on the people and practices of a dynamic, innovative construction industry, CERC develops new concepts and innovative solutions as well as improved methodologies for design, construction and operations. With active labs focused on Safety and Health, Project Delivery and Management, Virtual Design and Construction, Infrastructure Development, and Sustainable Built Environments the CERC faculty are not only experts and researchers in a wide array of topics but also lead the field in translating that expertise into excellent construction education practices and pedagogy to train tomorrow's construction professionals.

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Executive Summary

In this guide, we present tried and recommended practices for using BIM, data exchange, and communication strategies that emerged from the workshop and interviews with AEC professionals. While BIM promises more open and seamless information exchange between designers, owners and builders, researchers and VDC practitioners have found that a collaborative team culture, open communication and trust is required to leverage BIM's potential. BIM supports communication: it does not create it. With a focus on team buildings, leadership, and effective communication, this is not intended to be a comprehensive guide for team building, BIM or Lean Construction; however, this guide includes examples as to how BIM and Lean support communication and collaboration between owners, designers and builders. **This report provides a series of guidelines and tested practices as to how to:**

- **collaborate effectively with owner representatives, designers and contractors**
- **create a project team culture that supports information exchange**
- **lead an integrated project in the AEC industry**

This guide is a culmination of several years of research about collaboration with BIM and integrated design and construction teams, as well as a synthesis of best practices from Skanska professionals. The study focused on construction management and owner/developer perspectives; however, many of the collaborative techniques are relevant to all parties in an integrated project—those who lead teams as well as those who are on these teams. For collaboration to improve between designers and builders, it is important to help the team see the value of collaboration and the purpose for information exchange. When a project is risky, open communication through a collaborative culture drives clarity and certainty, where teams develop a better understanding of the project process at all levels. Those who have used integrated processes have found that collaboration helps team members (1) to inform each other of potential project improvements, such as improving energy performance, (2) to efficiently solve constructability issues, (3) to find better design solutions, and (4) to create more reliable project budgets and schedules.

We found that strong leadership tactics enhanced collaboration and caused team members to develop and sustain commitment to the project. The definition and communication of project goals and aspirations was foremost of these leadership tactics. Clear shared goals were key to aligning commitment across the team and to helping define the holistic success of a project. Team leadership also enhanced collaboration through social engineering techniques that produced collaborative values through encouraging respect for each team member's ideas and strengthening team relationships through trusting behaviors.[1] Social engineering methods included selecting individuals that are a good team fit, building on prior relationships for choosing collaborators, aligning team goals, encouraging trust and respect between collaborators and their disciplines, allowing the team to develop work processes, allowing risk taking, and discouraging confrontational attitudes.[2]

Process tactics involved the definition of the roles and structures of the team as well as the effective use of team meetings, communication strategies and technologies, and effective collaboration with designers, engineers and other team members. From this research, we recommend that project teams develop clearly defined roles and team structures during team formation and project execution. Having clearly defined roles helped to efficiently generate trust between team members.[3] If roles needed to shift during the project's duration to maximize expertise, team leaders needed to communicate that the team will engage in role flexibility.[4] There was room for flexibility and role shifting to leverage expertise when these shifts were well planned and clarified early in the project. Flexible roles within a team were successful when there is a strong sense of team culture, established communication procedures that continually clarify goals, trust amongst team members and leaders, and mutual respect between team leaders and team members.[5] Based on this research, we recommend that project leaders strive to develop a team structure that creates efficient paths for decision-making, and to resolve conflicts between disciplines as they arise on a project.

1. Homayouni, Dossick, and Neff, "Assessing the Impact of Collaboration and New Technologies in Increasing Energy Efficiency of HP Buildings." 2. Ibid. 3. Cheng, Integration at its Finest, 11. 4. Ibid., 23. 5. Ibid., 24.

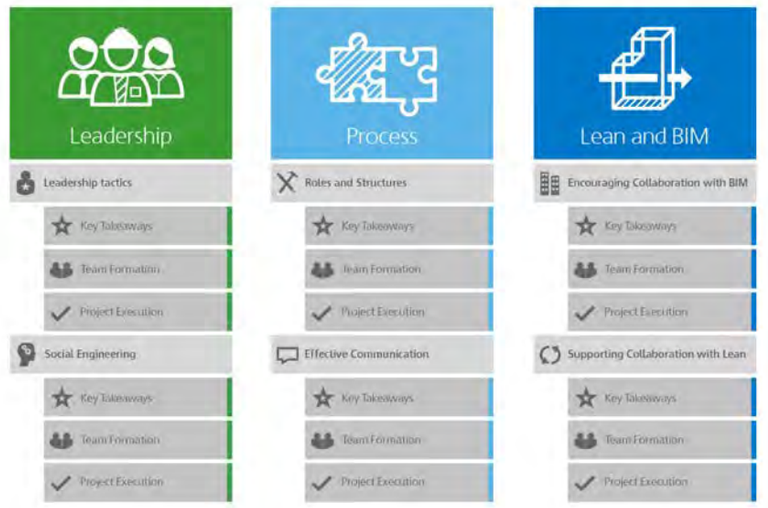
About This Report/Guideline

This guideline is a product of a study conducted with the support of a 2014-2015 Skanska Innovation Grant Award. This effort was led by Prof. Carrie Sturts Dossick, Director of the Center for Education and Research in Construction (CERC) and Faculty lead in the Communication Technology and Organizational Practices Research Group (CTOP) at the University of Washington. The research team included Omid Parsaei (MS, University of Washington), Dr. Laura Osburn (CERC, University of Washington) and Prof. Renee Cheng (University of Minnesota). We also worked in collaboration with Skanska VDC Staff, Sean Doolan and Greg Smith, and staff from the following offices: Blue Bell, PA; Oakland, CA; and Seattle, WA. These findings build on a long-standing program of research at the University of Washington around design and construction collaboration and communication practices. Prior research funded by the National Science Foundation, Mechanical Contractors Association, and the General Services Administration.

Building on prior research and a literature review, this study included two main activities:

- **AEC Collaboration Best Practice Workshop:** We facilitated a best practice workshop in Philadelphia, Pennsylvania (hosted by Skanska) where industry representatives from architecture and owner organizations gathered with Skanska staff and researchers from University of Washington, University of Minnesota, and Penn State to discuss the issues of designer-builder communication and collaboration practices. This workshop launched the analysis and interview effort and created a framework for the research effort.
- **Skanska Interviews:** For this study, we interviewed staff from both the building construction division and the commercial development divisions within Skanska. For the construction perspective, we interviewed twelve Skanska employees at various management levels (including project executives, project managers, superintendents, and project engineers), who have worked on notable collaborative initiatives in New York, New Jersey, Boston, Northern California, and Seattle. We have also captured the owner/developer perspective from executives and managers from Washington D.C., Boston, and Seattle with four interviews. These interviews were recorded and then coded for emergent themes that appear in their final form in this guide.

How to Use This Guide



This guide is designed for all levels of a construction project team. While we focused on the contractor and owner/developer perspectives, the findings in this guide are helpful for those trying to foster better team culture that supports communication and information exchange. When we identified issues particular to the owner's role, they are identified in a call out box.
The guide is organized into three main chapters:

Leadership: Leadership applies to all levels of a construction organization, not just for the project executives amongst us. Your day-to-day interactions with others on a project contribute to the team culture and ultimately the project's success. Lead by example when possible. Read this guide for both what is important for your own role and what you should expect from those around you. Under this section, you will find guidelines under two categories: Leadership Tactics and Social Engineering.

