Computational design helps architects, owners, and contractors assess coinciding parameters, such as geometry, logic, and performance to solve challenges involving many disciplines. With these tools, project teams can isolate the most important variables, while rapidly evaluating multiple factors using scripting to automate previously mundane tasks.

WHY ARE WE SEEING BENEFITS NOW?

The confluence of emerging technologies with an evolving understanding of the computation power allows these tools to be applied in a useful and efficient manner. The following trends contribute to furthering the realized benefits:

- Expanding computer processing power and improvements in graphics cards
- Progressing computer script (code) capabilities and the ability to embed script in specific tools, stages, or workflow
- Developing software allowing seamless integration of multiple plug-ins and custom computer script
- Producing increasing amounts of digital project information throughout all stages of a project

HOW CAN WE GET MORE FROM THE MACHINE?

Computational design improves human output, allowing the project team to focus in areas where thought and opinion dominate. If the work is repetitive, computational tools offer valuable results by absorbing time that might otherwise be time spent in iterative evaluations.

EXAMPLES OF COMPUTATIONAL APPROACHES

These approaches can apply to all stages of the design and construction process, including:

- **Planning/Programming Phase.** Computational design can be used for rapid layout and sizing of structural steel framing to inform various design options. While site location and overall massing are being determined at this early stage, designer can obtain real information on foundation loads, facade area, total number of beams/girders, and total steel tonnage.
• **Concept/Schematic Phase Design.** When multiple options (e.g., building types or areas) need to be compared, computational design can help track varying parameters within a range of options. What was previously a study of several specific options with few variables can now be a continuous and broad review of all aspects relevant to the design.

• **Drawing Automation.** The next stage for computer-aided drawing and building information modeling is automating drawing production. This approach prevents project changes from becoming repetitive edits manually implemented by all design team members. Specific computer scripts can track changes from multiple sources (e.g., spreadsheets, analysis software, etc.) and update three-dimensional models accordingly.

• **Daylighting and Facade Geometry.** Computational design helps the project team evaluate these two interrelated parameters previously designed or reviewed separately or in sequence through inefficient iterative design. By combining daylighting analysis in a parametric model, the designers can review the effects of facade form options, enclosure arrangements, or shading devices for their outward appearance simultaneously with the internal performance of illuminance and glare potential.

• **Steel Rebar in Concrete.** For both standard and non-standard concrete geometry, automated placement of reinforcement allows for early detection of design conflicts, rapid assessment of material takeoffs, and visual understanding by the contractor for the three-dimensional layout of the rebar placement sequence.

• **Optimized Pile Layout.** When pilecaps have varying load conditions and multiple piles, a symmetric layout of piles may not be efficient and can lead to waste of construction time and money. Computational scripts can review layout alternatives, providing an optimized layout while reducing the total number of required piles.

**CHANGING WHAT HAS VALUE AND WHAT HAS COST**

Computational design means rethinking where the design team provides value and where there is cost. With these tools, design complexity does not necessarily lead to added cost in the design or construction processes (see SGH Topic Brief, “Digital Design, Coordination, and Delivery,” by Matthew H. Johnson for more information).

Above all, computational design is where the architecture, engineering, and construction industries benefit from the technological advancements in the software industry to develop more efficient designs.