Design Development

*A maximum of 40 hours of core credit may be earned in this experience area.

Design Development

Introduction

By completing the activities in this chapter, you will gain an understanding of the activities involved in design development. The following information is taken from the NCARB IDP Guidelines:

Design Development
Minimum Design Development Experience: 320 Hours
Definition: During design development, a project's schematic design is refined, including designing details and selecting materials. This step occurs after the owner/client has approved the schematic design.

Tasks
At the completion of your internship, you should be able to:

- Prepare design development documents
- Investigate and select building systems and materials
- Meet with client to refine design and obtain approvals
- Conduct or respond to a constructability review
- Apply sustainable design principles

Knowledge Of/Skill In

- 3-D modeling
- Adaptive reuse of buildings and/or materials
- Alternative energy systems and technologies
- Applied mathematics (e.g., algebra, geometry, trigonometry)
- Basic engineering principles
- Building design
- Building envelope
- Building Information Modeling (BIM) technology
- Building systems and their integration
- Characteristics and properties of construction materials
- Computer Aided Design and Drafting (CADD)
- Conflict resolution
- Constructability
- Construction details
- Construction sequencing
- Creativity and vision
- Critical thinking (e.g., analysis, synthesis, and evaluation of information)
- Design impact on human behavior
- Design principles
- Designing and delivering presentations
- Engineering load calculations
- Freehand drawing and design sketching
- Furnishings, fixtures, and equipment
- Graphic communication
- Hazardous materials mitigation
- Implications of design decisions (e.g., cost, engineering, schedule)
- Indoor air quality
- Interior materials and finishes

2E

resources

Download the current Intern Development Program (IDP) guidelines at www.ncarb.org/Experience-Through-Internships.aspx.

The American Institute of Architects. Demkin, Joseph A., ed. *The Architect's Handbook of Professional Practice.* 14th ed. Hoboken: John Wiley & Sons, 2008.

- Chapter 12.2 - Design Phases

The American Institute of Architects. Demkin, Joseph A., ed. *The Architect's Handbook of Professional Practice.* 13th ed. New York: John Wiley & Sons, 2001.

The American Institute of Architects, *The Architecture Student's Handbook of Professional Practice.* 14th ed. Hoboken: John Wiley & Sons, 2009.

- Chapter 7.3 - Design Phases

Knowledge Of/Skill In *Continued*

- Interpersonal skills (e.g., listening, diplomacy, responsiveness)
- Life safety
- Managing quality through best practices
- Manual drafting
- Natural and electric lighting (e.g., daylight, solar control, energy consumption)
- Oral and written communications
- Problem solving
- Product evaluation, selection, and availability
- Project scheduling (e.g., construction document setup, storyboarding, staffing projections)
- Site design
- Space planning
- Spatial visualization and modeling
- Specifications
- Sustainable design
- Team building, leadership, participation
- Technological advances and innovative building products
- Universal design (environments usable by everyone regardless of limitations)
- Vertical circulation

notes

Take brief notes while reading the narrative and list key resources you used to complete the activities. Note discussion outcomes from meetings with your supervisor, mentor, or consultants. When finalizing the activity documentation (PDF), include your notes and the Emerging Professional's Companion *activity description.*

Design Development

Narrative

The beginning of design development (DD) is a logical extension of schematic design. DD tasks build on the approved schematic design to reach a level of completeness that demonstrates the project can be built. The schematic design is overlaid with more detailed information obtained from an array of multidisciplinary consultants and team members. Throughout DD, it is important to evaluate how systems, material selection, and detailing reflect the schematic design concept. The design team works out detailed coordination issues, while enhancing the project, so that major revisions are not needed during construction documentation or, worse, during construction.

Depiction of all aspects of the design, including architectural, structural, HVAC, electrical, plumbing, and fire protection systems are essential. Depending on the building type, acoustic and vibration considerations, lighting concepts, landscaping design, and other specialized factors also need to be integrated into the design. Design development may rely on extensive three-dimensional representations (models, perspectives, animations, full-size mockups, etc.) to communicate both the overall design and details to the design team, the client, and the construction team.

Historically, schematic design, design development, and construction documentation were distinct phases of project delivery. In a continuous process of evolution, refinement, and integration, digital developments have blurred these phases. Add to this the emergence of project delivery methods beyond traditional design-bid build to methods emphasizing multiple packages and sequential issuance of design information, and the crisp lines between traditional project delivery phases are often gone.

Design development documents are often similar to those in schematic design, but contain more detail in the drawings and specifications and may—depending on the contract—be accompanied by an updated cost estimate. The client reviews these documents and, upon the client's written approval, construction documentation begins. In some project delivery methods, the issuance of production information and even commencement of construction overlap the design development phase. In these instances, the architect must focus sooner on systems that affect early stages in the work.

Architects must be proficient in preparing design development documents that detail project scope, quality, and cost, providing details about materials, systems, and compliance with life safety requirements. Meetings during this phase are critical to an understanding of why design decisions are made. Ideally, interns seeking licensure should participate in discussions with the client regarding scope, quality, and cost and in technical coordination meetings with the engineering disciplines. Identifying conflicts between building systems, collaborating with design team consultants to resolve these problems, and ensuring that specifications and drawings conform to applicable codes are important activities during design development.

resources

Learn more about design development and contracts via AIA Contract Documents: www.aia.org/contractdocs

The Design Development Process

Design development in the architecture profession is continually evolving, responding to changes in technology, project delivery methods, and computer-aided design (CAD) systems. As a result of changes in computer technology over the past several decades, the distinction between schematic design (SD), design development, and construction document (CD) phases has blurred. When DD documents are hand-drawn, SD drawings are often discarded and larger scale plans and sections begun. Commencement of the CD phase also included creation of new drawings. Creating drawings in CAD is a different process. As the project delivery process moves ahead, information is continuously added to the drawings, allowing them to be viewed in multiple scales, and more recently, explored in multiple viewpoints with three dimensional CAD.

Another cause of this blurring of phases stems from the adoption of project delivery methods that seek to build faster and with more input from contractors and manufacturers. Some contracts actually delete design development, going from concept design to construction documents. Others require creation of bid packages for foundations and structural frames in the middle of design development. Despite these changes in technology and delivery, the tasks that make up the DD phase are still necessary for a successful project, even if they are performed in different phases or out of sequence.

Design Development Tasks

The main task that must be accomplished in design development is preparation of drawings and documents for your client that detail project scope, quality, and design. Specifications and details of selected materials and systems are part of the DD package, with more technical detail provided by consultants. The DD products make possible a more refined cost estimate and a better understanding of how different building systems are integrated and how the building is likely to perform. Ultimately, the DD documents allow a client to make an informed decision whether to continue a project into the CD phase and construction itself.
The skills needed to accomplish DD tasks vary.

Architects must have the technical skills to take the approved schematic design and incorporate appropriate levels of detail in drawings and specifications, coordinate and integrate the systems, and comply with code requirements. Necessary management skills include the ability to participate actively in meetings with clients and consultants and to keep a project moving forward. Problem-solving skills are needed throughout the DD phase, as architects resolve conflicts between systems or consultants, reinforce and support the initial design intent with selection of materials and details, and explore important portions of the building at a larger scale.