Process: This section covers specific tactics for fostering and facilitating collaboration such as defining roles and responsibilities, running meetings, and clarifying decision-making processes. As a project executive, you can identify tactics that you would like to specifically encourage on your collaborative projects. As a project manager, you will find inspiration and guidance on how to organize and run project teams. Project engineers can learn about what to expect from meetings, why they should open up lines of communication with their design peers, and how to develop a culture of trust from the ground up. In this section, guidelines are organized under two themes: Defining Roles and Structures and Effective Communication.

Building Information Modeling and Lean Construction: This guideline is not intended to be a BIM or Lean Construction guide, assuming that firms have their own best practices in these areas. In this guide, we illustrate how BIM and Lean tools and processes encourage and support collaboration and communication. We illustrate recommendations from the field as well as highlight best practices. This section of the guide is organized into two sections: BIM and Lean.

Each chapter includes sub-sections to help direct the user to content relevant to their project timeline and role.

- **Key Take-Aways:** Project personnel may want to start with Key Take-Aways for a high-level view of each section's content.
- **Team Formation:** Project personnel should use this section when the project is kicking off.
- **Project Execution:** Project personnel should use this section when the project is underway.

While we found that many of the guidelines apply to owners as well as contractors, owner/developer representatives will find the unique owner's perspectives highlighted throughout in *call out owner's boxes*. Throughout the guide we also illustrate the recommendations with illustrative examples, which can be found in *call out example boxes*.

Key Takeaways

In this section, we discuss and illustrate recommended leadership tactics that help you cultivate a collaborative project team culture.

These include:

- **Creating buy-in and maintaining collaborative culture**
- **Leading by example**
- **Selecting and cultivating the right people**
- **Maintaining project team excitement**
- **Cultivating an understanding of each team member's importance to the project success**

Note that collaboration does not mean the project team does not experience conflict. On the contrary, conflict is part of the process, should be anticipated, and can be productive. The goal of these leadership tactics is to acknowledge that each project team member negotiates between obligations towards the project, their own scope, role, and corporate management. These multi-tiered obligations are at times in conflict within the same individual's role, as well as between project participants. It is natural to have different agendas within a project team, even when project team members are in the same company. We recommend tactics on how to develop and use project goals as a focal point, how to illustrate to project participants that they contribute to project success, and how to make successful project outcomes a priority and a reality.

While reading this, think about the following questions:

- What makes your specific project important?
- How would you and your partners define successful collaboration?
- How would you make your project's goals and aspirations important and meaningful for other members of your team?
- What information should you provide to a team member to help them understand why they are doing a task?

Team Formation

1. Develop and Sustain Commitment

Develop, define and communicate project aspirations. Spend time before the start of the project to look at the project holistically. Once developed, communicate project aspirations to define success and make the project important for the whole team. Developing these project aspirations mitigates conflict and risk, increases the chances of successful collaboration, and improves a project's outcome. These aspirations need to transcend the interesats of individual team members to realign their personal and firm-based goals toward a larger project-level purpose of project aspirations.

Once these project aspirations are defined, document and communicate these goals and intentions to the team. This clarifies the owner's priorities for a project, develops and sustains team commitment throughout the project, and empowers team members to find creative solutions to project problems. A statement of these goals also ensures that a new team member will be a strong collaborative partner.

Project Aspirations and Goals

Define and communicate project aspirations for team selection. Some owners hire outside consultants to construct a "vision statement" based on interviews with early project team members. These statements develop a set of project values unrelated to financial goals. Owners also use these statements as a tool for interviewing potential architects and engineers, hiring based on successful responses to the vision statement.

2: Train, Teach and Inspire Collaboration

Establish common collaboration goals. Establish team collaboration goals with project performance goals. This helps develop the understanding that the team has a common purpose and a set of communication expectations. Collaboration goals should identify how successful collaboration is defined for the team, such as achieving positive and constructive communication between team members and openly sharing knowledge, information, and resources between team members. Document these goals (See also: Process / Roles and Structures / Team Formation / Develop a collaboration guide) and share them with the team.

Develop a culture of collaboration. Collaboration is more about team culture and individuals than the tools and work process. It is important for people to buy into the collaboration goals and establish a culture of collaboration in order to be successful. Establish the right culture through leading by example. State the collaborative goals that guide a project and then follow through with your own collaborative actions. For example, establish clear communication expectations that should be used in different team scenarios and lead the team by living up to these expectations when these scenarios occur.

Interdisciplinary engagement. Explain and clarify to the team the benefit of understanding the larger project issues and their team members' scope of work. When team members understand the benefit of another person's work, they are more likely to deeply engage in the project. *(continued)*

Team Formation

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Example: Developing and Reinforcing Collaborative Culture

Develop a culture of collaboration. One Skanska superintendent explained that trade contractors were motivated to work more closely with the engineers when they felt that their efforts were going to come back to help them. Subcontractors needed timely responses to submittals and RFIs. Cooperative team culture allowed the engineers to understand the needs from the field and act upon this understanding. When the project teams effectively responded to each other's needs in terms of timely information, this project culture reinforced itself.

Collaborative Culture as Positive Tension

Develop a culture of collaboration. View the constraints set by design and builder disciplines in a new light. Look at them as a pathway to finding innovative and creative solutions. One owner described this culture as positive tension where designers and builders understand "that everyone has constraints and just because their constraints don't match yours doesn't really mean it's a negative: it's actually kind of an opportunity to figure something out."

Project Execution

1. Develop and Sustain Commitment

Have the right people at the right time. While integrated teams commit to participate in working meetings, not everyone needs to be in every meeting. Decision-making team members, such as executives and project managers, attend meetings where decisions about project direction and development are made, while disciplinary team members focus on design meetings to discuss and debate design solutions. Having team members attend meetings that do not require their design, construction, or decision-making skills and authority is a waste of time and money for the company and the team member.

Make the project team feel important. Continue to communicate project aspirations and the motivations behind these aspirations to all team members to ensure partners continue to view this project and their work as important. When team members understand the shared project goals and workload, they are more effective in their tasks. Stress the importance of project goals and core values, such as project aspirations, to team members. Remind team members how their own goals align with the goals of the project, and how their individual work is an important part of achieving project goals.

Sustain Commitment

Assess team member workloads. Consultants, contractors, and other team members are often juggling multiple projects. Keep apprised of each team member's workload to ensure that are not overworked and can be committed to doing a good job for the team.

2. Train, Teach, and Inspire Collaboration

Recognize positive team behaviors. Recognize positive collaborative behaviors and motivate individuals to go above and beyond their obligations. Recognizing positive collaborative behaviors lets individual team members know that their work matters to the project and the team. Listen to—and incorporate—ideas from all levels into project discussions and publicly express recognition of team members' contributions and collaborative efforts as part of the project meetings.

Resolving conflicting obligations to focus on the project. When teams work collaboratively, many roles and responsibilities start to overlap. These overlaps sometimes cause conflict. Make it clear to the team that it is acceptable to challenge each other's ideas and empower them to look at the big picture. This allows them to make decisions that they feel addresses the project and collaborators' goals.

Ask questions and help others. As a team leader or team member, create a continuous learning environment where you take the lead and teach others or connect them with others on the team who have background knowledge. Ask questions yourself, both to understand how others do their work as well as to develop your skills and techniques. Understanding how others prefer to work goes a long way to establishing productive relationships across the team. Ask "what is important to you" or "how do you define…" to convey your interest in their opinions and processes. For example, when someone asked about an RFI with a 3D model view, the VDC manager had that person meet with the team member who wrote the RFI to hear the reasoning behind the RFI and proposed solution. *(continued)*

Project Execution

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Provide context but tailor information. Provide context behind each project deliverable or task when communicating with others on the team. Describe the reasons behind what your team is trying to accomplish. However, beware of information overload. Do not provide a team member with more documentation than they need or else key information may not be read or reviewed. People need to know why they are doing a task, but tailor this information to their individual needs.

