A New Direction

The Wisconsin Institutes for Discovery: Integrated Project Delivery

This paper no more seeks to define Integrated Project Delivery than the Discovery project itself definitively embodies it, and indeed neither is capable of doing so. Forty years ago, the CBC asked listeners to propose a Canadian equivalent to, "As American as apple pie," and declared the winner: "As Canadian as possible, under the circumstances." That conditional sentiment could similarly be applied to IPD. To succeed, it must assume an idiosyncratic form responding to the unique circumstances surrounding the project on whose behalf the approach has been undertaken. This paper simply describes one application of a relatively new alternative approach to capital project delivery.

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An environment in which to experiment and excel

From its earliest conception, the Wisconsin Institutes for Discovery ("Discovery") — comprised of the public Wisconsin Institute for Discovery and the privately funded, non-profit, biomedical research organization, the Morgridge Institute for Research — was envisioned as a new direction in collaborative research and research facility design. Breakthroughs to be found in the evolving confluences of once-discrete disciplines inspired a program focused on social ergonomics strategies and laboratory flexibility. Goals for energy-efficiency and sustainability were set at a 100-year building lifespan, 50% reduction in CO2 emissions, and a 50% reduction in water use in the operation of the building, as compared to recently constructed research laboratory buildings elsewhere on the UW-Madison campus. Achieving this within the already complex program of a research laboratory building warranted a new direction in project delivery as well, enlisting pairs of otherwise discrete owners, architecture firms, and construction companies in a network of commitments and relationships similar to those the building will support for decades to come. In so doing, the building project itself became Discovery's first environment in which to experiment and excel.

Discovery's mission is to accelerate new knowledge improving human health and well-being. Research being conducted in the Discovery building includes: Systems Biology; gene activation (Epigenetics); therapeutic cellular and tissue implants (BIONATES); Regenerative Medicine; Virology; Pharmaceutical Informatics; and, health care systems, environments, and treatment technologies optimization. Underscoring the urgency of Discovery's mission is an equal commitment to public and educational outreach, served by a resource clinic and symposium forum on the ground level, and embedded teaching labs throughout the facility for use in knowledge and technology transfer to researchers, companies, public groups, teachers, and K-12 programs. The facility fundamentally represents the achievement of a mission-driven and mission-driving building project.

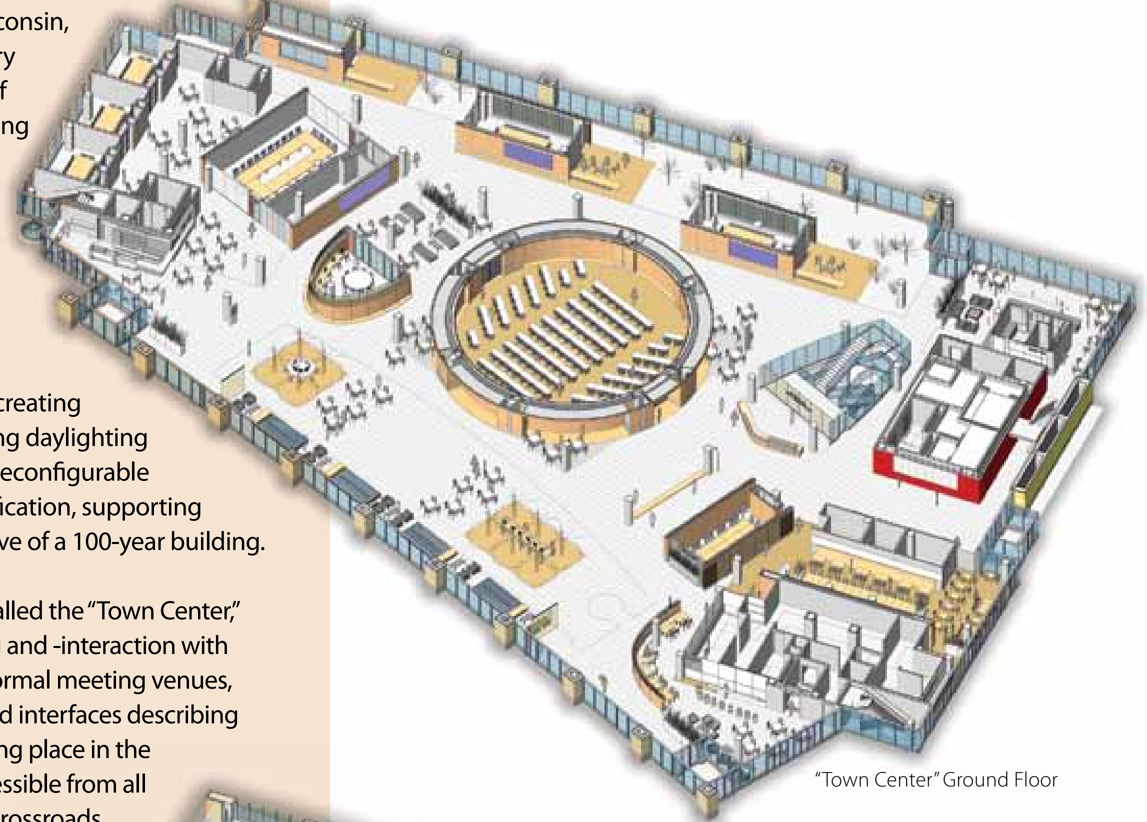
The Wisconsin Institutes for Discovery Facility

Made possible by a gift from John and Tashia Morgridge, matched by the Wisconsin Alumni Research Foundation and the State of Wisconsin, the 300,000 square foot Discovery building is a unique realization of synergistic optimizations. Fostering and supporting flexible, interdisciplinary collaboration within a larger public context defined a non-linear, concentric pod organization of research spaces. This in turn supports sustainable design strategies to reduce energy consumption by creating thermal buffers, in turn optimizing daylighting through extensive use of glass. Reconfigurable utilities accommodate lab modification, supporting the sustainability-related objective of a 100-year building.