Design Development Team

The project team gets bigger during design development. The core design team of architects and engineers is augmented with a number of consultants in specialties such as geotechnical issues, wind tunnel testing, security, sustainability, acoustics, lighting, vertical transportation, landscape design, and so on. While some of these consultants may have been brought into the project during SD, all of them have more work to do in DD. Today construction managers and cost estimators are included earlier in the design process, so they often participate in DD meetings. The cost control team works closely with the architecture/engineering team

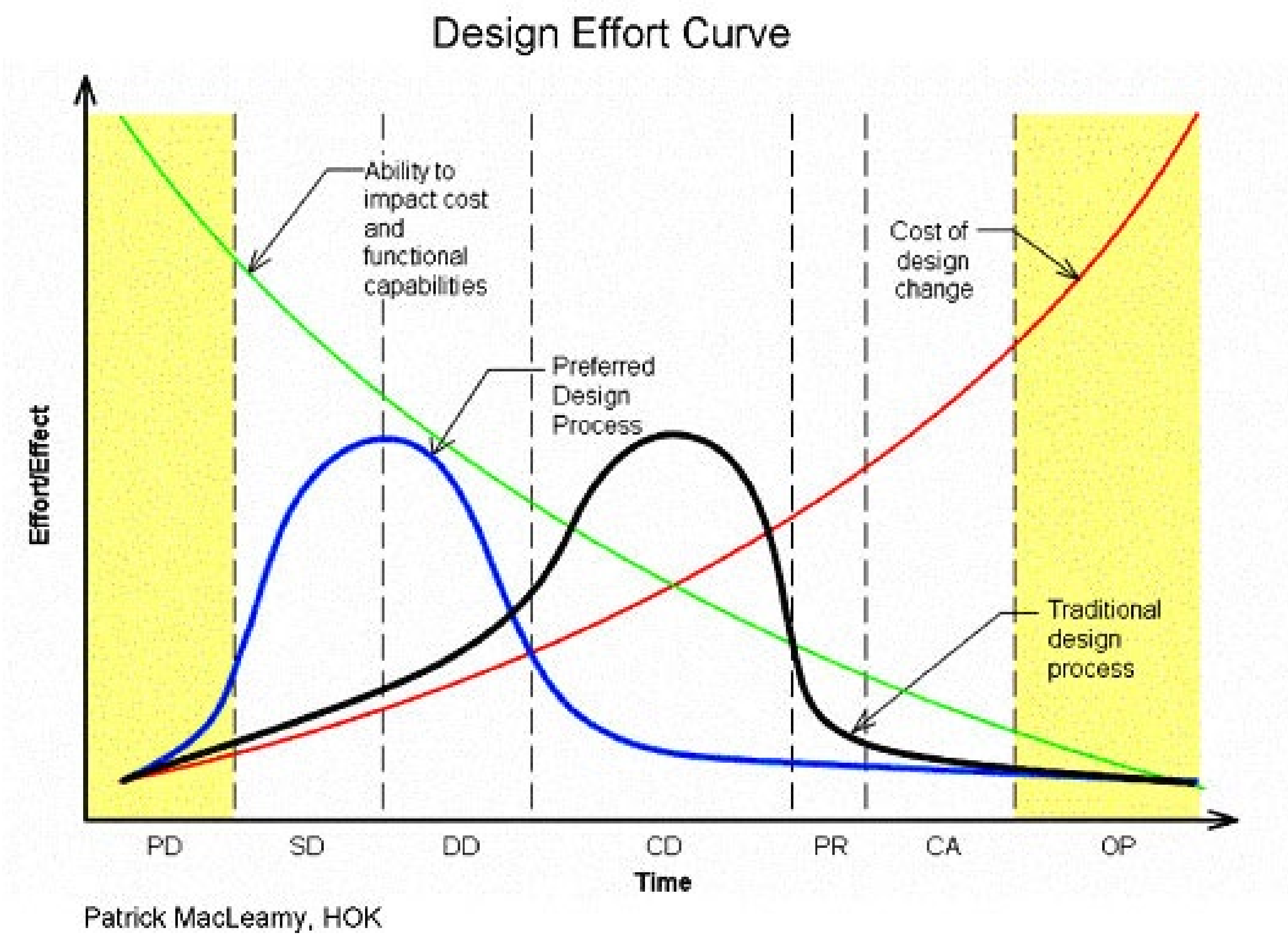
notes

during so everyone understands the cost implications of design decisions. (For more information about cost issues, see Chapter 1C - Project Cost and Feasibility.) Subcontractors and suppliers are also brought in early for their valuable input into construction feasibility and construction and materials cost. While many architecture firms "do it all" in-house, many other firms specialize in technical aspects of architecture. The latter offer services in specifications writing, code and life safety issues, exterior wall design, theaters, sport venues, laboratories and hospitals, and physical model building as well as new virtual model building. Depending on the scale and complexity of a building, many of these consultants are assembled for design development.

Effects of New Technologies

The traditional role of design development is as a step in a continuously increasing effort that leads to construction documentation, which is the climax of the design effort. A by-product of the new technologies used in architecture practice is the alteration of this process, as described above. In response to this change, Patrick MacLeamy, FAIA, CEO of HOK, proposed an alternate effort chart that makes DD the peak effort in the design process (see the accompanying diagram below). This view of design development coincides with its position on the design effort curve in MacLeamy's graph, which shows the design team's ability to affect cost and quality diminishing over the life of a project.

Prescriptive vs. Performance-Based Codes



When DD is seen as the peak effort in the design process, more final work occurs during this phase, requiring more effort. For example, construction of 3-D building information models (BIMs) and other means of achieving interdisciplinary coordination during design development require greater effort than traditional

2-D drawings. However, expending this effort during DD reduces the effort required during construction documentation. The Construction Users Roundtable (CURT) is presently considering this approach to DD as a way to increase A/E productivity, while improving the quality of construction documents.

Architects and their consultants use a variety of techniques to explore the design of a building throughout the DD phase. These techniques range from traditional hand sketching and physical model building to computer modeling and animation borrowed from the aerospace and entertainment industries. New technologies make it possible to take information from physical models of buildings and mockups of portions of a design and enter them into computer programs for use in design development.

The expansion of CAD into the third dimension has increased the number of tools available to explore design issues. In addition to placing 2-D design information into 3-D computer programs, it is now possible to export 3-D information. Rapid prototyping machines "print" 3-D model buildings and mockups. Even the physical models used in wind tunnel analysis often begin with 3-D models of the building and surroundings created by computer numerical control (CNC) machines. Other ways of assessing building performance during design by using 3-D models exported to other programs include computational fluid dynamic (CFD) analysis, lighting studies, timed exit analysis, and energy analysis.

Using the technology available today gives architects quantities of information to help them analyze designs in ways that were not affordable or even possible a few years ago. Examples of how several well-known firms are making use of this new technology are shown at the end of the narrative.