Example:

Got buy-in through recognition. One VDC Manager felt that when team members witnessed their insights and expertise being recognized on a project, there was greater buy-in on that project. The manager noted that when people from different experiences and work background had their input heard and recognized they engaged on the project, became more thoughtful and creative, and intensified their contributions. This manager felt that with this buy-in "the final product is always going to be better."

Help Your Team Understand Your Priorities

Provide context but tailor information. Continue to give context to team project goals using project aspirations and the intention behind these aspirations. (See Leadership Section, Communicate Intention Behind Goals). While team members do not need to know the details around the owner's organizational politics, it can be helpful for them to understand why the owner has certain priorities. For example, one project team helped the owner "look good" to the community because they understood that the community really cared about the building's impact on the neighborhood. With this knowledge, this team made connections to the community in big (building images on the construction fencing) and small (conversations about the project in the local coffee shop) ways that supported the owner's goals on the project.

Key Takeaways

In this section, we expand on the tactics presented in the first tab of Leadership and focus on how to develop and strengthen relationships within the team. **These recommendations include themes such as:**

- **The right people**
- **Mutual trust and respect**
- **Management of different agendas**

The Right People: In this section, the recommendations for finding and cultivating the right people extend to finding the right firms with a culture that is a good fit for collaborative work on the project. We also explore terms of contracting to consider when developing teams.

Mutual Trust and Respect: In terms of cultivating mutual trust and respect, it is well known that owners and builders cannot legislate these aspects of teams. We present methods of working that support team building, developing social interaction on (and off) the job site, and developing transparency.

Shared Project Goals: As with leadership tactics, we reinforce that different agendas are natural and should be anticipated. Through team building and relationship building, project participants find ways to prioritize project goals and shared success.

While reading this, think about the following key questions:

- What characteristics make a person or firm a good fit for your project?
- How would you communicate your respect for the roles and responsibilities of different disciplines?
- What are some ways you can encourage positive relationships?

Team Formation

1: Develop and Strengthen Relationships

Find the best fit for partnering. Finding the best fit for partnering is not just finding a good firm, but the right people. **You want individuals on your team to be:**

- **Creative**
- **Open to collaboration**
- **Aligned in work processes with other project team members**
- **Not have an adversarial history with designers or constructors**
- **Willing to set aside their personal and firm-focused egos and agendas**

The right people will be able to demonstrate that they understand why a project is important and how they and their firm can contribute to the project's goals and aspirations.

Understand and respect each other's deliverables and timelines. Know the goals of the contractor and designer and try to align them so that success feels shared across the team. Encourage all team members to be responsible and respectful of an individual's personal tasks and the project deliverables to support the development of stronger working relationships between builders and design team members. Through aligned goals, contractors and designers understand their similarities and differences and work together toward project solutions.

Focus on team culture. People are more motivated when they are a part of an inclusive and solution-focused team culture rather than a culture where leaders or other team members place blame or engage in other negative confrontational behaviors. Emphasize the importance of the work and communicate to the team what the barriers are for a project to succeed. Generate a team culture of honesty and respect, setting expectations that together the team will successfully find solutions to project problems.

Example:

Found the right people. One owner described that to build strong teams he had to have the right DNA on the team and the right people. Having people with legacy experience did not necessarily mean that they were open to a collaborative, trusting environment. In this owner's experience, they interviewed proposed team members and sought collaborative team players as well as highly reputable firms.

Find the best fit for partnering

Invite contractors to early interviews with potential architects and engineers for a project. This ensures that all partners have compatible work processes and helps partners begin to develop strong interpersonal relationships.

In cases where a specific architect, builder, or consultant has a personality that isn't fitting in with the team, have a candid conversation with the individual and focus on potential solutions rather than asserting blame. If the problem persists, a team member may have to be replaced with another individual recommended by the team.

Understand and respect others' deliverables and timelines: While uncommon, one owner was able to align contractor and owner goals using financial incentives through role reversal. The contractor and owner switched responsibilities for a day, with the owner conducting a safety walk and the contractor reviewed RFIs with the team. Having walked in each other's shoes, the team built respect for the other's role and the innate challenges they faced.

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Team Formation

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2: Respect Others' Ideas

Establish respect for the roles of each discipline. Communicate to the team that certain disciplines have specific knowledge or expertise that is vital for project success and how their own knowledge and expertise contributes to that success. Individuals like architects and builders may have different ways of approaching a problem. Continue to communicate respect for the roles and responsibilities of each discipline throughout the project to build an inclusive work culture.

Welcome team member's new ideas. Hearing out new ideas, concerns and engaging the team in constructive and respectful dialogue around a team member's idea promotes stronger working relationships. If a team member voices concerns that are perceived as critical of a potential project solution, emphasize that their concern highlights a potential future problem or constraint that the team can discuss and solve together.

Be flexible. After working a certain way for many years, it can be easy to not want to change or listen to other ideas about how to accomplish one's work. However, it is important to be flexible. Keep an open mind to new technologies and new approaches on a project. Be open to thinking in different ways when working with a team of people from different generations and cultural backgrounds, who might approach working and problem solving differently from you.

Example:

Established respect for the roles of each discipline. One VDC manager reflected that architects are much more apt to understand the design values of the project, while builders are more focused on how to realize the project. For this manager, it was important for team members to understand that everyone plays an important role in achieving the goal rather than doubting the expertise of another discipline. They encouraged their team to focus on what their design partners knew (e.g., basis for design), as opposed to pointing out what they did not know in terms of constructability. Instead, they reinforced the idea that it is the contractor's role to bring constructability issues to light and work with their design partners to resolve conflicts between design intent and constructability constraints. This shifted the team culture from one of defensive posturing to a more constructive atmosphere of addressing constructability issues together to realize project design goals.

Project Execution

1: Develop and Strengthen Relationships

Encourage trust. Encourage trust between team members through sharing project motivations and transparency about project financial goals. Trusting relationships between team members and team leaders accelerates the speed of information across the team, helps team members share a sense of risk, encourages team members to admit to mistakes, and helps teams efficiently work towards solutions. Positive relationships between team members develop when they see their teammates adhering to the project goals and trying to find the best solutions to achieve those goals. If a team member is perceived to not be adhering to the project's goals, then it will be difficult to build strong relationships and effective collaboration as individuals retreat to their own scopes of work with defensive postures towards others on the project.

Make a personal connection. Make a personal connection with your team members. For example, have lunch together and talk about non-work interests. Developing personal connections with your teammates helps to better understand their personalities, communication styles, interests, and ideas. The benefits of making a personal connection transfers into the work environment: when project problems arise, it is easier to find solutions when you know how your teammates think and communicate.

Host social events to encourage relationships. Host formal and informal events to encourage strong social relationships between your team members. Social events support the development of trust, help team members make personal connections with one another, and create long-term professional relationships.

Socializing strategies can include Happy Hours after work, barbecues on site, "lunch and learn" presentations and webinars, software or system training, and interim partnering meetings that remind the team of the central project goals and drivers and welcome new members.

Show appreciation for others' work. Leaders encourage good working relationships through showing appreciation of their team or team member's hard work. Acknowledge the work the team member has accomplished or acknowledge a project milestone through arranging an informal event to celebrate.