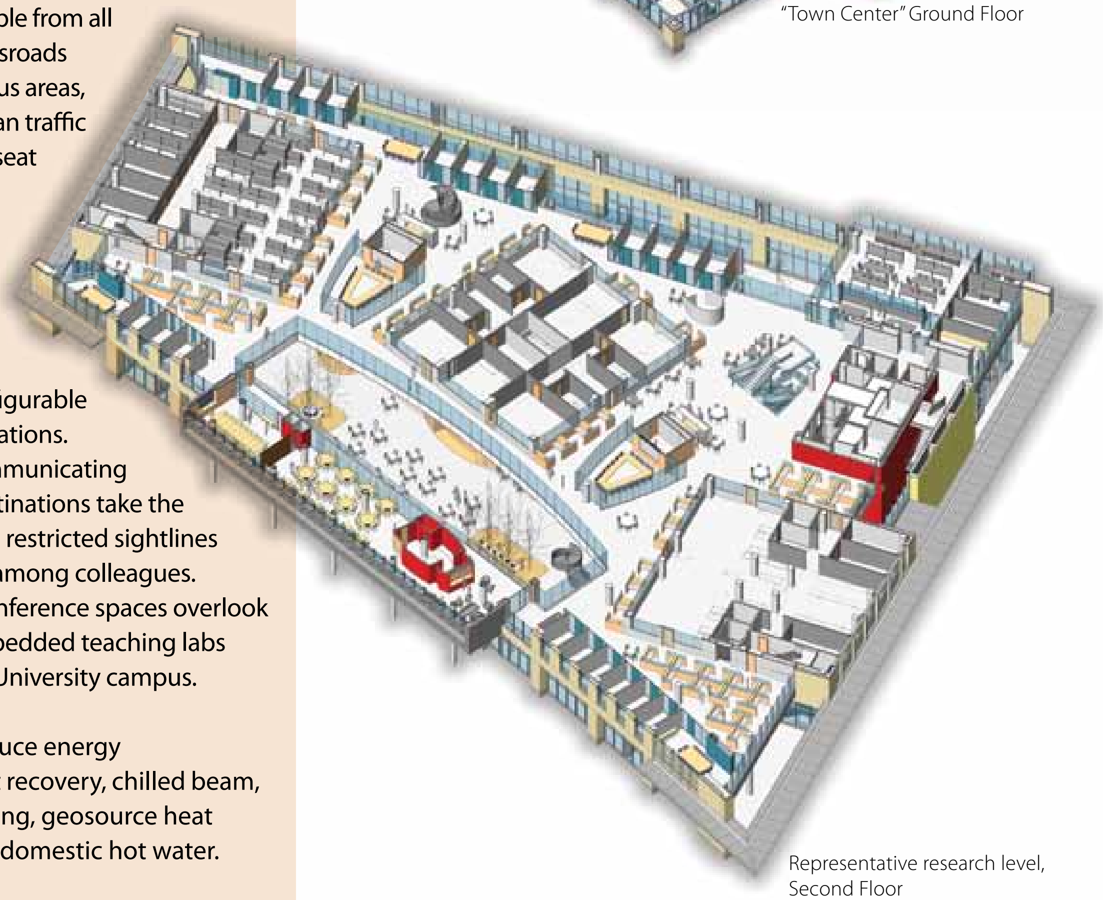
The ground floor of the facility, called the "Town Center," encourages community-building and -interaction with three restaurants, formal and informal meeting venues, and an assortment of displays and interfaces describing the research and discoveries taking place in the building. The ground floor is accessible from all sides, creating the dynamic of a crossroads between the north and south campus areas, encouraging pass-through pedestrian traffic with inviting winter gardens. A 300-seat central forum symposium space is encircled by retractable walls and supplemented with conference spaces and breakout rooms.

The lower level, second, third, and fourth floors provide secure, reconfigurable laboratories, and office and work stations. Open floor plates, glass-walled communicating stairs, and incidental gathering destinations take the place of conventional corridors and restricted sightlines to encourage frequent interaction among colleagues. Researcher lounges, dining, and conference spaces overlook one of the winter gardens, and embedded teaching labs are stacked facing the heart of the University campus.

Technologies and strategies to reduce energy consumption include exhaust heat recovery, chilled beam, LED task lighting, daylight harvesting, geosource heat exchange, and solar generation of domestic hot water.



"Town Center" Ground Floor



Representative research level, Second Floor

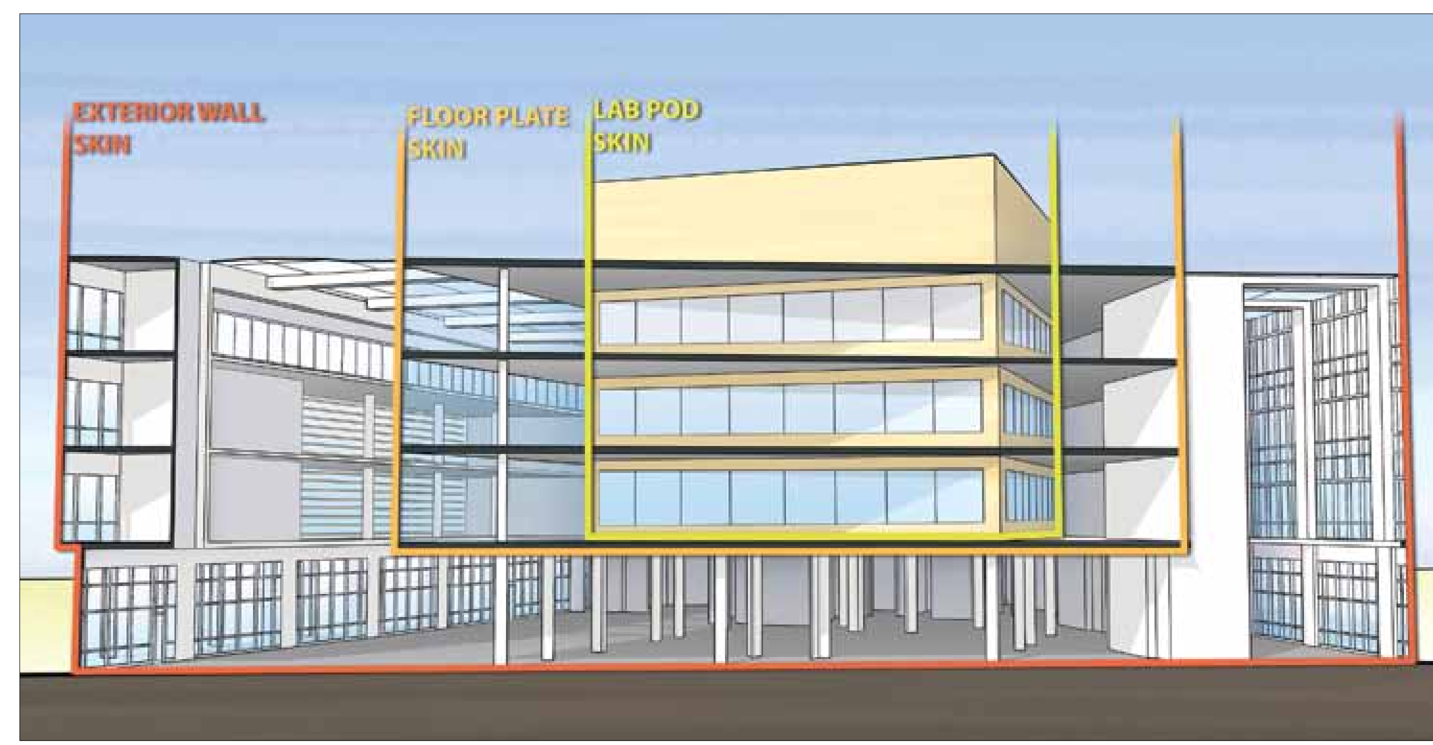
"The Institutes' home is an exceptional research tool that we needed as soon as possible," says Dr. Sangtae Kim, executive director of the Morgridge Institute for Research. *"Measuring time as potential begs the question of what delayed research really costs. What if the polio vaccine had been delayed by a year? What would have been the human cost?"*

