Preliminary Results
Currently, the research team is actively involved with three of the four facilitated projects. Since each project is involved in a different stage of the design and construction process, interviews, facilitated meetings and evaluation surveys data are being conducted concurrently as each project team works through the implementation of the new collaborative practices. The following observations are based on early and somewhat generalized information:

Response to Collaboration: In two of the four facilitated projects, the key project team members are housed in the same offices or trailers. Both teams showed skepticism towards the cost and productivity of this arrangement, but overall seemed receptive to its benefits.

Response to Collation: In two of the four facilitated projects, the key project team members are housed in the same offices or trailers. Both teams showed skepticism towards the cost and productivity of this arrangement, but overall seemed receptive to its benefits.

Team Environment Surveys: Early survey results for interparty trust, respect, teamwork, and communication have been generally positive. However, factors such as the amount of work being done onsite, specific incidents between party members, and even seasonal changes have been reflected somewhat in the survey responses.

Communication Data: RFI and submittal resolutions have been fairly quick. These, however, seem to be similarly affected by the intensity of jobsite activity, interparty incidents, and periodic design changes.

Acknowledgements
Participating Firms:
• Balfour Beatty Construction
• Barton Malow
• Clark-Nexsen
• Massaro Corporation

Collaboration Addendum Facilitators:
• John Bechtel
• Jason Hopper
• Bevan Mace
• Dave Parker

For additional information or questions regarding this research, contact:
Hector Velez, Graduate Research Assistant
hve114@psu.edu
Dr. Robert Leicht, Assistant Professor of Architectural Engineering
rbleicht@engr.psu.edu

Lean and Green: Research Initiative
Piloting the Implementation of Facilitated Collaboration on University Park Projects

Hector Velez and Bryan Franz, Graduate Research Assistants, and Robert Leicht, PhD, Advisor

AEC Industry’s Collaborative Transition
The architecture, engineering and construction (AEC) industry has experienced a broad movement towards more collaborative processes, with a focus on improved team performance and better project outcomes. "Design-build (DB), partnering and integrated project delivery (IPD) are among the numerous methods being used to achieve such results. However, recent studies have shown that project and team-level performance may rely more on the interactions and relationships between team members than the particular delivery method or contractual agreement being used. Thus, emphasis is being placed on building effective teams to improve project performance, independent of the type of delivery or procurement methods.

Several large, institutional owners have begun to require such collaborative approaches on their projects. The legal implications of IPD and similar options, along with the inherent risk of using relatively new and untested methods, has made this transition difficult for some owners. "IPD-lite" and "IPD-ish" deliveries have been used to describe new methods in which the basic principles of collaboration, teamwork, and integration are tailored to the specific circumstances of each project. Collaboration "facilitators" and "coaches" provide leadership, room for adjustment and a platform for improvement.

Project Delivery Methods in Penn State Construction
OPP is the in-house construction management and facility management office overseeing all of Penn State’s construction projects. It manages over 1,700 buildings and more than 30-million gross square feet of space. The sheer volume of capital construction on Penn State’s campuses necessitates effective delivery methods, high-performing project teams, and high quality buildings. As a public institutional owner, OPP frequently uses two delivery methods: construction manager at risk (CMR) and construction management agency (CMA) with multiple primes. Various constraints, such as the procurement limitations of public funding and OPP’s organizational structure, have prevented the use of IPD and other collaborative delivery methods. Consequently, the facilitated efforts on the four pilot projects represent OPP’s commitment to effective teamwork, improved project performance, and an overall collaborative environment in its projects.

Research Goals
This research aims to assist Penn State’s Office of Physical Plant (OPP) in developing effective design and construction teams by piloting a collaborative project framework, in the form of a Collaboration Addendum. This collaborative attachment is currently being tested in four University Park campus projects, including a major laboratory expansion and dormitory renovation.

Each project is individually analyzed in terms of collaborative practices, communication effectiveness; inter-party trust, respect, and relationships; as well as the resulting effects on project performance. These projects will be compared to each other, and to six previously completed OPP projects without the Collaboration Addendum. The combination of these case study comparisons will ultimately attempt to answer the following research questions:
1. What factors define collaborative project teams?
2. Do collaborative project teams produce better outcomes?
3. What is the value of collaboration within construction-driven projects?
4. How should team and project effectiveness be distinguished, and which approaches can lead to both?

Research Methodology
This research involves observations of two categories of case study: the four ongoing, collaboration-focused pilot projects, and six previously completed projects that provide historic context. A quasi-experimental research approach is used to compare these facilitated and non-facilitated both quantitatively and qualitatively. Quantitative metrics include cost and schedule growth, timeliness of RFI and submittal responses, and interparty team evaluations. Qualitative metrics include perceived levels of teamwork, collaborative tools and methods employed, and facilitation effectiveness. As Figure 1 shows, the research entails project team observations, individual interviews, periodic surveys, and data collection periods.

This research will not present statistical results on the differences between facilitated and traditional, non-facilitated projects. Instead, it is intended to create a baseline understanding of OPP’s collaborative initiative thus far—the particular methods being used, the effects on team and project performance, and the implementation aspects that can be improved.

Figure 1: Research Methodology Steps
### Selection of Pilot Projects
At the University Park campus, OPP managed the construction or renovation of 18 capital projects in 2009 and 2010. For this research, seven planned projects were identified as potential pilot cases for the Collaboration Addendum. From these initial seven projects, three were eliminated from consideration for not meeting one of the following criteria: (1) at least one team member has prior experience with design-build, and (2) the project is pre-RFP or within one month of CM selection. The remaining four projects were selected as pilots for customized versions of the Collaboration Addendum and are summarized in Table 1.