Understand others' communication styles. Consider the personality types and communication styles of other team members to ensure that good collaborative communication occurs. Appreciating and understanding the diversity of personality types and communication styles can help to resolve later potential conflicts between team members. One team went as far as reorganizing team members' roles to separate incompatible people and keep the team productive and focused.

Leverage team member's strengths and address the weaknesses. Know your staff's strengths and weaknesses in their work. If weaknesses are found, address them privately, face-to-face (if possible) with team members. Be honest, but also careful with the language that you use in these conversations: emphasize that these weaknesses are your perception about an individual's performance and not necessarily a fact. Often there is a root cause for missing deadlines and other project problems. Find out the cause of these weaknesses and propose ways that you can address weaknesses together as a team.

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Project Execution

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Focus on solutions. In the heat of the moment, it is easy to become defensive. Avoid placing blame on individuals—particularly in public meetings—as placing blame only creates tensions and divisions. In a strong team, individuals take ownership of their mistakes as others on the team come together to focus on a solution. Have an honest, respectful, and candid conversation with the team or team member to understand why a task was not completed or why a response was not what you expected.

Example:

Employed lean practices. One builder stated that incorporating Lean methods, such as team events and group trainings, improved social relationships on their project. These social relationships translated into strong working relationships and improved team interactions.

Showed appreciation for others' work. One team leader emphasized the importance of showing appreciation for others' work stating, "Make sure you're appreciating what other team members are doing. If someone helps you, make sure you're appreciating the effort. It goes a long way; you would be surprised."

Trust through transparency

Owners can establish trust with contractors through clarifying the goals and motivations behind a project and being transparent about financial per forma. In turn, contractors can enhance trust through making costs more transparent. When these dialogues occur, owners should express to contractors that the focus of sharing information on costs is to build trust and transparency and that no blame will be placed upon an individual for mistakes.

Appreciate others' work. Owners can acknowledge achievements of team members by hosting fun and celebratory informal events at project milestones. Do not include work-related activities or work presentations during these events.

Focus on solutions. Do not take sides or yell when a problem occurs or a mistake is made: focus on solutions. When problems do occur with an individual's work, talk to that person privately in a face-to-face meeting to uncover the cause of a problem (this could be an individual or firm-level cause) and ask how to help them find a solution. Have a candid conversation about the problem with an individual, team leader, or company head if the problem persists. An owner noted that providing solutions is central to resolving team issues: "If someone isn't pulling their weight, hopefully a relationship has been developed where you can approach them and see if they need help figuring out what it is they need to get to their end line. A lot of times you find yourself saying, 'help me help you get to the finish line here.'"

Key Takeaways

We recognize in this section that different types of projects require different types of teams. The recommendations here is to take a pragmatic approach that is not prescriptive in terms of team structure, but provides some items for consideration when setting up project structures. These include decision-making; the right people, firms, contracts and timing; as well as establishing good communication habits.

Decision-making: When developing decision-making structures make them planned, transparent, and consistent. While early project phases may be more informal and fluid, it is important for larger project teams to understand project goals and decision-making processes. Misunderstandings about who, what, when, and how decisions are made on a project can lead to destructive conflict and disenfranchisement of project team members. The tactics in this section build upon the themes from the leadership section that stress the importance of team members understanding their role and importance on the project through an organizational structure that values team member contributions and provides them clear direction as to how, when, and where to engage other project stakeholders when making decisions on a project.

Right people, right firms, right contracts, right timing of involvement: This section also provides process tactics that address the communication of expectations, careful onboarding processes, and explores the possibilities for team co-location. One interesting note is that successful projects exercised both onboarding and offboarding strategies. Onboarding is the process of bringing new members into the project by sharing project goals, collaborative aspirations, decision-making structures, and communication expectations. Offboarding is used to describe when team members are removed if they are not working out and were unable to nurture the collaborative team culture.

While reading this, think about the following key questions:

- How would you organize your project team?
- Would your project benefit from co-location?
- How would you communicate formal and informal decisions making processes and share project information to a team?

Team Formation

1: Clarify Decision-Making Processes

Develop a decision-making structure: Clarify decision-making structures at the beginning of team formation and define roles and responsibilities representing the disciplinary scope, schedule, and budget. For example, in one larger integrated team, they defined working groups to develop design solutions while they had a core team to manage decisions and set direction.

Develop a collaboration guide. Develop a written collaboration guide to formalize collaboration goals (See also: Leadership / Team Formation / Train, teach and inspire collaboration / Establish collaboration goals) and develop strategies and tactics to meet these goals as a team. Distribute this guide throughout the team. During project execution, measure your team's performance against your collaborative goals. For example, one team used a checklist to monitor their collaboration outcomes. In this checklist, they included metrics such as RFI turn-around time as well as a qualitative self-survey to rate 1 to 5 measures, such as "having fun" and "feeling successful".

Match team size with project needs. Match the size of the team to the project's scope complexity and size, then communicate to the team how work will be delegated so that everyone knows the boundaries of their roles.

Case Study Example:

One project executive described the recent team structure as a flattened structure where "horizontal" work streams developed design solutions that addressed design goals (e.g., MEP systems, exterior envelop). Then "vertical" team structures, consisting of subject manner experts, intersected decision-making across the horizontal team work streams and focused on issues such as schedule and the logistics of constructability. With a vertical overlap between horizontal work streams, subject experts were able to address problems that spanned across building systems.

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Team Formation

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2: Involve Engineers and Builders Early

Have decision-makers in the room. Involve the engineers and builders early when complex tasks are being worked through and decision-making is needed. Remember to bring in the right people at the right time. For example, meeting with trade partners while still engaging in design charrettes is not a productive way to use your trade partners' time. The decision of who to bring into the team depends upon when their expertise contributes to needed decision-making.

Conduct onboarding and team building. Onboarding and team building creates shared understanding within the team. Consider bringing in a coach/consultant to help the team develop shared goals, objectives, and contracts. Then, as design consultants and trade contractors join the team, they go through an onboarding process whereby they learn about the project goals and aspirations (See also: Leadership / Team Formation / Train, teach and inspire collaboration / Establish collaboration goals). Establish a collaboration champion within the team or determine how project roles develop at the project scale (as opposed to the internal leadership within the design and construction firms). Depending on the leadership structure and character in the project, a team member (e.g. owner's representative, designer, or builder) can be appointed the collaborative champion.

Consider co-location. Some projects require co-location of team members: a shared workspace to facilitate communication and strengthen trust in working relationships. Co-location helps to efficiently resolve small project issues (rather than wait to resolve them in formal meetings), facilitates communication, and strengthens trust in working relationships. A project's complexity and schedule determines whether co-location will benefit the project. Some projects require co-location of team leaders at different points in design, with some periods of a project's design not requiring it at all. In general, having designers co-located at the construction site facilitates day-to-day communication during construction.

Example:

Adjusting to co-location One MEP Manager described a project where they committed to co-location. With co-location there was more collaboration between disciplines in the development of the design, although initially the team felt that it was not the most comfortable place to work as they were used to taking tasks to their home office, solving them in isolation, and then presenting their results to the team. However, once they adjusted to the new environment, co-location was deemed effective when integrating different divisions within the same company and building teams with partners.

Co-location based on project characteristics

One owner believed that the need for co-location depended upon the scope and time schedule of the project. For example, during the DD phase of a 500,000 square foot urban office building project that had to be completed within 24 months, the team co-located key members from the architecture, structural engineer, and MEP teams for the first three to four months of DD to increase their collaboration efforts, which rapidly advanced design decision-making.