Integrated Project Delivery (IPD)

The conventional wisdom on capital project value holds that of scope, quality, and cost, the best you can hope to realize is two out of the three. The Discovery project team is confident that it has achieved all three, crediting the implementation of an alternative method of project delivery.

The Discovery building is co-owned by the University of Wisconsin and the Wisconsin Alumni Research Foundation (WARF). WARF acted as private project developer on the State of Wisconsin's behalf. An exception to the State's usual practice, this role was an outcome of the unique conditions of Discovery's public-private partnership. With project funding coming from WARF and from John and Tashia Morgridge, the State would realize a project of at least $150 million for a $50 million public investment. In exchange, WARF assumed the risk and was given latitude to explore approaches other than those traditionally followed on campus building projects.

Value is a compelling motivation, inspiring accuracy, efficiency, and speed to, in turn, realize quality, cost, and scope. Consideration might have been given to a fast-track method, in which construction begins before design is completed. However, fast-tracking alone doesn't require the extent of team collaboration necessary to successfully execute so complex a design. Nor would bid contracts of any kind address the increased potential for error and exposure to liability implicit in the combination of complexity and speed. The WARF board saw the project as an opportunity to undertake an Integrated Project Delivery approach, and encouraged the project leadership to pursue it. IPD incorporates principles and methods characterized in Sutter Health's "Five Big Ideas" and popularly associated with the concepts of Lean Manufacturing, in which the expenditure of resources for any goal other than the creation of value for the end customer is considered inefficient, even wasteful, and is targeted for elimination. In the case of Discovery, those methods and principles included: a single integrated project agreement (IPA) between owner, designer, and builder; early design participation by the builder and sub-contractors; and, the use of a single design/construction/operations platform, BIM (Building Information Modeling), to coordinate and integrate the activities of project team members.



"Nesting" Configuration of Spaces

Wisconsin Institutes for Discovery
Project Timeline

2004	November	James Doyle, Governor of the State of Wisconsin, proposes $50M for interdisciplinary biomedical research facility at UW-Madison, naming it the Wisconsin Institute for Discovery.
2005		WARF board member, Stanford trustee, and Giving Pledge philanthropist John Morgridge promotes interdisciplinary research model of Stanford's Clark Center to WARF managing director Carl Gulbrandsen. Proposal is developed.
		Project complexity and schedule inform alternative delivery strategies.
		Proposal submitted to WARF board of trustees.
2006	February	WARF adopts proposal, approves $50M. Morgridge donates $50M.
		WARF names its project manager.
	April	Public announcement; within two weeks, the Building Commission and UW Board of Regents approves the project. WARF becomes State's developer of Discovery.
		RFP issued to architects.
	June	WARF endorses use of Integrated Project Delivery method.
	September	Ballinger/Uihlein Wilson named architects.
	October	RFP issed to construction managers/general contractors.
	December	Building concept program phase begins, with benchmarking and surrogate user groups.
2007	January	Findorff/Mortenson a Joint Venture named CM/GC.
	February	First meeting of Owner, Architect, CM/GC core team.
	May	Building concept phase ends. Concept program issued.
	September	WARF approval of concept.
	November	Morgridge Institute Board approval of supplemental sustainability features.
		Research support space relocation.
		Site rezoned.
2008	January	First researcher identified.
		Demolition permit issued.
		Multi-party IPA executed.
	February	Demolition begins
	March	Specific implementation plan approval.
	May	Building permit issued.
		Groundbreaking.
2009	May	Topping off.
	June	Discovery researchers selected, 5 meetings to determine fit out.
	November	Building enclosed.
		Fit out schematic drawings and cost estimates.
2010	January	Construction of buildout begins.
	December	Ribbon cutting.

Team Selection & Contracting | Design | Construction

The Discovery project leadership determined that IPD would allow the desired compression and overlap of the traditionally sequential phases of team selection, contracting, programming, design, and construction. Also, the form of contract involved could mitigate risk and motivate performance through joint project management and by obviating blame.

The Discovery project team consisted of:

Owner
- Wisconsin Alumni Research Foundation
- University of Wisconsin

Architect
- Milwaukee-based Uihlein/Wilson Architects and Philadelphia- based Ballinger, with GRAEF (Structural/Site/Civil); Affiliated Engineers, Inc. (Mechanical/ Electrical); PSJ Engineering (Plumbing); Intelligent Network Solutions (Telecommunications); and, Olin Partnership and GRAEF (Landscape).