DD Deliverables and Products

Refinement of the schematic design approved by the owner, including design of details and selection of materials, is the primary goal of design development. However, drawing content varies according to project size, type, location, and local practice, making it impossible to develop a single list of DD deliverables appropriate for every project. Following is a list of items frequently considered for inclusion in DD documents, along with some particulars that might be included in each:

- **Site plan:** Zoning and site development requirements, property lines, elevations, pavement and sidewalks, walls and curbs, landscaping, utilities, typical site details
- **Floor plans:** Rooms, corridors, and other spaces; windows and doors; fire ratings and compartments; expansion joints; reflected ceilings; structural grid; major dimensions
- **Building elevations:** Materials and features, major dimensions and elevations, typical windows and doors
- **Building sections:** Materials, fire ratings and compartments, expansion joints, major dimensions and elevations, outline specifications
- **Typical wall sections:** Partition types, fire-rated assemblies
- **Integrated sections/plans:** Architectural, structural, mechanical, electrical, and plumbing systems depicted on the same drawings to show how they fit together
- **Schedules:** Room finishes, doors, windows, vertical transportation
- **Structural:** Foundation plan, floor framing, roof framing, typical notes and details, outline specifications

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- **Mechanical:** Equipment rooms and distribution zones, riser diagrams, equipment rooms, outline specifications
- **Electrical:** Equipment rooms and distribution zones, riser diagrams, equipment schedule, outline specifications
- **Plumbing:** Equipment rooms and distribution zones, riser diagrams, equipment rooms, outline specifications
- **Outline specifications:** Brief description of the project, architectural materials and systems, engineering specifications
- **Visualization:** Models, mockups, material samples, renderings, computer models, animations, sketches, lighting studies
- **Other material:** Code and zoning analysis, floor area summaries, LEED rating summary

Approvals
The architect submits DD drawings and specifications to the client for review and comment. Some architects (or clients) prefer a design development presentation, with plans and sections put up on the wall or projected from a computer. Some clients prefer to study the drawings and specifications carefully while a cost estimate is prepared, and then have a meeting to discuss comments. If a project budget is not on target, the architect and client discuss ways to achieve the client's objectives. Sometimes, the DD documents need to be revised before the client will approve them. In any event, the architect should not commence construction documentation before written approval has been received. In fast-track delivery, however, work often begins on the CDs during the client review period. The owner-architect contract should address the approval process for a particular project.

Standards for Drawings and Computerized Design
Standards for the graphics that depict building plans and details have evolved along with the transition from drawings created with pen and pencil on paper to those created using CAD. In the past, individual architecture firms often developed their own standards, leading to many variations on the commonly agreed plans and sections that make up a DD set. Today paper standards have given way to CAD standards because the CAD files themselves have become deliverables.

CAD standards to be used for a project are commonly identified in the owner-architect agreement. The Construction Specification Institute (CSI), the National Institute of Building Sciences (NIBS), and the American Institute of Architects (AIA) have joined their efforts to publish and promulgate the National CAD Standard. In addition to this standard, some architecture firms have established their own standards, which are often a variation of the national standard altered to fit the way the firm works. Clients can be another source of standards, such as the General Services Administration (GSA), which has the GSA CAD standard available as a PDF on its website. See "Resources" side bar for more information.

New ways to deliver architecture products are on the horizon. An example is building information models (BIM), which store information in 3-D graphic databases. Organizations such as the International Alliance for Interoperability (IAI) are working on standards for building construction

resources

Learn more about the United States National CAD Standard® by visiting their website: www.nationalcadstandard.org

Download the General Services Administration's CAD standards via their website: www.gsa.gov/portal/content/104697 objects in these databases to improve efficiency and productivity in the design and construction industry. The BIM standards are beginning to evolve in a way similar to the development of CAD standards. The promise of these standards for building products and their use in BIMs is that the development of software applications will dramatically improve productivity in building design and construction. The automobile and aerospace industries have shown this is possible, without sacrificing design and performance.

Multidisciplinary Design Issues

Many issues in building design require coordination and collaboration among team members from different disciplines. Attention to these interdisciplinary efforts begins during schematic design, but responses to such concerns are refined during design development. In particular, the revived emphasis on energy conscious design and the emergence of sustainable design objectives have introduced increased intersections in the work of architects, engineers, and specialty consultants.

Attention is given to the following multidisciplinary design areas at many points in the project delivery process. By necessity, none can be considered independently by practitioners of just one discipline. As mentioned above, detailed coordination may wait until construction documentation; however, an integrated approach to addressing these issues during design development yields better results.

Energy-Conscious Design

Decisions about building systems, the exterior envelope, daylighting, and the indoor environment all influence the design and affect the energy use of a building. During DD, refining the enclosure strategies established in schematic design includes evaluating window size and location, shading, and glass type with the goal of minimizing heating, cooling, and lighting loads. The heating and cooling systems chosen for a building are an important part of energy-conscious design, but these systems also influence the structural systems and service spaces of a building. M/E/P engineers, lighting designers, exterior wall consultants, and structural engineers are all needed to study these aspects of the design.

Sustainable Design

During design development, sustainable strategies can be introduced to refine energy-conscious designs and to influence product selection. For example, lighting and HVAC systems can respond to passive energy and ventilation strategies, and dimming ballasts and photo-sensor lighting controls can be used to dim electric lights when daylighting is available. Other building materials can also be selected for their environmental characteristics. Structural engineers, geotechnical engineers, and mechanical engineers are often involved in developing these strategies.

Achieving a LEED rating is sometimes a project goal. To accomplish this, the architect must pursue the rating throughout the design process, using measures to verify performance. The process involved in achieving sustainable design goals is illustrated in the sidebar.

Acoustic Design

Architects working on acoustically sensitive buildings often hire specialized consultants to determine the characteristics of sound quality and sound isolation appropriate to the project. Criteria are established that affect door, window, and enclosure design, as well as structural and HVAC design. In addition, interior design of critical spaces may be affected by the need for absorptive or reflective materials. Acoustic and vibration consultants lead the effort to evaluate design options and make recommendations. However, the architect must coordinate a number of interdisciplinary issues, including those introduced by M/E/P and structural engineers and exterior wall consultants. A number of ways are available to simulate sound qualities in buildings, including specialized consultants who build and test physical and computer models that help the architect evaluate alternatives.

Lighting Design

Good lighting design can enhance the physical form and structure of a building. In addition to the technical aspects of lighting levels and functionality, design decisions about lighting systems can reinforce ideas imbedded in the schematic design. Lighting consultants work with the architectural design team and the electrical engineer on computational fluid dynamic (CFD) analysis, lighting studies, timed exit analysis, and energy analysis to establish design concepts for various project conditions. For example, lighting simulations can be run in 3-D CAD, giving the architect an unprecedented ability to study lighting during design development. Sophisticated modeling programs are now a standard part of rendering programs available to architects.

Envelope Design

Designs that incorporate large glass walls, curtainwall systems, and skylights often require the expertise of specialists, who work with the architectural design team during design development. In particular, decisions about the building envelope affect structural and mechanical systems. Information about window washing and skylight maintenance/cleaning should also be considered during design development.