Project Execution

1: Clarify Decision-Making Processes

Communicate the needs of deliverables and timelines. Define the intentions behind individual project deliverables and their timelines. This will empower teams to confidently make decisions, solve problems, and avoid mistakes that arise during a project in a timely fashion.

Document and disseminate formal and informal decisions when co-located. From a documentation standpoint, co-location can pose certain difficulties as decisions are made more quickly during informal day-to-day interactions. Document decisions and relay this information to the broader team. For formal decisions, consider having weekly or bi-weekly meetings in order to document key items through meeting minutes. For informal decisions, develop a process to document decisions and disseminate them to the broader team, such as sending an e-mail to project team members confirming informal decisions.

Continue to refine and reinforce project goals and priorities. One owner said that by communicating the intent of the project and goals in the beginning, everyone is empowered to work toward the same goal. Once established, they reinforced those goals through decision-making. When something went wrong, it was easier to start thinking of a solution and move forward with next steps when the team reminded themselves of project goals and priorities.

2: Involve Engineers and Builders Early

Involve all levels of staff in collaboration. Keep work processes transparent and communicate all important information and decision-making throughout the team to facilitate future work and meetings. Sometimes there are challenges disseminating information to the project engineers and VDC managers. Techniques for engaging all levels of staff in the flow of project discussion and decision-making includes having quick all-hands reports, involving staff at all levels in working meetings, and engaging in project discussions with outside project team members. Isolating staff to their scope of work limits their ability to understand larger project goals and to make detailed decisions that support those goals.

Key Takeaways

Effective Communication: This section covers a variety of communication tactics from meetings to emails, to informal hallway interactions. We emphasize the importance of visual tools to help illustrate technical issues, as well as the importance of dialog to work through problems in real-time. It is important to have a process in place to document decisions once they are made.

Right people at the right meetings: We emphasize the use of face-to-face conversation as a means of communication. All too often project participants turn to email or RFI documents to communicate with each other. However, conversations between designers and builders not only support innovative problem solving, it is also a more efficient use of everyone's time on a project. However, with structured meeting schedules, team members can feel that their time is wasted in meetings. Defining who should be in a meeting grows out of well-defined roles and understanding the right time to get the right people involved. Careful onboarding (See also: Process / Roles and Structures / Team Formation/ Involve Engineers and Builders Early / Conduct onboarding and team building) sets expectations for individual engagement and project goals. Visualizations can support cross-disciplinary communication and helps develop mutual understanding of the issues at hand.

In this section, we address conflicting team member agendas, culture, and jargon. Recommendations support ways to help team members put the project goals as top priority by focusing on desired outcomes, both in terms of project deliverables as well as communication processes.

The cultivation of mutual trust and respect supports communication and transparency, where team members listen to each other's ideas during meetings and appreciate the value of each member's contribution to the project.

While reading this, think about the following key questions:

- How often and what type of meetings should you have for a large project?
- How do you run an efficient and productive meeting?
- What are some ways that you could learn about another team member's tasks and discipline?
- How do you communicate project issues and propose solutions to team members in a meeting?
- How can you show your appreciation of others' hard work?

Team Formation

1: Conducting Meetings

Conduct kick-off meetings. Have kick-off meetings to talk about the expectations of the team and how communication will flow between team members so everything is concise and clear. This will help to avoid confusion and problems in later project stages. Have clear onboarding procedures for team members who join after the kick-off meetings. (See also: Process / Roles and Structures / Team Formation / Conduct onboarding and team building)

Have regular and frequent meetings. Conduct face-to-face meetings with the design and engineering team, contractors, subcontractors, and trade contractors to communicate project issues. As a standard, try to meet weekly or bi-weekly depending on the size of the job, complexity of the job, and the stage of the project. Meet frequently with architects and engineers to better understand design, solve problems, and get everyone on the same page.

Invite only key (value adding) personnel to meetings. Involve team members in a meeting when they can add value to the process. Build meeting invitation lists by identifying which team members are the best ones to resolve the issues on the agenda. Establish methods of sharing a meeting outcome with everyone on the team. Have somebody who is able to understand the meetings' needs take the lead and call key people from the meeting invitation list as opposed to contacting everyone every time. When identifying which key members to invite to a meeting, consider whether other team members have expressed interest in wanting to be involved in the problem solving process on a specific issue. Invite team members that have expressed interest in a specific meeting to make them feel like a valued member of the team.

Example:

Contractors involved in design phase. One architect stated that they usually involved contractors in meetings in detailed design, but not in early design. Depending on when the deliverables were due, these meetings between architects and contractors often occurred once a week to help guide architect design decisions from a constructability standpoint. These meetings also gave the contractor an opportunity to understand the design goals and basis for design, engaged their expertise to help realize the project's goals, and assisted with relationship building between design and construction where team members learned about each other's styles and expectations.

Meet frequently in an IPD project. In one case, face-to-face meetings occurred once a week for three meeting types: 1) an update meeting for the core team, 2) an update meeting for project teams, and 3) cross disciplinary workshop meetings for project teams. A representative from the general contractor noted that they meet more, but the project work happened in these meetings through joint brainstorming and vetting of design proposals.

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Team Formation

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Meetings

For owners, the early integration of team members occurs in meetings. The timing for integration often occurs at the early concept or design stage, but ensure that only the necessary people are attending these early meetings: bringing in specific consultants before their participation is needed is a waste of time and resources. For meetings in the early design stage, encourage flexibility in meeting time and organization to allow for greater creativity and the free-flow of ideas. After the early concept and design phases, encourage more organized meetings. These meetings should end on time, include visual aids, and have a meeting leader and someone to take notes. Meeting frequency depends upon the type of project, its complexity, and the project phase, but allows enough time in between meetings for team members to complete their work.

2: Collaborate Effectively

Engage in others' activities. Get to know each of your teammate's tastes and disciplines. This enhances collaboration, leading to successful project outcomes and creative solutions. This engagement also provides team members with a holistic view of the project that bridges occupational and organizational divides. Team members will also gain a better understanding about different project scopes and team member contributions that will benefit project needs that fall outside of their personal scope. From our research, we have found that when BIM is used reliably on a project, successful projects have teams that understand each other's scope.

Learn about technical issues. The best way to communicate between designers and builders is to ask many questions. However, architects and engineers often have different styles of communication than construction managers. Be curious about their work and their perspective. Ask design partners to teach you about technical issues on the project and ask specific questions that may affect your work. Having conversations on technical issues demonstrates your interest and engagement of the issue, allows you to ask questions to fill in the gaps of your technical knowledge, and helps to alleviate each other's concerns on specific project issues.

Take the initiative to start collaboration. To break down the divisions between disciplines, you have to take the initiative and lead by example. Do not wait for others to cross the boundaries and build relationships. Establish collaborative relationships at the beginning of the project by asking questions and seeking advice. Team members from other divisions and disciplines have skillsets that will benefit you, and the relationships you build will make the project successful.

Highlight the accomplishments. In a design and construction project, team members often engage with each other around the "problems" and work together towards solutions. At the beginning of each meeting, highlight accomplishments that occurred since the last meeting to help the team come together in a positive ways. Congratulate one another and recognize the immediate benefits of working together.

Use visual communication technologies. Use visual tools, such as renderings or models, to help communication in the early stages of a project.

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Team Formation

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Using visual tools helps builders to better understand the motivations behind design early on in the process rather than through verbal or written descriptions. Visualizations make conversations easier and reduce guesswork and misinterpretation. Particularly in early design work, use visualizations to clearly represent decisions that have been made and communicate decisions that that need to be made.