Construction Manager/General Contractor
- A joint venture between Madison-based J.H. Findorff & Son, Inc. and Minneapolis-based M.A. Mortenson Company, with General Heating and Air Conditioning (Mechanical Contractor); Westphal Electric (Electrical Contractor); and, Hooper Corporation (Plumbing Contractor).

While most of the project team members had extensive experience with collaborative work methods on previous complex building projects, certain aspects of IPD differed significantly from their conventional delivery project experiences.

The Integrated Project Agreement (IPA)

In a conventional project delivery, the designer and builder contract individually with the owner, effectively creating jurisdictional boundaries. The Discovery project team instead developed its IPA in negotiations including all three parties. Owner, designer, and builder established and agreed to honor operational protocols optimizing coordination, transparency, and accountability.

Negotiating the IPA became the project team's first collaborative exercise. Writing a contract over the course of a year (drafting commenced during the building concept development phase and was completed only at the outset of site preparation work) perhaps is not the ideal. However, while the team was creating a trust-based agreement, the project proceeded, based largely on trust. A project culture of protocols and terminology began to evolve, and with it an understanding that for any one party to succeed, every party had to be allowed to succeed.

The combination of building complexity and desired speed of completion informed the decision to undertake an IPD approach on Discovery.

The team further agreed to follow a target value approach to design, in which a team designs to a set budget, rather than the conventional approach of designing a project, pricing it at a series of project milestones, and paring out elements until the cost estimate falls within the owner's budget. The target value approach requires ongoing cost estimating, starting with establishing the target value itself, thus requiring early design participation by those team members who establish a basis for pricing, namely the CM/GC and subcontractors.

In setting up the integrated team for the Discovery project, the team leadership was ultimately implementing an exercise in setting realistic expectations, focused on the ability to avoid problems occasioned by the inevitable unexpected circumstances of a project. A team-managed and -controlled project contingency fund, established as part of Discovery's target value approach, covered unanticipated developments impacting project scope. The Discovery contingency created a safety net providing change management for a project with significantly undefined elements at its outset, and also covered mistakes, failures of coordination, and workmanship issues. Where a natural inclination might otherwise be self-protection and, consequently, blame, this was preempted. In contrast, the negative penalty incentive model of a conventional Guaranteed Maximum Price approach, in which the designer and contractor contract separately and operate from protective silos, creates a dynamic of contention. By removing fear of incidental error, shared project contingency also removes a climate of looking for what could go wrong, allowing team energies to be more positively focused.

The Wisconsin Institutes for Discovery
Eight Value Propositions

The process of creating the physical facility to support the Institutes was intended to set a new standard by delivering greater value than traditional design and construction industry practices. The single Integrated Project Agreement used by the Discovery project team in executing the project included this explanation — adapted from Sutter Health's Integrated Form of Agreement — of their intentions and expectations for themselves and for those other subconsultants, subcontractors, and suppliers involved in the project.

A "value proposition" isn't typical to these types of contracts, and while in many respects IPD bears similarities to other collaboration and CMAR projects, this is still a largely unknown method of delivery lacking much precedent. This value proposition is meant to convey the spirit of the understanding.

Relatedness: Recognize and work to increase the relatedness of members of the Project team. Build interdisciplinary teams to solve both design and construction problems. Use the "Big Room" Design Workshop strategy throughout the Project.

Collaboration: Collaborate throughout Project Formation, Systems Development, Project Procurement, and Project Delivery Phases with all members of the team recognizing that the leadership of WARF, Architect, and CM/GC is Project-wide and not based solely on the magnitude of effort at any single point on the Project timeline.

Network of Commitments: Plan and manage the Project as a network of commitments. Quality must be controlled at the source where the work is being performed and by those performing the work. Therefore, develop Project-specific support systems for team members.

Building Information Modeling (BIM): By using Revit Building by Autodesk, and other software, the Project team will develop the physical components of the Discovery design as an association of elements with inherent parameters that maintain a dynamic internal relationship within a common data base. During the full life cycle of the Discovery facilities, information about those facilities can be extracted from the dynamic data base and used to serve the interests of WARF, the University, Architect, CM/GC, and future users.

Reliable Promising: Each Project team member agrees to help develop the reliability of work flow across the entire Project timeline by having the willingness and ability to make and keep reliable promises.

Planning and Scheduling: Project scheduling must be based on the principle of "Pull Scheduling." End of work stream outcomes are identified and then work is extracted (pulled back) to the current condition. The developed work stream must be connected and have a clear way to request action and receive a response (Should, Can, Will, Did). The schedule must be base on collaborative planning by all Project team members who will perform in a phase. Team focus is on making things happen rather than monitoring.

Minimize Waste: Learn to recognize and eliminate waste throughout the life of the Project.

Dynamic Cost Modeling/Target Value Process: The maximum price of the Project together with any contingencies is identified in the Project Budget. Initially, the project cost model will be developed using a combination of historical project data, current industry cost information, and systems-based cost data. Through the sharing of evolving information, the collaborative expertise of the team, and supported by BIM tools, the model will be used and updated in real time using the Project Formation, Systems Development, Project Procurement, and Project Delivery phases. Budget milestones will be confirmation points that the Project is in compliance with the maximum price of the Project and not stopping points in the process of pricing. WARF, Architect, and CM/GC staffed target cost teams will be charged with delivering set based design solutions to systems, components and sub-components within the target costs of those elements of the Project.

In compliance with a requirement of the State's exception allowing WARF to function in a project developer role on the Discovery project, subcontractors were bid. As these contracts were not subject to the IPA's contingency protections, Findorff-Mortenson joined to their contract six of the trades — mechanical, electrical, plumbing, and three enclosure contractors — formally tying them to the IPA and replacing their hard bid contingencies with incentives distributed at three points in the project, with guaranteed distribution to the craft level. Incentives were based on performance, graded for safety (injury), quality (rework), productivity (schedule), and BIM integration.