Site Design and Geotechnical Issues

For many projects, a site investigation and geotechnical recommendations are needed. Evaluation of foundation options, suggestions for controlling groundwater, and recommended designs for basements and other earth retention structures will provide information helpful for refining a foundation design. For large site development schemes, recommendations are needed for the design of pavements and retaining walls, as well as for dealing with utility and transportation issues. Architects lead the effort in advancing site issues during design development, with the help of civil, geotechnical and structural engineers.

Life Safety Design

Life safety and other code specialists are commonly hired to assist on large, complex projects. Fire ratings and separations affect mechanical and structural engineering systems and must be coordinated among the disciplines. A building code analysis will reveal many of the issues related to egress, fire separations, and structural protection, which generally have prescriptive code requirements.

Performance-based design concepts developed in Europe and Australia are coming into use in the United States. Techniques such as timed-exit analysis, computational fluid dynamics (CFD) analysis, and structural analysis with fire design load cases require specialized consulting services. Design development is the time to explore these options, particularly if a project falls outside the typical building types addressed in building codes.

Indoor Environment

Many buildings, including hospitals, schools, libraries, laboratories, and residential buildings, have critical indoor environment requirements. Indoor air quality (IAQ) issues, including release of volatile organic compounds (VOCs) and effects of hazardous materials, affect the choice of interior

resources

Acronyms to Remember

- DD - Design development
- IAQ - Indoor air quality
- BIM - Building information modeling
- M/E/P - Mechanical, Electrical, Plumbing
- CFD - Computational fluid dynamic
- VOCs - Volatile organic compounds
- CNC - Computer numerical control

finishes and engineering systems. Indoor air quality consultants help architects in these areas, especially in evaluating existing buildings, and mechanical engineers play an important role in addressing any concerns raised.

Seismic Design

In many parts of the country, designs must accommodate the level of seismic force expected in that region. While the structural engineer takes the lead in design to resist earthquakes, the seismic design process includes consideration of the design of nonstructural elements and mechanical systems, as well. State-of-the-art earthquake resistant systems may include active and passive damping systems and base isolation systems. All of these have an impact on detailing of expansion joints and access requirements as well as mechanical systems.

Integration of Systems

The often-conflicting requirements and restrictions of technical building systems require engineering systems coordination during design development. The more complex the project, the larger the design team is likely to be, making collaboration skills key to successful project development and completion.

Structural Systems

Structural engineering aspects of building design can have a significant effect on an architect's overall design concepts. For example, a wide range of system alternatives can be developed for the foundations and superstructure of most buildings. Structural concepts also influence the development of details such as cladding, skylights, stairs, and guardrails, elements that may have been identified during schematic design but now require more in depth design.

Architects explore foundation and basement alternatives with structural and geotechnical engineers. Geotechnical site investigations and analysis are used to determine how to protect basements from groundwater and earth pressure. Usually, a foundation system is selected during design development to meet performance, cost, and construction requirements.

Tall buildings and long-span buildings, as well as complex urban environments, may be effectively modeled in wind tunnels to assess a number of critical design considerations. The structural engineer often takes the lead in working with the wind tunnel consultant; however, a number of other disciplines receive valuable information from the wind tunnel tests. Wind pressures on cladding and at the pedestrian level are estimated. The effectiveness of exhaust and air intake locations may be assessed, and snow drifting and sliding and ice buildup may be estimated. The primary reason for wind tunnel testing, however, is to assess the aerodynamic properties of the building, that is, the probable movement of the building in wind.

Wind tunnel testing often occurs just before or during design development as it is essential for the building form to be determined before testing. The exception to this are buildings, such as super-tall towers, where the building form contributes to the building's aerodynamic performance. For these projects, early testing assists with the evaluation of optimal schemes. Although uncommon, when wind tunnel testing reveals

notes

the need for supplemental damping systems, as in seismic design, these systems are designed during the DD phase. In addition to the cost of such systems, the building program must be stretched to accommodate them. Design to resist seismic forces is becoming more common in the United States. The primary concern of earthquake-resistant design is stability and safety, making the structural system of particular concern. Nonetheless, significant secondary concerns include life safety, mechanical/electrical system design, and choice of cladding systems, particularly in essential facilities such as hospitals, police and fire stations, and emergency response facilities intended to be operational after extreme events. Building codes define additional requirements for these facilities.

Mechanical/Electrical/Plumbing (M/E/P) Systems

The evaluation of alternative systems for mechanical, electrical, and plumbing aspects of a building is a critical activity in design development. By the end of DD, the optimal systems should be selected and incorporated into the building design and the documents. Alternate systems often have different space requirements, quality, costs (initial and life cycle), and implications on the structural systems, and their selection is often a design issue. Design decisions about sustainability, lighting, energy use, and indoor environment all affect selection of these systems.
While it is true that much detailed engineering coordination occurs during construction documentation, it is important for overall engineered system concepts to be achieved during design development. Mechanical rooms, exhaust shafts, ventilation louvers, and penthouses may support or conflict with the architectural design. When these elements appear late in the design, it can be difficult to insert them unobtrusively into the design.

Sitework and Landscaping

The scope of civil engineering varies widely from project to project, from tight urban sites to wide open rural settings. Where utilities enter a building affects the location of mechanical and electrical rooms. Grading and drainage for a project affects the ground floor elevations. Again, detailed coordination is not necessary at this stage; however, overall concepts for utilities, site drainage, earth retention, and water retention should be resolved by the end of design development.

Although the approved schematic design often incorporates landscape concepts, more detailed studies are needed in design development. The goal is to integrate the landscape design with civil, structural, and plumbing design. With more and more buildings incorporating atria, and green roofs, landscape decisions affect engineering coordination as well as sustainability and energy conscious design.

Security Design

Acts of terror perpetrated in the United States have instigated new analysis and design requirements for many public facilities. Public buildings owned by the General Services Administration (GSA) and other government agencies require compliance with federal security guidelines, including those set by the GSA, the State Department, and the Department of Defense. Corporate and institutional owners are also evaluating security risks. Integrating solutions to security requirements into an architectural

resources

Grondzik, Walter T., Alison G. Kwok, John S. Reynolds, and Benjamin Stein. *Mechanical and Electrical Equipment for Buildings.* Wiley & Sons Canada, Limited, John, 2009. Print.

design can be a challenge, with a number of conflicting issues. One of the biggest challenges in the design of public buildings is balancing the desire for openness and transparency with requirements for security and blast resistance.

Security consultants have a wide range of specialties, and very often owners employ them directly. While they may have provided initial concepts during schematic design, a more detailed analysis is performed during design development. If design for blast loading is a requirement, a specialist in blast analysis is needed to define the structural design criteria for the project, including loading requirements, which structural engineer project then incorporates into the analysis and design. Security consultants may also be asked to analyze security requirements for access to a building.