Example:

Inspired collaboration through action. One VDC Manager described a project where they were encouraged to help out other team members and to accommodate them within the scope of the contract, such as helping team members populate their model. This created and reinforced a project team culture where everyone helped each other out.

Project Execution

1: Conducting Meetings

Prep team members for meetings. Establish norms and practices around meeting preparation. Define what team members should review before the meeting and what types of questions or solutions they should prepare. Surprises in meeting topics lead to less productive meetings and delays in finding solutions. Techniques for prepping team members and setting meeting expectations include collecting meeting topics from team members; sending out a detailed agenda with design or construction questions; requesting visualizations such as models, drawings, or analysis from team members; and prompting team members to be ready to present on a topic (e.g., present an energy model result).

Maintain productive meetings. While some meetings in the early design phase can be loosely structured and flexible in their organization encouraging creativity and engagement, meetings in later stages of a project need to be efficient, run within their allotted time, and well organized with an appointed leader, a note-taker, and visual aids. Having organized meetings can help people to stay engaged and encourage mutual respect of team members' time.

Encourage team engagement in meetings. Key members of each team have to participate in order to simplify the flow of information. Try to get everybody to be active participants in meetings and encourage team commitment on project goals. If team members are not engaged in a meeting, then perhaps they do not need to be there. If they do need to be there, privately have a face-to-face candid conversation explaining why it is important that they are present and engaged, and ask them what you can do as a leader to help them feel more engaged. If someone continues to not be productive in a meeting, put them on an on-call or optional basis, keeping the invitation open.

Avoid Jargon. While it is important to explain technical details and learn about the technical language of another team member's discipline, avoid using disciplinary jargon when it is not necessary for the audience to understand the problem you are trying to solve or the question you want answered. Instead, use unambiguous words that are known in all disciplines. This reduces the perception of clichés amongst the team.

Example:

Used communication technologies. Some general contractors used Bluebeam to communicate their construction comments to the architect in the later stages of the design process. During meetings, Bluebeam comments increased work efficiency as everyone in the meeting could view the comments projected on a screen, understood the issues up for discussion, and transformed the meeting into an interactive session to find solutions. (See more tools and techniques in section: Encouraging BIM/ IT Usage / Lean Tools, lean construction method)

Contractors and sub-contractors also used On-Screen Takeoff and Model Takeoff to show the design team the construction analysis and to explain and validate what the quantities represented in their analysis. This strategy is particularly useful for those in preconstruction roles who interact with design decision-makers.

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Project Execution

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2: Communication Strategies and Technologies

Provide deadlines, reasons, and information needs. The workloads are different between AEC professionals and each culture defines terms in different ways. For example, "as soon as possible" has a different meaning for architects than it does for contractors. When you communicate with architects, be clear and concise about what information you need, why you need it, and when that information is needed.

Use phone calls. If face-to-face communication with a team member is not possible, use the phone instead of sending instant messages or emails. Instant messages are not documented on a project and emails are often difficult to track and respond to, especially on large projects. Some managers recommended weekly scheduled phone calls to engage with team members that are located far away. Open the lines of phone communication with welcoming and encouraging phone call conversations. After the call, document decisions, such as confirming RFIs or other project records.

Encourage discussion with models and documents. Visual aids do not tell the full story about a project. Have face-to-face discussions using a screen or sharing a desktop monitor to provide the person you are conversing with a better understanding of what you are talking about. If using written correspondence, accompany images with a written narrative describing the meaning of the images.
Use virtual meeting technology. When face-to-face meetings are not available, virtual meeting technology is an effective solution to connect team members with project information and to discuss project issues. Explore using virtual desktop, web meeting, and other virtual meeting tools to connect the project models with the team members. Encourage discussion around models and other project documents, as opposed to the notion that digital storage and retrieval is sufficient communication. Use tools that help the team interact together with their documents.

Use explanatory memos. Use memos that provide narratives with technical information, such as estimates and models to communicate with architects and engineers. These memos provide the design team with better contextual information about construction means and methods and the ramifications of your analysis.

Example:

Used dual displays in face-to-face meetings. One team described their use of dual displays in design assist meetings: "We did dual screens. On one side of the screen we would have a projector displaying the Naviswork model, which had the sub constructor's information as well as the design team's information linked to it, while they had a live Revit model up on the other screen. We made our way through the Naviswork model, highlighting where we had concerns or wanted to focus our design. So, it was a live collaboration between the construction Naviswork model and the design Revit model."

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Project Execution

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3: Collaborate Effectively

Be aware of others' capabilities and knowledge. Respect disciplinary roles and differences and understand that each department, discipline, or trade has a different way of approaching a problem and different areas of expertise on certain jobs. Respect the roles and responsibilities of each party, but understand that in collaborative teams, the roles and responsibilities of each party often overlap depending on an individual or firm's area of expertise. Allow some flexibility in this overlap, as this improves collaboration and participation as a team player. Avoid dictating and forcing people to conform to specific responsibilities. (See also: Social Engineering / Team Formation / Respect Others Ideas / Establish Respect for Discipline Roles and Be Flexible)

Appreciate others. Always show your appreciation of what other team members are doing: if someone helps you, express recognition and gratitude for the effort. Showing appreciation and gratitude supports a positive collaborative project culture and strengthens individual relationships. (See also: Social Engineering / Project Execution / Develop and Strengthen Relationships)

Be efficient and provide solutions. If an issue with another team member (e.g., architect, engineer) arises on the project, do not talk to him or her about a potential issue or mistake in public or in front of the team. Talk over the issue in person or on the phone. During this conversation, explain the issue, ask for advice and guidance, and provide potential solutions for resolving the issue.

Example:

Be efficient and provide solutions. One IPD manager suggested that Integrated Forms of Agreement (IFOA) require people to learn collaborative behaviors: for example, a contractor should go to architects with recommendations and ideas and not just expect to receive answers without providing information and ideas.

Key Takeaways

In this section, we present some recommended practices for using BIM, data exchange, and communication strategies that emerged from the workshop and interviews. This is not intended to be a comprehensive guide for BIM, but examples as to how BIM supports communication and collaboration.

Visualization: BIM excels at helping project teams communicate the impact of cost and constructability during both design and construction phases of a project. BIM supports the team by making the problem clear for everyone. This shifts the discussion from a debate about the scope of the problem, to a discussion around potential solutions. Furthermore, it can be used to demonstrate detailed construction sequences, conduct virtual walkthroughs, or combine multiple data sources into one integrated package, such as cost, logistics, and schedule. Visualization deliverables can take the form of a series of images or renderings as well as custom-designed, interactive displays. Advanced visualization can assist a project team in communicating complex work methods clearly in a non-technical way that all team members can understand to gain buy-in and agreement.

BIM execution planning is highly recommended for all BIM projects. The team can come together around project goals and a shared understanding about how BIM uses will support these shared goals. It is a recommended best practice to include BIM execution plans in subcontract bids and contracts, which communicates the technical requirements as well as the staff abilities needed for the project. Once brought onboard a project, subcontractors should be given an opportunity to revise and update the BIM execution plans to support their work and how it intersects with others. It is important to communicate the intended use of models, create trust through the exchange of models, and establish reliability through communicating the intended level of detail and model accuracy.

BIM Champions: Another recommended practice is to cultivate BIM champions on the project and provide them support through recognition of the value of BIM throughout the project. Invest in training, recognize the learning curve, and help the whole team understand the value of BIM activities for the project. You can further engender trust in the model by making the model accurate. For example, if the structural steel model is accurate, mechanical, electrical, plumbing, and fire will be able to use it for BIM coordination and rely about this information for prefabrication.