Early Participation in Design

The value to including the CM/GC and trade subcontractors in early design is threefold: initiating the target value approach and setting in motion the project's dynamic cost modeling function; establishing a thorough understanding of design intent; and, soliciting design concept feedback from the perspective of design implementation. While the process began with a period of cultural acclimatization for designers and contractors alike, it quickly produced valuable insights that otherwise might have only amounted to powerless — or costly — hindsight. For example, early design analysis indicated a structural height above the threshold for highrise classification, which requires such additional expenses as stairwell pressurization. The project team used the BIM model to maximize the efficiency of above-ceiling MEP distribution, reducing the overall building height by three feet, thus avoiding highrise status and its attendant expenses. Also, minimizing the overall volume of the facility subsequently reduced structure, enclosure, and interior construction costs. From the perspective of trade subcontractors, the experience of early participation in design was clearly rewarding, going by such reactions as "Usually nobody ever asks us what we think," and "We never sit at the table."

Informed by prior benchmarking and the input of surrogate user groups, cluster teams consisting of owner, designers, and construction representatives addressed six critical components of the project: Site, Structure, Enclosure, Interior Construction, Lab Casework, and MEP/IT. Groups were charged to challenge convention, find opportunities for innovation, and add value.

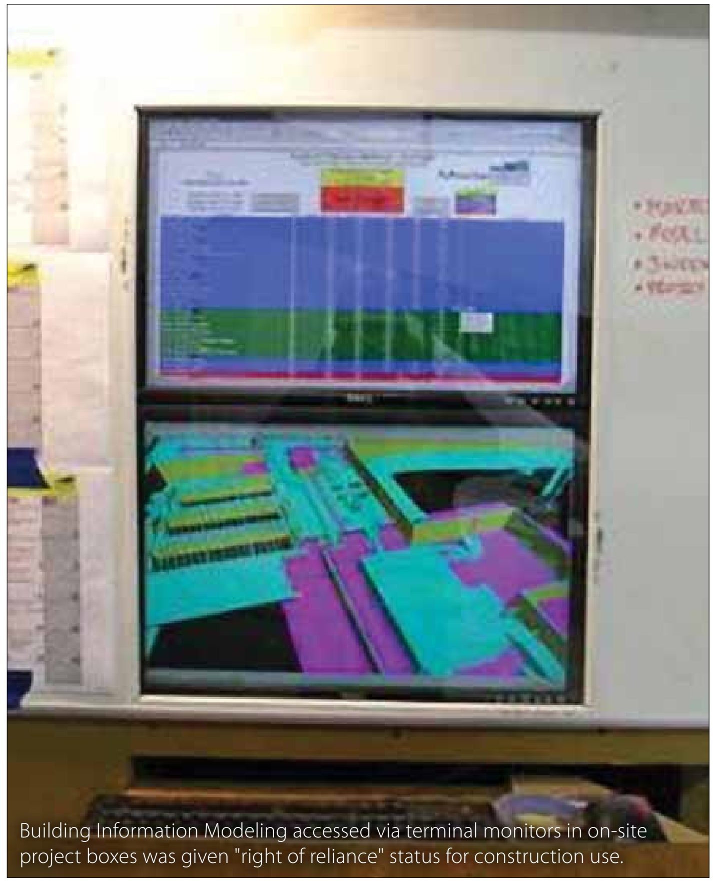
The concept development phase took five months, allowing relationships between project team members to develop and reinforcing a full understanding of the project's programmatic values. This period also allowed for more extensive bench-marking of comparable facilities and adjustment to an Upper Midwestern locale.

It is worth noting that at the completion of concept development, the actual IPA still wouldn't be executed for another eight months. The project team credits the broadly integrated concept development phase with establishing a culture of good faith and cooperation that — though not without challenges to it — would become a defining characteristic of the project.

Building Information Modeling (BIM)

The term "Building Information Modeling" refers to a dynamic suite of three-dimensional design programs used by project designers and contractors to design, coordinate, plan, and build a virtual facility prior to putting work in place in the field. An early deliverable of the IPD team on the Discovery project was a BIM protocol manual that set up the requirements and expectations concerning the software platforms, file sharing, communications, and related processes instrumental to the successful implementation of BIM technologies on the project. The BIM protocol manual was especially critical on the Discovery project, given that all design disciplines were required to design in 3D and the CM/GC was required to coordinate and plan by developing enhanced versions of the original design models. Relatively uncommon to the design and construction industry, the CM/GC was given "right of reliance" on the design BIM models, essentially meaning they had the right to rely on the BIM models for construction use, as much as any traditional 2D documents. Establishing BIM as a primary building tool was instrumental in enhancing collaboration, integrating the project team, and eliminating waste on the project.

The use of BIM on the Discovery project enhanced the IPD team's ability to identify and resolve problems and conflicts early in order to avoid them altogether on the job site, where they are costly to resolve. The team also leveraged the visual attributes of BIM to more effectively communicate design concepts and ideas to the multiple project constituents. Communicating with visual models allowed user groups, subcontractors, owners, operators, and maintenance personnel to have a better



Building Information Modeling accessed via terminal monitors in on-site project boxes was given "right of reliance" status for construction use.

understanding of the facility design and to better participate in its development. As a communications enabling tool within the immediate project team, BIM increased productivity, quality, and safety, ultimately maximizing space use within the facility, assuring long term operational efficiency and maintenance ease, and contributing significantly to the overall value of the project.

The prominent applications of BIM on the Discovery project included: early design coordination; 4D scheduling; quantity take-off (5D); vibration analysis; smoke control modeling; site logistics planning; integrated work planning; earth retention coordination; concrete lift drawings; MEP coordination; virtual mock-ups; prefabrication enabling; and, "smart modeling" long term operational use.

Outcomes During Design and Construction

Challenges and successful outcomes of the IPD approach on the Discovery project became dramatically evident both prior to and upon groundbreaking. Incidents of unanticipated site conditions and evolving project elements, however, should not overshadow cases of functional optimizations that perhaps would not have been possible without an integrated approach.

The project benefitted from another process identified with Lean practices, Reverse Phase — or "Pull" — Scheduling, in which the project team collaboratively plans and executes production schedules, working backwards from their intended completion dates, establishing in six week (or shorter) increments the materials, labor, and equipment necessary to succeed, each subsequent week accounting for a further week's requirements. Not only did this method of production increase efficiency and collaboration from the outset, it also served as a catalyst and forum for continuous learning and improvement, and established one of the bases for awarding incentive compensation.