Preliminary Regulatory Review

The DD phase is an excellent time to schedule a preliminary review with regulatory agencies such as the local building department, fire marshal, health department, education agency, planning and zoning office, and/or design review board. Often an in-progress set of drawings is used to present the building to the officials. A zoning and building code analysis should be performed (or updated from schematic design), as well as an energy code analysis, as required. Although consultants can be hired to address code issues, architects often perform the zoning and code review and M/E/P engineers the energy code analysis. Again, an early meeting with officials is helpful, especially for designs with issues open to interpretation or requirements for variances.

The Evolution of Design Development

Design development is a central part of the design process, and it continues to evolve. It is more complex today than ever before, yet a number of new computer tools and consultants are available to help architects evaluate these complexities. For each project, what must not be lost during DD are the important concepts imbedded in the schematic design. Design development should enhance these features, while finding ways to weave in the technical demands outlined in this chapter.

Written by Joseph G. Burns, FAIA, RIBA, PE, CEng

Joseph Burns is a managing principal of Thornton- Tomasetti Group in Chicago. He is an advocate for the deeper integration of architecture and engineering, which he promotes through technical innovations in the design of structural systems, collaboration in practice, and participation in building science education.

notes

Sample DD Applications of Computer Technology

A sample of the range of tools used in design development today is illustrated in the brief descriptions that accompany the sample drawings on the following pages. Each paragraph outlines how an architecture firm—small, medium, or large—practices design development today.

This is by no means an exhaustive list of examples; rather, it shows how broad choices are today, as the building industry continues to develop new technology and to adapt technology from other industries for use in architectural design.

resources

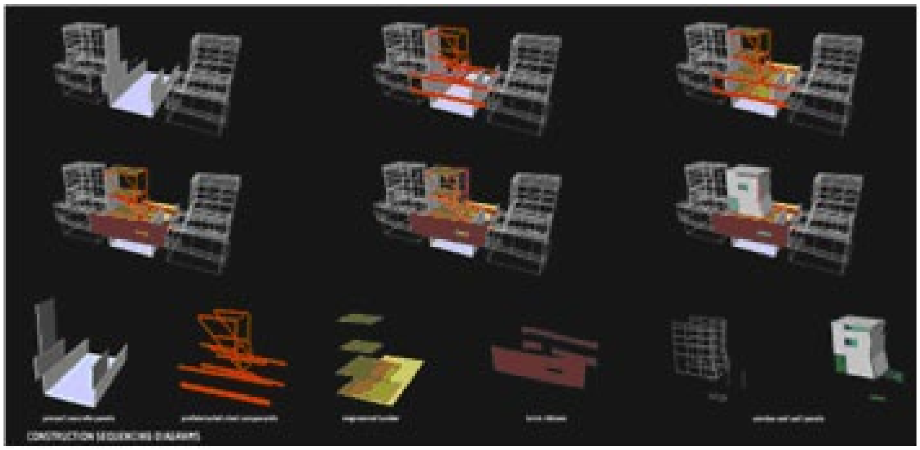
As you research and look for more information on topics presented in the *Emerging Professional's Companion*, remember that a quick internet search of keywords can be incredibly useful to completing your Activities.

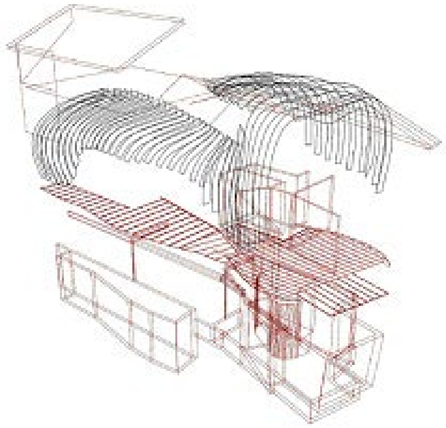
DD Example #1

Garofalo Architects

Location: Chicago

Garofalo Architects uses a wide range of computer software to study buildings throughout the design process. They mix physical models and computer models and make use of animation software. In particular, they use Maya, computer animation software borrowed from the entertainment industry, which allows for assembly of 3-D objects and rapid exploration of space and time. In design development, assemblies of structural systems and other building systems can be coordinated in three dimensions. MicroStation is also used for 3-D modeling and for plan and section construction. Visit www.garofaloarchitects.com for more information about Garofalo Architects.





DD Example #2

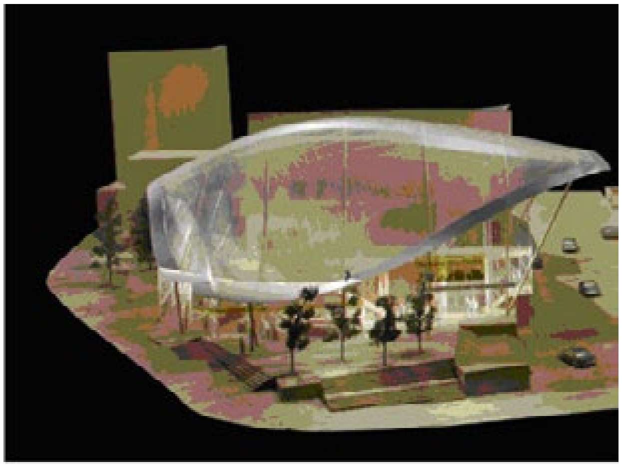
Gehry Partners

Location: Los Angeles, California

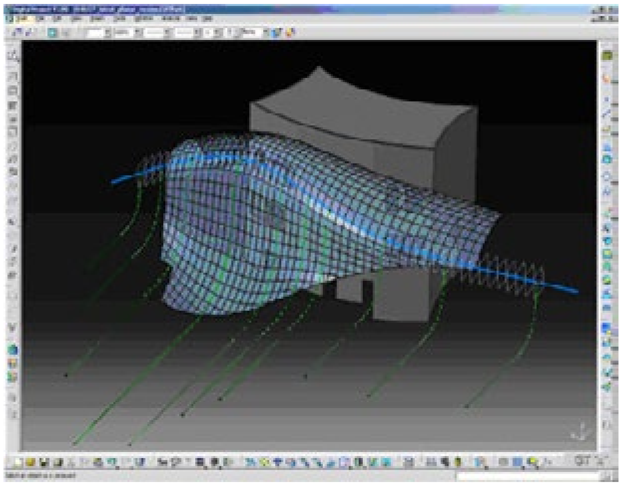
Gehry Partners employs a mix of physical models at various scales and sophisticated 3-D software to model complex surfaces. Spatial digitizers are used to input complex surfaces from the physical models, and rapid prototyping equipment is used to reverse the process and verify the contents of the computer models. Architects and engineers use 3-D object programs to model systems and their integration. Two-dimensional plan and section information is exported from the 3-D software for traditional documentation. Gehry Techologies is a separate company that conducts research on building practice and develops software products for the building industry.

An important part of the firm's success in realizing its projects has been to use building systems that can accommodate substantial geometric variations while minimizing engineering and shop drawing effort for individual pieces. Recent advances in parametric modeling allow the firm to efficiently reuse material developed for systematic design, engineering, and modeling strategies across the project. Information such as geometry, materials, system assembles, and so on are available to everyone on the project team.