Have conversations with the models. Bring experts together to work together with the model as the experience they have cannot be fully captured in a model. Often optimal solutions require negotiation between disciplines to balance trade-offs and brainstorm solutions. Consider adding narrative to BIM representations to provide a more complete picture when distributing images. If possible, have design team representatives in BIM coordination meetings to facilitate decision-making and reduce RFI correspondence.

While reading this, think about the following key questions:

- How do you set up expectations across the team about how to use BIM?
- How do you empower other team members to use BIM?
- What communication strategies could you use to explain model issues to another team member?
- What are some ways that you could use BIM models to help find solutions to project issues?

Team Formation

1: Using BIM

Show examples of previous works with BIM. Show examples of how you have successfully used BIM in the past, (e.g., how BIM has improved the deliverable, helped the process, or made the process more successful). This will go a long way to convincing other team members or firms to use it.

Start BIM execution planning early. Start a conversation about expectations of BIM throughout the design and construction process. This will allow for widespread use of design models. Early conversations help architects understand builder expectations and can help architects modify the way a model is built to meet builder needs.

Include BIM execution plans in subcontractor purchasing. Contracts are the starting point of the onboarding process for subcontractors. Make subcontractors aware of the BIM execution planning process to get buy-in for the plan as they join the project. Clarify expected uses and levels of development of BIM to subcontractors when they are bidding on work. Once subcontractors are onboard, bring them into the team by having them participate in BIM execution plan refinement.

Establish clear BIM uses and benefits for the project. People need to see a clear benefit to using BIM. Communicate BIM uses and benefits to project team members to establish trust in the BIM process and the BIM plan. During the early stages of the project, establish how BIM can help achieve project goals and match the project's level of complexity to the BIM uses and levels of development.

Clarify costs and risk management strategies. Be up-front about BIM costs as an investment in design. Clarify how the investment in BIM will off-set costly issues that may arise later on in fabrication and construction. As one VDC manager explained, "the more collaboratively we drove the model, the more time we spent, the more resources we needed, the more expertise we needed. You amp everything up to the next level."

Share models as they develop. BIM managers recommend getting models to the team as early as possible to better understand the model's value, such as extracting quantities or using it for early clash detection and visualization.

Understand the costs of BIM. Learn about the costs of purchasing software for BIM, the manpower needed to effectively and efficiently run the software, and the training needed for other employees to use the software.

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Team Formation

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2: Data Exchange

Establish BIM uses and information exchange early in a project. Using BIM during the early stages of a project helps the process of information exchange between designers and builders. Establish modeling standards and protocols to support BIM uses between designers and builders.

Build trust through reliable models. Be transparent about how BIM is used to support the development of trust with designers. Follow through with BIM execution plans to establish and maintain trust between design and construction. Be transparent if changes to the BIM plan are needed. As it is a living document, set expectations that the team can and should revise as the needs of the project become better understood.

3: BIM Communication Strategies

Support BIM at all management levels. It is difficult to sustain BIM implementation on a project if people do not understand its value. All management levels need to support and reward team members using BIM.

Create a network of BIM champions. BIM champions understand the future direction of their larger corporate BIM strategy. Local BIM experts empower other employees to use BIM through leading by example and sharing knowledge about BIM uses and benefits.

Commit to BIM. Empower team members to use BIM through company-wide commitments to BIM and developing project-level support of BIM. Use it collaboratively and resource it properly. Take the time to understand the resource needs for desired BIM uses, and then invest in those resources.

Invest in training and recognize the learning curve. Official training helps people understand how the tools can be used. On average, it can take three to six months for people to be competent in BIM. Invest in BIM training and recognize the length of time it will take to be efficient and knowledgeable in BIM.

Transition gradually. It is rarely recommended to abruptly transition to new tools. Show staff the benefits of new ways to use BIM and ask them to gradually apply BIM in these ways. When helping or teaching people to transition from older tools, such as AutoCAD, to newer tools, such as Revit, show how these new tools improve upon their day-to-day tasks and innovate their work practices. A few smaller scale successes can support sustained adoptions and fundamental shifts in practice.

Leverage knowledge throughout the team. Often, senior staff has knowledge about construction means and methods and junior staff has knowledge about technology skills. Create intentional pairs where junior and senior staff can learn from each other.

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Team Formation

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Example:

Used BIM daily. A Preconstruction Director stated, "Every time we do something, we ask for a model. We have tried to force it into our daily workflow (in preconstruction). This used to be a struggle but it's not anymore. When people see the value in it, what was a chore doesn't seem like a chore anymore: it is just part of what you do."

Play a role in BIM Implementation. While some owners do not have extensive experience in BIM, they should still have a role in BIM in terms of defining the project's goals, organizing who is responsible for the model, deciding on software for the project, determining the cost of buying software and training team members, coordinating design and construction contracts, and aligning information between stakeholders. One owner reported having to meet with the BIM team twice a month for the whole project. This facilitated conversation throughout the project as well as validated the use of the modeling effort.

Invest in training BIM coordination with team. While you may only need one BIM expert on a team, collaboration improves when everyone on the team has a basic education and knowledge on BIM. Support efforts to train team members in BIM uses and coordinate a BIM execution plan with consultants.

Project Execution

1: Using BIM

Make models available and easy to use. Models are a project resource. Just as a plan-room has drawings, make models available to everyone on the team to empower team members to reference and query the models. Allow individuals to explore and find ways to integrate BIM views and data into their everyday tasks. Look for ways to make the model accessible and easy to use. Explore creating quick links in common software packages to ease the application of tools more broadly through the project team. Some teams have explored using field kiosks and game controllers to share models on the construction jobsite.

Standardize the use of BIM. Create project standards for BIM uses and information exchange throughout the BIM Execution Planning process.

Address interoperability. Interoperability is one obstacle to using BIM. Explore ways of reducing the types of software used on the project in the BIM execution planning process. Develop workflows for exchanging models and data between design, fabrication, and construction software packages.

Maintain trust in the model. Maintain reliability in the BIM model through accurately modeling building elements, such as structure. Subcontractors are relying on those models to prefabricate and install their work.

Encourage model exploration and process innovation. People can feel resistant or overwhelmed about learning a new technology. To overcome this obstacle, use team training, adopt technology (e.g., the use of iPads or BIM kiosks on site), or establish onsite BIM experts to make models easy to access. Reward project workflows that utilize new tools and methods in innovative ways.

Mentor consultants and subcontractors who do not yet use BIM. Not all team members have BIM capable staff or have team members with negative (e.g., expensive) BIM experiences. Illustrate the benefits of using BIM, select BIM uses that match project needs, and support team member firms without in-house BIM capabilities by mentoring team members.

Provide social opportunities to learn more about BIM. Teach team members about BIM through social activities, such as site visits to companies using BIM and shared lunch and learns with designers and builders. These social activities are also training and team building opportunities.

2: Data Exchange

Exchange models. For increased collaboration, create, exchange, and share models between the design, structure, and construction teams. As one builder explained, "we could have controlled them with pieces of paper, but we would have missed the real answer." Another project manager reflected that their project only had mistakes when the scope was not modeled.

Have a powerful server. One of the challenges of models is sharing them back and forth. File sizes are large and it becomes cumbersome and time consuming to transmit model versions back and forth. Establish a central model repository that is accessible to everyone. With version controls, this shared server is also a project record of model development.

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Project Execution

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3: BIM Communication Strategies

Define programs and platforms. Define programs and platforms for sharing models and images. Know what programs subcontractors and designers will use and determine the place and the time for posting the files to eliminate waste and improve coordination.