The light is green and the meter is running.
Do not apply the brakes...

An early test of the IPD approach presented itself shortly after groundbreaking, when testing of vibration readings suggested unacceptable levels of movement. A site between two heavily trafficked streets and adjacent to an existing rail line, the irregular geometry of the building footprint, and an open floor plate configuration that spaced columns from eight to forty feet further apart than is typical, exposed the Discovery design to vibration. The instinctive response of defensive behavior and assigning blame in the face of construction delays yielded to the terms of the Discovery IPA and the remonstrations of the project leadership concerning agreed-to behaviors. The project team agreed to collectively seek solutions. Test pits were installed to subject different sub-foundation materials to vibration conditions and observe their capacities to mitigate groundborne disturbance. While a number of materials substantially did so, their performance did not adequately manage aberrant extremes. The leading vibration specialists in the country were engaged and revisited the design criteria for lab equipment, comparing aberrant extremes ("time domain") and frequent extremes ("frequency domain"). The project team reviewed the cost and structural impacts of placing the entire building on shock-absorbing springs and at the same time convened lab equipment manufacturers and scientists to assess the frequency domain performance of their equipment. Ultimately, frequency domain was found to be acceptable criteria for the majority of the lab equipment. Further analysis and field testing verified that the building would meet vibration velocities within the frequency domain with no structural modifications to the foundation or structure. Supplemental field leadership was added, optimizing resources to preserve project schedule despite a two and a half month delay. Just as importantly, the team's solution process reinforced relationships, setting the tone for the rest of the project.

...and do not slow on a sudden incline.

Even before the vibration issues emerged at groundbreaking, the project team had to accommodate a significant development impacting project scope, when the client asked that complex functional research support spaces initially planned for the lower level of the building be relocated with the loading dock to an additional, otherwise unplanned, separate smaller structure along the eastern edge of the site. In so doing, a 360-degree access would be created, fully realizing the desired "campus crossroads" dynamic of the building's public ground floor, and additional space would be made available to laboratories with equipment requiring the greater floor-to-floor height of the lower level. Also, the separate support building would similarly serve and benefit the eventual second phase of Discovery facilities, planned for the lot to the east. The Discovery team took the scope change in stride (which included requesting and receiving responsibility from the State for removing a utilities substation occupying the intended site of the support building) with little effect on the project schedule, even completing the additional $25 million structure five months ahead of the main Discovery building.

Successful building enclosure design and construction was essential to realizing thermal buffer nesting strategies.

Better by integration.

Decisions made by the Enclosure Design Cluster Team during the concept development phase ultimately engaged the largest number of participants in implementation, including the architects and the individual manufacturers and installers of the curtain wall, the terra cotta rain screen, the air and vapor barrier, and the flashing. Mockups were used throughout the Discovery project to resolve questions concerning construction standards and details. In this case, the enclosure group worked together in a warehouse to fully understand the integration of their individual elements in assembly, by building, testing, disassembling, and rebuilding mockups in a series of refinements to assure the flow of water over the exterior surface. Full water, air, and pressure testing ultimately confirmed a successful assembly reducing need for sealants, thus minimizing future maintenance. Testing of the final envelope strategy, conducted by the nation's leading façade liability assessment firm, exceeded the most stringent industry standards for whole-building air tightness. (Discovery's above-grade exterior enclosure tested at a 0.2 cfm/sf air leakage rate at 75pa., for an overall air leakage rate of 0.13 cfm/sf at 75pa., compared to the U.S. Army Corps of Engineers standard of 0.25 cfm/sf at 75pa.)

Future lab flexibility put to the test during construction. Essential to providing future laboratory reconfigurations capable of accommodating unknown research team permutations — in turn supporting a 100-year building lifespan — the complex "plug-and-play" lab pod utility feeds were immediately engaged in supporting an unexpectedly accelerated schedule of initial lab configurations. When the Discovery project began, identification of researchers and subsequent lab fit-outs were expected to occur over a five year schedule, and lab pod construction proceeded in more or less generic wet, damp, and dry models. The sequential became simultaneous, however, when the first researcher was identified shortly after groundbreaking and the remainder followed within a month of topping off — five months before the building was fully enclosed. The variety of specific lab requirements included support of cellular and molecular biology, biochemistry, organic synthesis, genetics, chemical engineering, computational modeling, bioinformatics, and biomedical engineering. Generic pod construction ceased, precise needs were determined, and a fluid schedule of ongoing design and buildout was developed to act on elements as they became defined. Had the project been delivered via a design-bid-build model, significant delays would have been required to resolve the pricing of buildout designs. Instead, the resiliency of the integrated team relationships, the nimbleness of response established within the integrated team culture, and the versatility of the lab pod utility feeds allowed adjustments to the more aggressive requirements, preserving the project schedule and allowing Discovery to open thirteen months later.

Interim director of the Wisconsin Institute for Discovery, John D. Wiley was Chancellor of the University of Wisconsin - Madison from 2001 to 2008, has chaired the Big Ten Council of Presidents and Chancellors, and has been a member of the National Security Higher Education Advisory Committee. He is the co-founder of the Center for X-ray Lithography and the Engineering Research Center for Plasma-Aided Manufacturing, and has served as UW's senior research officer and chief operating officer. *"The launching of Discovery is the most complex, interesting, rewarding, and challenging undertaking of my career,"* says Wiley.