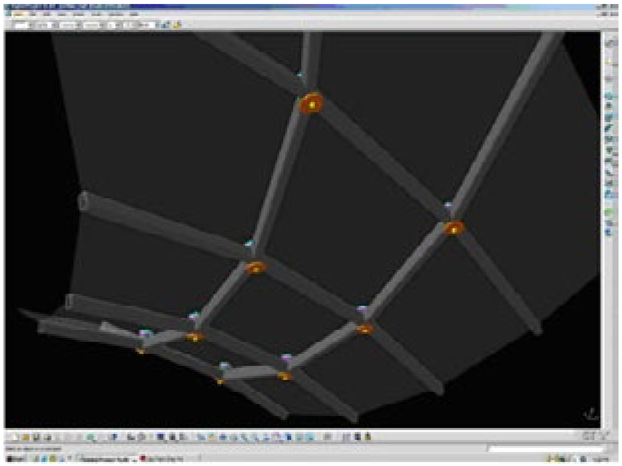
In the project illustrated here, a glazed atrium roof system makes it possible to construct certain types of curved surface forms using flat, quadrilateral sheets of glass. Gehry Partners has developed a parametric description of the geometry required to support this construction. A set of curves initially defines the object in the parametric modeling program, allowing designers to modify the surface shape while preserving construction requirements. For instance, construction details such as mullions and connection geometry, created as parametric objects, respond automatically to changes in the overall form of the glazing system.



A physical model



A parametric model of glazing systems



A parametric model of mullions and connections

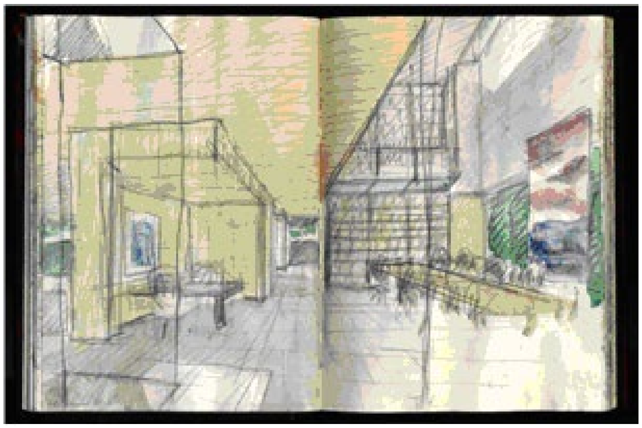
DD Example #3

Wheeler Kearns Architects

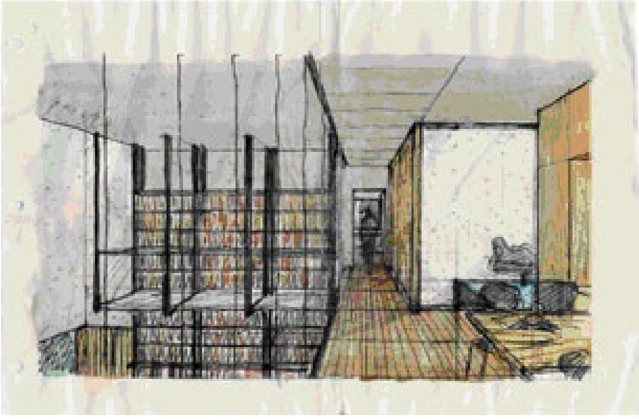
Location: Chicago, Illinois

Wheeler Kearns employs a range of sketches, perspectives, models, renderings, plans, and sections throughout design development. A high degree of coordination between the architectural design and building technology is sought through integrated section and plan details. AutoCAD is used to create plans and sections. Visit www.wkarch.com for more information about Wheeler Kearns Architects.

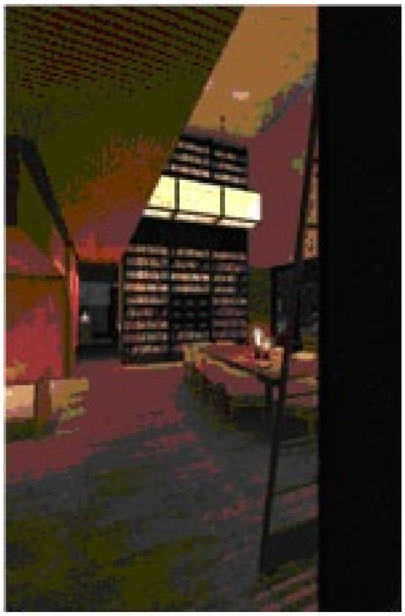
Illustrated here is the design development study of a bookcase in a private residence.



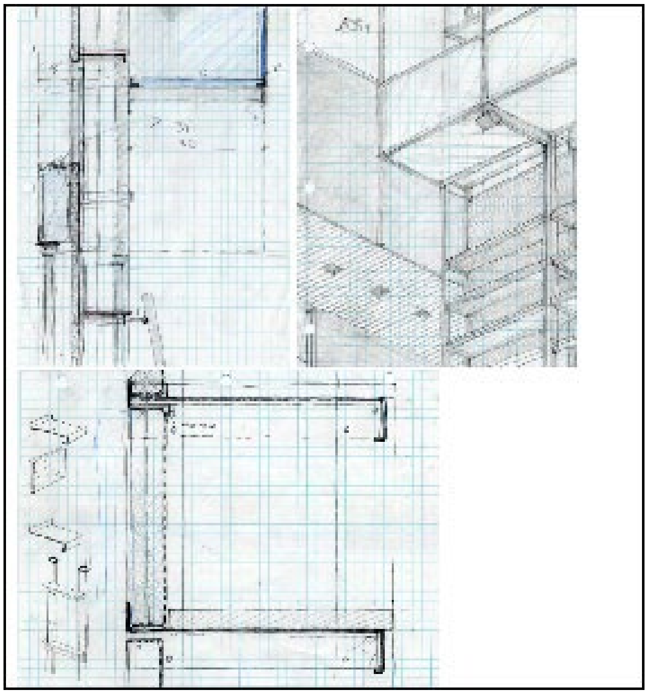
Schematic design sketch of bookcases in room