Add narrative to BIM representations. Due to software constraints, it is difficult to add text in a 3D digital model, which would be helpful in the RFP process. Create viewpoints and images from the models and add descriptive text to explain model issues. One builder recommended asking project team members to create pdf views "with everyone shown on it" to share with project team members.

Connect the VDC team with the field. Field supervision and crews benefit from reviewing models to identify issues and understand the project. Use 3D modeling as a visual tool, turning on and off the different elements. Use preset viewpoints to tell the story of logistics and coordination. Actively navigate the model during meetings to match the flow of conversations. Use a SmartBoard or projection on a white board to draw and illustrate over the model views, just as builders would draw on top of a 2D plan set.

Use the model for reviews and conversations. Use the BIM model to review issues and have conversations with architects and builders that lead to solutions. Using the model as a focus for the conversation, builders can ask the architects about clashes in design and work together to solve these issues.

Example:

Model and data exchanged. On one project, a steel fabricator in the Philippines uploaded their fabrication model to the architect server each week. The architects used the fabrication model for design coordination. At the same time sophisticated contractor detailers put RFI numbers, cost event numbers, and change orders numbers into BIM and coded all of them in the model.

Used a BIM server. On one project, there was heavy file integration between the design team and the construction team. Part of the work involved quantifying the model and adding additional input to help populate certain areas and see progress. The design team gave the contractor access to the virtual desktop interface (VDI) using VMware (Virtual Machine, cloud computing: the design team had a computer in a data center that provided a centralized location for team members to log into and work from.) This helped the team stay on the same page and better understand progress. To help geographically dispersed teams access the model, consider allowing the design and engineering team virtual access to documents through tools like VMware.

BIM exchanged. One team received a design from the architect and engineer in a 3D format. The builders further developed the details, processing a total of 70,000 shop drawings in a month. *(continued)*

Project Execution

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A general contractor reflected, "it was because we knew exactly what there was: it was there in 3D space. We were taking their design and updating it in the way builders want it."

Used the model for review and conversations. On one project there were clashes in the architect's design using Naviswork. Using the model, the builders discussed these clashes with the architect and brought in MEP contractors to comment. The builders wanted a clear understanding with the architects about what level of detail the architects would draw, such as focusing on details with the line size and schematic and design routing. Using the model as a focus for the conversation, the builders were able to ask the architects how they envisioned the routing.

Key Takeaways

In this section, we present some recommended practices for using Lean Construction techniques, tools, methods, and assessing team capabilities that emerged from the workshop and interviews. The focus of this section is to highlight how the application of lean principles and operational processes reduce waste and optimize efficiency through all phases of design, fabrication, construction, and occupancy. Lea also helps teams properly allocates resources to reduce errors and avoid rework.

Take time to plan. Lean tools, such as the Last Planner System, provides structured processes for planning that helps build trust and mutual respect between project participants. Taking time to plan allows the team to come together, created a shared understanding of project goals and mutual obligations, as well as understand each other's obligations to their own discipline and scope of work.

Bring people together to solve problems. One of the sources of waste in processes is submittal reviews and requests for information. These create paper trails of decisions being made, but are time consuming and inefficient compared to working meetings where designers and builder meet to discuss issues and develop solutions together. Consider developing processes (e.g., job walks and coordination meetings) where designers and builders can critically engage an issue, exchange knowledge, and resolve problems together. Then, a confirming RFI can be used to document these decisions. Better solutions emerge when various disciplines come together around a problem, understand the disciplinary constraints, and work together to resolve those constraints.

Prepare individuals for a lean project environment. To see changes with lean processes, individuals on the team need to understand the philosophy behind the tools and processes. Invest in the project by investing in continuous learning for project participants. For example, lunch and learn workshops are recommended to bring the team together to extend their knowledge about lean construction. This has the added benefit of team building where project participants get to know each other in a constructive way.

While reading this, think about the following key questions:

- How would you apply lean techniques to your project?
- How do you pre-qualify team members for lean experience?
- What communication tools can you use to support a lean culture?
- How can you help everyone on the team learn a bout lean?

Team Formation

1: Tools and Methods

Strategically apply lean technics to your project. It is important to recognize the principles of lean that are most important and add value to the job. Recognize the status of team members in terms of lean construction understanding and reward all levels of performance from beginner to expert. Setting specific and achievable goals will help you set expectations.

Use a Last Planner System. The Last Planner System can help collaboration by setting up a structure where team members talk about mutual obligations and make commitments to each other. This is one of the most active ways of promoting collaboration, overcoming daily obstacles, developing weekly work plans, and creating a reliable team culture. This extends to field interactions where team members get to know each other and their constraints and obligations. This interaction builds trust if these obligations are heard and met by others.

Take time to plan. Use lean techniques to plan big events in advance, such as delivery and installation of air handlers on the roof. Engage the owner and designers in planning. Conduct field walks with the designer and try to come up with the best solution together.

Example:

Using pull planning. One project manager reported, "It took people a while to understand because everything starts from the end. But after a few sessions, our scheduler learned how to do it correctly and all of the trade partners saw its benefits. Every major milestone was scheduled with pull planning. If the schedule was behind then we developed a new pull plan. This showed that everyone was dependent on each other and then understood the level of commitment. Everyone became honest on their schedule."

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Team Formation

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2: Team Capability

Pre-qualify team members for lean experience. Ensure core team members have experience with lean processes. Have a lean alignment workshop, because lean means different things to different people. Ensure that the general contractor and trade partners each have a lean champion, the go-to person for lean, who is the liaison for their companies. It is also important to communicate across the whole team your expectations for lean.

Select individuals who want to try lean construction. Establish lean advocates who are in a position to lead the processes directly, so they are not in conflict with other authorities on the project. Note, it is about the incremental growth of the team—not everything from the beginning.

Set expectations. In our research, we have found that the owner has a significant impact on the culture of the team. When the owner sets the vision of collaboration for the team and reinforces that vision throughout the project, team members respond with collaborative behaviors. Conversely, if the owner organization is misaligned or disengaged, the team conducts "business as usual." As an owner, realize that you have a significant impact on team culture.

Project Execution

1: Tools and Methods

Use just in time delivery. Coordinate the deliveries with the schedule to load materials where they are being installed in the building at the appropriate time. This keeps the job site clear of barriers and obstacles. This makes for a safer and more efficient work site.

Extend lean thinking to document management. On one project, the builder reported that "We did not have any… [attachments] going through email, it was all [central and] electronic." Using document management systems supports a lean culture by reducing the waste and management time spent updating drawings, version control, managing RFIs, and the submittal process.

Example:

Used cloud-based document management. One project reported using Bluebeam studio for marking pdfs in real time, instead of uploading and transferring documents. As one builder observed, "If we get to the point that everyone is working in real time…between contractors, architects, and engineer, then we save a lot with lean and integration."

2: Team Capability

Use lunch and learn across the team: One project reported using a Lean Book Club to help everyone learn about lean processes and tools. Designers, builders, and owner representatives met together during lunch to discuss lean books. Consider using webinars, lectures for the whole group, and providing a library of lean books. This also supports team building as team members read, discuss, and learn together. They can also talk about how to apply what they are learning to the project at hand.

Think more about lifecycle, operation, and maintenance costs. While first costs are often pressing, when builders put themselves in the shoes of a building's owners and users, the result is better quality construction. Lifecycle thinking sets construction apart as a service and is where builders can differentiate themselves from competitors in the marketplace.

Conduct lean training for field crews. Convey foundational principles of lean. Teach specific lean techniques such as pull planning. Help field crews understand the importance of their role in making a project successful.

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