Outcomes Upon Completion

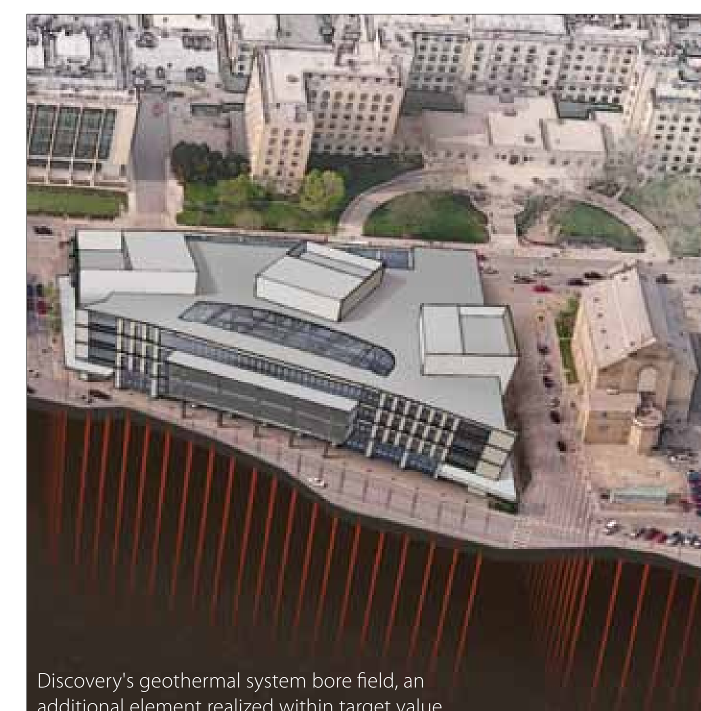
"Quality" can be an elusive status to quantify. Most immediately evident, the implemented quality of the building's intended finishes — cherry wood, limestone, stainless steel — complete the spatial design strategies in creating comfortable, pleasant settings that inspire, enliven, and focus. The functional performance of building's engineered systems have undergone quality assurance/quality control verification by rigorous building commissioning extending into the operations of the facility. The integrated system of building controls and automation will monitor and record the energy- and water-efficiency of the facility, tracking usage of power at the substation level, and use of water and of energy for lighting, heating, cooling, ventilation, equipment, and plug load at the building and individual lab levels. Ultimately, the quality of the Discovery building will be borne out by the quality of the research conducted within it and the reach of the knowledge coming from it. For purposes of this recounting of IPD on the Discovery project, we focus on how those qualities have been augmented by the efficiencies of this method of project delivery.

A year sooner than otherwise possible.
Given the complexity of the program and the project team, the newness of the delivery method, the significant early obstacles, and an evolving program throughout the undertaking, the most dramatic outcome of the Discovery project is that it was completed on schedule. This is conservatively estimated as having been a year sooner than would have been possible using a conventional design-bid-build approach.

A team commitment to value.
A central tenet of IPD is the creation of value for the end customer. In understanding the ramifications of Discovery's mission, the project team committed to making best choices on behalf of the project and allocated contingency to the value of the project. Proceeding with the schedule overlap and compression necessary to realize so complex a project at such speed, the team accepted in good faith the progressing definition of the facility while the owner assumed the risk for any extent of uncertainty. One senior project executive observed, "With the traditions and paradigms brought to the table, it strikes me as extraordinary that the team was so committed to making this an exceptional, no-regrets building at the expense of selfish interests … it is a testimony to the IPD philosophy that we all finished strong and took measure in the pride of a job done well and well done."

Significant additional project elements realized within target value.
The Discovery project was built within the target value identified at the outset, and value was augmented by both methodology and the form of agreement. The greater extent of team coordination combined with phase overlap and compression relative to conventional delivery created efficiencies that allowed the project team to absorb the evolving scope of 100-year building elements without impact to the project schedule. Meanwhile, savings realized from unused "safety net" contingency, the removal of sub-contractors' hard bid contingency, and through the precision of target value design, were reinvested in the project, ultimately providing within the original target value:

- Lab fit out for all researchers in the facility.
- Expansion in size and capacity of lower level server farm.
- Supplemental sustainability initiatives, including the Earth Heat Exchange System, solar generation of domestic hot water, LED task lighting, and the extensive "Intelligent Building Architecture" systems integration approach.
- Town Center enhancements on the first floor, including additional informational media displays and TelePresence room, and fit out of three food venues.
- Radio-frequency identification (RFID) system for research project asset management.



Discovery's geothermal system bore field, an additional element realized within target value.

The Discovery team observed stretch and bend requirements to reduce soft tissue injury.

Safety Program and Owner-Controlled Insurance

Discovery's owner-controlled insurance program (OCIP) and the building team's safety program both far exceeded initial expectations by assuring the safety of workers, project team members, and the surrounding public, and consequently minimizing construction delays and significantly reducing the project's overall insurance costs. Over the course of the project, there was precisely one lost-time injury, resulting in only 16 hours of time lost from work. The final year was flawless: no injuries whatsoever.

The owner-controlled program creates a reduction of insurance claims and adjustment expenses because one insurance company insuring all parties eliminates lawsuits and subrogation expenses between contractors, owners, and their respective insurers. The owner receives direct, broad liability coverage because it is a "Named Insured" on its own policies and not an "Additional Insured" on the contractor's policy. Keys to the Discovery project's success with safety were an absolute focus by the entire project team on practicing all attributes of the building team's "Zero Injury Safety" program, creating a true safety culture on the job site, and pro-active claims handling procedures that minimied costs to the OCIP.

RISK MANAGEMENT ITEM	INITIAL GOAL	ACTUAL RESULT
Loss Ratio (%)	20%	6%
Incurred Claims ($)	$580,972	$174,503
Contractor Insurance Savings	$5,378,050	$6,013,588
Program Savings ($)	$2,407,586	$3,555,728
Program Savings (% HC)	1.45%	2.15%

Rather than policing safety on the Discovery site, the CM/GC instilled a safety culture whereby all participants in the project were obligated to make safety their first priority, maintaining watchfulness and providing assistance for one another in their daily activities. A successful history of such programs on previous projects and an unrelenting focus on safety planning assured that the objectives of the safety program were met despite frequent project changes. Key components of the program included: first day, first hour safety orientation, followed by second and third orientations over the next several weeks; "safety leadership from the top" workshops applied to all levels of project management; daily stretch and bend sessions to reduce soft tissue injuries; daily pre-task planning; Plan of the Day (POD) meetings; Integrated Work Planning; safety-focused speakers at worker lunches; specialty safety training made available to all trades; multiple levels of daily site audits; worker-to-worker observation; and, a robust Event Management System to identify the root cause of near misses and incidents in order to avoid recurrence. Full-time on-site safety consultants representing WARF conducted daily jobsite safety inspections, monitored jobsite access, and coordinated immediate onsite claims reporting and investigation.

LESSONS LEARNED

Engage an IPD consultant early.