Design development sketch rendering of the bookcase from under the balcony



Design development computer rendering of the bookcase from under the balcony



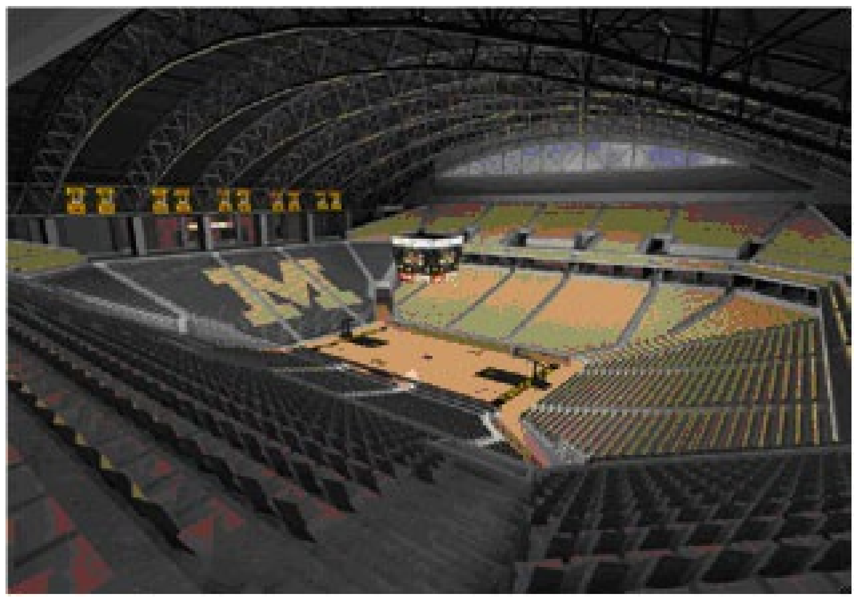
Design development sketch details of the bookcase

DD Example #4

Populous

Location: Kansas City, Missouri

Populous, formerly HOK Sport + Venue + Event, uses the full three-dimensional capabilities of AutoCad Architectural Desktop (ADT) throughout the design process. In design development, a building is constructed in three dimensions, as is the consulting engineers' work, easing integration and technical coordination of engineered systems and the building design. Specialized software is used for interference (clash) checks. See the accompanying sidebar for examples of these documents. For more information about Populous, visit www.populous.com.



3-D renderings made during design development, from which plans and sections can be "extracted"

notes

Take brief notes while reading the narrative and list key resources you used to complete the activities. Note discussion outcomes from meetings with your supervisor, mentor, or consultants. When finalizing the activity documentation (PDF), include your notes and the Emerging Professional's Companion *activity description.*

Energy Code Compliance

Supplemental Experience for eight (8) Core IDP Hours

In this scenario, you are the project architect remodeling an older office building in the design development phase. Your mechanical consultant has just issued a report indicating the project will not meet the city-mandated energy code. Among other problems, the type of glass selected for the project and the size of openings shown on the approved schematic design drawings, the energy uses are too great.

You have reviewed the options with the principal in charge of design in your office. If possible, the project architect does not want to make changes/revisions to the size, location, or glass type of the windows.

Activity - Core

You are tasked with creating alternative solutions. Using an older office building project in your area that no longer meets current energy codes as an example, write a report for the principal detailing what changes you suggest.

- Research the energy codes for your state and see what has to be done to the project in order to bring it up to code.
- Since you are not allowed to make revisions to the size, locations, or glass type of the windows, what else are you able to change? What changes would you make?
- Be sure to include a cost analysis for any proposed changes.
- How does your regional environment complicate this project? How can you environment be used to your advantage?
- How does the project being in the design development phase affect your decision making? Explain.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Lessons Learned in Check Sets

Supplemental Experience for eight (8) Core IDP Hours

In this scenario, you are the project architect for a new downtown retail and office building that includes a parking garage in the basement. You are reviewing the design development drawings, specifications, and other project records to check compliance with the code analysis performed by your team. During your review, you have discovered several omissions.

One omission is the absence of four-hour rated construction separating the parking area in the basement from the retail space on the first floor. This separation is not shown on design development drawings, and the structural engineering drawings indicate steel floor framing with a metal deck concrete slab, which appears to provide a two-hour separation. Although both steel and concrete structural frames were evaluated in schematic design, steel was selected for cost and speed of construction.

You discover another omission in one of the exterior walls, where four-hour rated construction is required along a property line. Your design shows several windows in this wall; closing them will require revising the schematic design for some of the spaces. In addition, it appears to you that only a two-hour separation is provided at this location on the design development drawings.

The design team is happy to receive your comments before they have completed design development. They have asked you for ideas on how to revise the construction to comply with the code.

Activity - Core

Research and describe various options for resolving these two omissions. Write your findings in narrative form and include illustrations. Discuss with your supervisor or mentor. Then, outline the lessons learned from this experience that would inform your approach to future projects.

Consider these questions:

- Do any of the identified solutions involve requests for a variance from the local building authority? Are there any trade-offs in the design that would make it possible to use the assemblies as intended in the DD drawings?
- Should the decision to select a steel frame be revisited? How would the project team evaluate this option? What is the best way to approach the client with this option?
- Are there any options for the wall openings that include alternate window types or fire suppression systems?
- Be sure to include any change to building systems and components. Detail how these solutions would affect the schematic design, time and cost of the project.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Observing the Work of Others

Supplemental Experience for eight (8) Core IDP Hours

Observing projects you are not working on is a key component of learning for architects. Choose a project at your firm or your mentor's firm and perform a brief design and/or technical review of the drawings and specifications near the end of design development. If your office has a checklist for project reviews, utilize it in your evaluation.

Activity - Core

Follow these steps in preparing your evaluation:

- Compare the design development documents with the approved schematic design. Is it consistent or have there been some major revisions? If so, why? Point out the reason for the change and the positives and negatives.
- Look at the documents prepared by the engineering disciplines. Are they consistent with the architectural documents? If not, how could this be rectified?
- Review the specifications prepared for the project. How do these sections support the design concepts?
- Perform your own evaluation of the code analysis and accessibility report. Does the building comply with these requirements? Make note of any place it does not and explain why.
- In what ways could integrated project delivery help this project?
- Review the DD deliverables and make note of which are applicable to this project.

Write a summary of your review.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Value Engineering the Exterior Wall

Supplemental Experience for eight (8) Core IDP Hours

Value Engineering (VE), also referred to as Value Analysis (VA) is an area of practice where architects are frequently pushed around, and which can be the source of trouble on a project. All participants must realize that value engineering is an often necessary though extremely disruptive process that usually subverts coordination and leads to measurable errors in drawings and specifications. VE can also lead to quality reductions that were not within the realm of the owner's expectations.

A less commonly discussed problem is that VE changes to drawings take time, and usually occur during the beginning of the construction phase when coordination oversights and drawing mistakes are more costly. Architects can participate to some extent in the VE process, but are usually under the control of the owner's or contractor's desire to reduce costs.

Activity - Core

Please reference the following documents:

- *The Architect's Handbook of Professional Practice,* 14th ed. Chapters 12.5, 12.11 and 14.2
- EIFS Industry Members Association (EIMA), *Guide To Exterior Insulation & Finish System Construction* (PDF)
- Other EIFS information such as; Dryvit Systems, Inc., Sto Corp., Teifs
- The Portland Cement Association
- *Gimme Shelter*, February 2006, AIArchitect article by Grant A. Simspon, FAIA and James B. Atkins, FAIA.
- *Managing Project Risk*, James B. Atkins & Grant A. Simpson, John Wiley & Sons, 2008.

In an effort to understand what an architect is faced with when building systems and materials change, you will research two different materials and make note of the differences. The objective will be to create a list of pros and cons to discuss with the owner. Answer the following questions:

- Is it really any of your business if the owner and/or contractor choose to change the design of the building?
- If the owner or the contractor changes the design of the building, aren't they going to be responsible for the design?
- Do you have any responsibility to explain the advantages and disadvantages of decisions they have made about the building design?