### Step 1: Develop Addendum Template
A template Collaboration Addendum was drafted, using IPD contract examples from practice, including ConsensusDOCS 300, AIA’s Single Purpose Entity agreement, and similar attachments from several industry partners (Figure 2). Six core IPD contract elements were identified in literature and included: (1) early involvement of key participants, (2) mutual trust and respect, (3) mutual benefit and reward, (4) collaborative innovation and decision-making, (5) jointly developed and validated goals and (6) appropriate integration of tools or technology. The template was comprised of six sections, each containing one or more of these principles. The section headings included: Communication, Integrated Planning, Scheduling, Budget and Cost Control, and Quality of Work. The last section, Incentives, was considered optional and intended to be addressed on a project-by-project basis.

### Step 2: Project-Specific Refinement
The Collaboration Addendum draft was customized and refined for each of the four case study projects to include OPP’s project-specific goals, performance metrics, contract language, quality and incentive structure. When the timing of bidding and contract award allowed, all project teams were also involved in the customization process to provide feedback, recommendations and commitment to the collaboration concept. The refinement process was conducted over a period of several weeks and included a series of meetings with the design and construction teams to introduce the intent and educate the team members to the language and elements embodied before the establishment of measurable goals and realistic, but challenging, expectations for each project.

### Step 3: Implementation
The draft Collaboration Addendum underwent a legal review, to ensure the attachment language did not conflict with existing contract language used by OPP. The final version was then attached to the design and construction contracts on each of the four pilot cases. Participants in the Collaboration Addendum meet monthly to present and discuss the pre-established project performance metrics.

### Tracking Team Performance
Ongoing measurement of changes in project team behavior is central to this quasi-experimental design; therefore, data collection included both pre-established metrics and team observations. In accordance with many team construction and IPD principles, the focus of these metrics was reliability and team efforts, rather than individual performance. An example of a completed set of metrics, developed in cooperation with the project team on the Dormitory Renovation, is shown in Figure 4. Each case study project is developing a similar matrix with comparable metrics, customized to the goals and capabilities of the individual project teams.

While intended primarily for the administration of an iterative process, these quantitative metrics will continue to be collected by researchers on a monthly basis to track and trend changes in collaborative team outcomes. This metric data will be supplemented by qualitative observations, intended to monitor changes in team behavior and processes. Researchers will assist the project teams in generating metrics each month to ensure data accuracy and consistency between the case study projects.

### Example in Practice: Dormitory Renovation
On the Dormitory Renovation case, a metric for timely communication was defined as the percentage of RFI’s returned within three days of issuance and submittals returned “Approved” or “As Approved” within two weeks of issuance. To achieve the target of greater than 90%, the construction manager, architect and subcontractors would need to communicate frequently and effectively. Results of the first quarterly data collection of this RFI metric are provided in Figure 5. By establishing a challenging, but attainable goal, this contract attachment attempts to foster more collaborative team behaviors. While the Project Team did not achieve their target of 90% returned in 3 days or earlier, the presentation of these results sparked discussions on the RFI process, encouraging the team to reconsider the how RFIs are distributed, responded to and documented.

In addition to process metrics, the Dormitory Renovation Project Team also participated in 360° evaluations, administered by researchers. The goal of these evaluations was to assess the team environment, both from an individual perspective and as a unit, across several commonly cited indicators of collaboration, including respect, trust, accountability, cooperation, acknowledgment of problems and communication. The initial results of the evaluation is provided in Figure 6, which compares the average ratings for November 2012 against July 2012 across each indicator.

### Participation in the Addendum
Stakeholders in the Collaboration Addendum varied by pilot case, but always included the construction manager and architect as the primary participants (Figure 3). Some cases also involved design engineers and MEP or façade subcontractors. The team’s participation in pilot cases was influenced by the delivery method, timing of contracting and identification of key subcontractors, trades or vendors. While the customization of the Collaboration Addendum for each case was intended to include feedback from all selected project participants, involvement was frequently limited due to the timing of contract awards.

---

### Table 1: Summary of pilot cases for Collaboration Addendum

<table>
<thead>
<tr>
<th>Case Study Project</th>
<th>Organizational Structure</th>
<th>Contract Type</th>
<th>Approximate Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Union Addition</td>
<td>CM at Risk</td>
<td>GMP</td>
<td>$25 M</td>
</tr>
<tr>
<td>DORMITORY RENOVATION</td>
<td>Design-Build</td>
<td>GMP</td>
<td>$75 M</td>
</tr>
<tr>
<td>RECREATIONAL BUILDING</td>
<td>CM at Risk</td>
<td>GMP</td>
<td>$25 M</td>
</tr>
<tr>
<td>RESEARCH FACILITY</td>
<td>CM Agency w/ Multiple Prime</td>
<td>Lump Sum</td>
<td>$26 M</td>
</tr>
</tbody>
</table>

### Figure 2: Collaboration Addendum development process

### Figure 3: Summary of participation in Addendum by pilot case

### Figure 4: Example goal and metric matrix for Dormitory Renovation case

### Figure 5: First quarter RFI metric results for Dormitory Renovation case

### Figure 6: Comparison of team evaluations on Dormitory Renovation case

---