As of the composition of this paper in March 2011, the list of projects built using an IPD approach is not long and the number of project participants is relatively few. There were fewer still five years ago when the decision was made to use IPD for Discovery. So the project's team members were uniform from the start in at least one respect: none of them had ever done this before. The team ultimately brought in a third-party, IPD-knowledgeable facilitator when, during completion of build out documents, the team began reverting to siloed behavior. In retrospect, a consultant should have been engaged far earlier. Had an IPD consultant worked with the team as a facilitator at the project outset, a rhythm of collaborating would have been established more methodically. After all, the Discovery team was not only integrating separate disciplines, but also integrating two architects, two contractors, and two owners. Complexity is intensified by a compressed schedule and the stress points are in the transitions from party to party. Eventually those rhythms fell into place, but the team felt it would have benefited from early instruction in using the tools of collaboration, as well as standardization of protocols and procedures, meeting formats and frequency, and project terminology.

A sooner understanding of mutual support — deferring to the driver and valuing the supporter — can also pay dividends in efficiencies and savings. Overlapping project phases and introducing conventionally late construction participants to the design of the project allows anticipation of complications in execution. And retaining conventionally earlier design participants through the construction of the project allows the resolution of unexpected developments in a manner that best preserves design and programmatic intent. However participation in otherwise unconventional roles occasions emphatic reminder of the adage to "let the experts be the experts."

Get concerns, preconceptions, and expectations out in the open immediately. They will ultimately surface anyway, and an early forum for expression and resolution preempts disappointments and resentments.

Incentivize more project participants and more frequently.

The Discovery IPA initially involved only the owner, the architects, and the CM/GC team, meaning that only these parties were contractually tied to the IPA's incentive provisions, which were, as drafted, funded 100% from project savings following completion. Well into the project, the project team invited six of the key trades — mechanical, electrical, plumbing, and three enclosure contractors — to give up their hard-bid contingencies in return for formally tying them to the IPA and incentivizing them by distributions at three points in the project, with guaranteed distribution to the craft level. These interim-established incentives were based on performance, graded for safety (injury), quality (rework), productivity (schedule), and BIM integration.

The Discovery team believes that including these key trades (as well as certain others such as flooring, millwork, and landscaping) in the IPA from project inception, both bringing them within the safety net of the IPA as well as giving them the opportunity to share in the incentive pool at pre-determined project milestones, would have engendered more (and earlier) integrated behavior from them. While the trade contractors on Discovery actually did work very collaboratively, awareness of inconsistencies among the way project trades and consultants were or were not included in the IPA did give rise to occasional resentments. And there is never any guarantee that parties not "paid" to act collaboratively will still do so.

Supplement the MEP cluster with subgroups.

The success of the cluster team approach to building concept ideation is illustrated by the MEP cluster team's discovery that a six-inch ceiling drop would be necessary to increase capacity accommodating overhead utility feeds. The integration of MEP engineers and contractors also determined that substituting spool pieces for Phoenix valves at future fume hood deployment points would produce savings that would offset the cost of the Phoenix system itself. However, the prominence of the building's complex engineered mechanical, electrical, and piping systems relative to the overall project value (50%) was reflected in an unwieldy number of participants included in the MEP cluster. Where an ideal cluster team size is eight individuals, the MEP cluster had over 30. As a result, consistency suffered and the group received a disproportionately smaller percentage of "big room" workshop focus. Supplementing those disciplines with subgroups would have focused and simplified management of these areas throughout the course of the project.

Collocation is vital.
The overlapping of project phases and overlayering of otherwise sequential roles in IPD benefit from having the right people in the same place. The Discovery project team met this imperative by establishing a “big room” design workshop strategy space in a building adjacent to the project site, supplemented with WebExes as needed. In the absence of full owner/designer/builder participation, however, continuity in information flow was challenged and presentations had to suffice for conversations. Even too-frequent reliance on BIM and web-based tools as substitutes for face-to-face time reduced immediacy, resulting in lag time. Project team integration optimizes resourceful solution-finding; collocation of people is the collocation of information, from owner to designer to builder.

Be Practical and Flexible Where Modeling and BIM are Concerned
If the crucial dynamic of IPD is everyone being on the same page, that same page is BIM. This imbues the modeling function with primacy. The same page must be perpetually current and complete. Realistically, however, to do so despite the significant design changes likely in so compressed a project schedule would require an impractical degree of staffing redundancy.

On the Discovery project, the relocation of research support spaces from the lower level to a separate building was just such a significant design change, and construction did get ahead of modeling. The construction model maintained the integrity of the original basis of design while serving as the basis for maximizing free space in the lower level, but prioritization meant that BIM updates of the upper floors were delayed, becoming documentation of changes in as-built conditions after completion. Nevertheless, despite field coordination, the model still played a central role in organizing trade flow and utility routes, and all known field issues were documented in the BIM model as they arose. The team succeeded by never regarding BIM as anything other than a tool in service of a building project, and used it fully mindful of conditional limitations.

Limitations inform prioritization. The Discovery team prioritized the model based on which team members were actually using BIM. There is a hindrance in having only some subcontractors modeling and other associated subs not doing so. On the Discovery project, while the MEP systems were all modeled, the associated casework was not. Many of the issues that arose during installation could have been prevented had the casework subcontractor produced a model, allowing cross reference with the MEP model.

CONCLUSION

Parallels between the actual program of the Wisconsin Institutes for Discovery building and the form of its delivery method give the lessons of the Discovery project the resonance of archetype. Discovery’s mission of improving human health and well-being and the challenge to support that mission equally compel excellence. And the means of realizing excellence in both cases is rigorous experimentation and purposeful implementation.

The details of Discovery's integrated project delivery shouldn’t be taken as a universal roadmap. The conditions of its success are as abundant as the details of any highly complex undertaking. Two essential factors, however, stand out. Discovery benefited from an enlightened, resolute owner, assuming risk and acting with prescribed autonomy. Meanwhile, in fully understanding the project’s programmatic values, the Discovery project team equally understood the client’s mission. The outcome of the Discovery project was driven by that mission. The ultimate measure of its success will be the extent to which the Discovery project drives the mission, augmenting and enhancing Discovery's future.

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