EIFS (Exterior Insulation and Finish Systems): Your owner has elected to change a large portion of the exterior wall of the building you've designed from brick masonry veneer on metal studs to EIFS on sheathing on metal studs. You've heard stories that concern you about the quality of the EIFS product. You start your research and discover there are several grades of EIFS, including drainable systems and barrier systems. Answer the following questions:

- What are the advantages of brick masonry veneer on metal studs?
- What are the advantages of EIFS cladding systems?
- Is cement plaster stucco a viable alternative to EIFS that you might propose to the owner?

Prepare a report that compares the advantages and disadvantages of brick masonry, drainable EIFS, Barrier EIFS and ¾" cement plaster stucco. Consider the following:

- Remember that the EIFS manufacturer website present information on the comparison of EIFS with other materials.
- As does the Portland Cement Plaster Website.
- Be neutral toward each system until you are convinced that one or more are better systems.

Share your work with your IDP supervisor or mentor and make suggested changes.

Research a Multi-Disciplinary Design Issue

Supplemental Experience for eight (8) Core IDP Hours

Choose one or more of the multidisciplinary design issues listed in the narrative, and prepare a detailed evaluation of one that interests you. Research alternative solutions to the issue you have chosen, and evaluate some of the reasons (cost, aesthetics, technical) for choosing among them. Choose challenging design issue(s) on a familiar project you are familiar with, one you have read about in a magazine, or one you are interested in learning about.

Activity - Core

Prepare a memo to a client explaining at least two alternatives you have explored that are appropriate to work during DD, and explain your recommendation for one of them. Be sure to include the following:

- A few sketches to illustrate the alternatives.
- The approximate cost of each alternative based on the use specific materials.
- How the alternatives affect the rest of the design.

In researching the issue(s) you have chosen, consider these points:

- What disciplines are needed to address the issue? Speak with a consultant from each area of expertise to understand the issue from different perspectives. These could be with experts within your firm, consultants who regularly work with your firm, or an expert you have read about and are willing to approach.
- Research precedents that have solved these issues. If you find any less than successful examples, explain why they were not successful.
- What are alternative ways to consider this issue?
- Prepare a summary memo for your “client” and include illustrations or reference materials if needed to explain the issue.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Change-of-Use Dilemma

Supplemental Experience for eight (8) Core IDP Hours

In this scenario, you are the project architect for the conversion of an existing four-story office building into an arts center. No drawings of the existing building are available. Your structural engineer told you the change of use will result in an increase in live loading, and he recommended a structural survey to determine the size and strength of the beams and columns in the building. Because the building is currently occupied, the client did not want to disturb the tenants so did not approve a structural survey. As a result, you completed schematic design without the structural information for existing building.

The project is now in design development, and you have convinced the client to proceed with a limited survey. At selected locations, the engineer was able to access the ceiling areas and measure some beams. Assuming some reasonable material strength, your structural engineer evaluates portions of the building and concludes insufficient structural capacity for public assembly is likely on all but the ground floor. As you had positioned the most heavily loaded gallery spaces on the second floor during schematic design, this is a problem.

Activity - Core

List the questions to explore with your structural engineer in evaluating options for increasing the capacity of the other floors. What other steps could be taken to confirm what the engineer suspects about existing building conditions?

Write a narrative to your client explaining the results of the limited structural survey and what suggestions you have for dealing with the situation.

Make your recommendation and include sketches illustrating your ideas.

Ideas for approaching this assignment follow:

- What will you need to document existing conditions in order to obtain a building permit from your local building department?
- How would this affect the time, cost, and quality of the project?
- What changes to materials or components would you make?
- Speak with a structural engineer that is working on one of your projects, and ask his/her opinion about how to approach this problem.
- Should schematic design be revisited? Would this be an additional service under a standard AIA owner-architect agreement? If so, should you mention it to the client if reworking the SD drawings is one of your options for moving forward?

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Understanding Building System Selection

Supplemental Experience for eight (8) Elective IDP Hours

During design development, major building systems are selected. For this assignment you will study a building system on a recent project in your office or a mentor's office. Choose a structural, mechanical, enclosure, lighting, or other building system.

Activity - Elective

Address the following in a narrative:

- Speak with a representative of the technical discipline involved with this building system to understand the design issues from their perspective.
- Review the schematic design documents, and compare them with the design development set. Does the system selected support or weaken the design concepts?
- What are the major design considerations for this building system? Did the design team take all of them into account?
- What other disciplines have an impact on your case study system? Were these considered in the selection of the building system you are studying?
- Are there any design alterations that you would recommend for these systems? Incorporate specific changes in materials, components, and possible cost.
- Are there any multi-disciplinary design issues you must consider?

Prepare a presentation explaining the research results and your suggestions. Explain why the selected system was chosen and any changes proposed.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Buildable Entities

Supplemental Experience for eight (8) Elective IDP Hours

The design development phase when architects begin to turn single line sketches into buildable entities. If you are not careful you may mislead the client by under or over estimating moulding profiles, window mullion or muntin size, or eave profiles.

Activity - Elective

Using schematic design sketches showing windows, research a popular window manufacturer's details for head, jamb, sill, mullion, and muntin size. Redraw the sketch with appropriately sized members. Write a narrative describing the differences. If the difference is significant, what other options do you recommend to be explored in order to achieve the original design intent?

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Errors in Survey of Existing Building

Supplemental Experience for eight (8) Elective IDP Hours

In this scenario, your architecture firm has been hired to design an industrial building with offices in an old manufacturing district of your city. The client wants to demolish much of an existing building on the site, but she wants you to reuse its foundations for the new facility. The footprint of the existing building is very large, 400 ft. x 600 ft., and the existing column grid is typically 40 ft. x 40 ft.

Because no drawings of the existing building could be found, your firm surveyed and documented it. The work was needed to accurately represent the existing column grid because the client intends to build a new superstructure on the existing foundation. The survey of existing conditions was performed during schematic design, and all the team members for the development of engineering systems and architectural design have used the results.

This is a fast-track project, and the contractor must order steel midway through design development to meet the project schedule. Your firm is nearly finished with design development, and the contractor has discovered a number of inaccuracies in the existing conditions survey. It turns out that one of the exterior bays is skewed and follows a rail siding; it varies in width from 38 ft to 42 ft. The structural engineer will have to revise the drawings before the steel can be ordered.

Activity - Elective

Compose a draft letter on behalf of the partner in charge of the project to the client, who has blamed your firm for the delays. Explain how to address the needed changes without further delaying the project. Use the Design Effort Curve, defined in the narrative, to explain the benefits of catching the setback now. Include effects on cost, functional capabilities, and effort. In addition, explain how this will affect building components, systems, and overall design.

Review your responses for this assignment with one of the following: (1) an insurance agent or broker who specializes in professional liability insurance for architects, (2) an attorney who practices primarily in the field of construction law, or (3) legal counsel or the claims staff representative from one of the major insurance companies for design firms.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

notes

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