DAYLIGHTING DESIGN TOOL FOR ARCHITECTS

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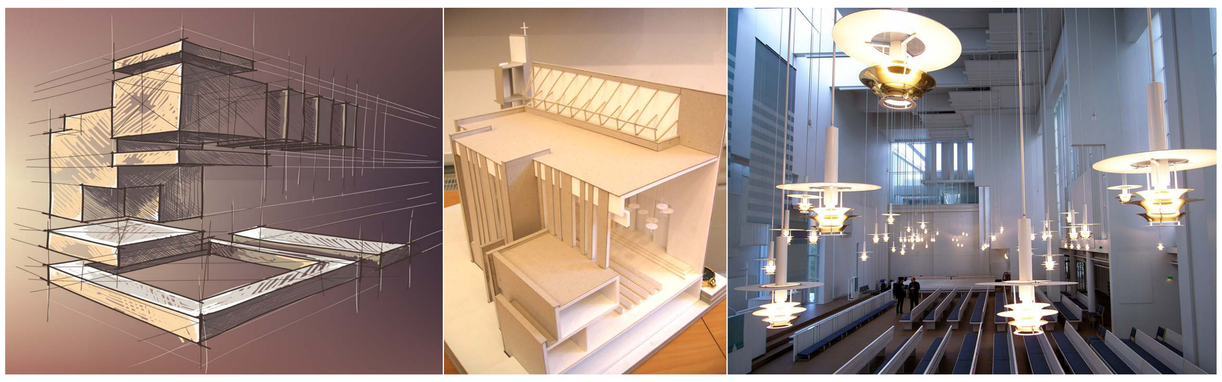
1 DAYLIGHTING AND ARCHITECTURE

Architectural designers require **specific design aids**, enabling them to bring **informed design decisions** from the early design stages. The **generative daylighting design method** presented here comply the **accuracy** of the physical model measurements, the **consistency** of the conventional daylighting diagrams, and the **speed** of the computer software applications. It provides **explicit design information** for architectural designers at **any stage** of the design within minutes **without expert knowledge**. Further **benefits**:

- provide **practical** help to support design decisions
- provide **accurate** and **reliable** results about the daylighting characteristics of the interior
- can be successfully utilized at **any design stage**
- **no deep knowledge**, existing skills or external consultants **are required**
- results can be produced **within 15 minutes** instead of days or weeks
- available **free of charge**



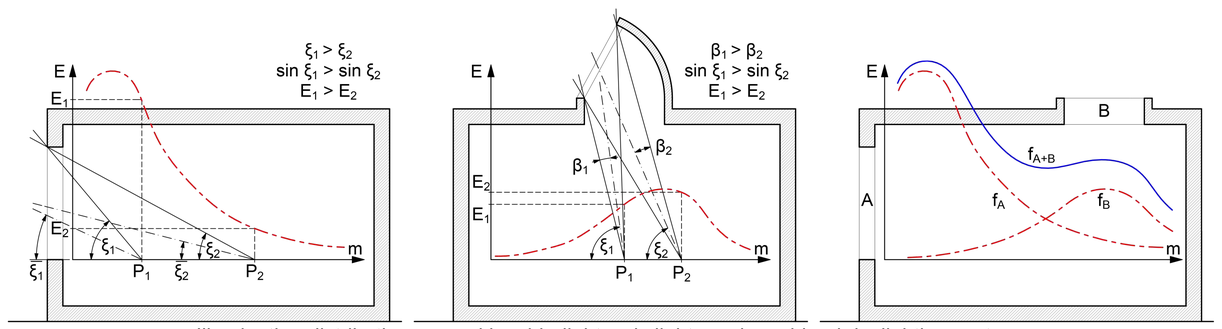
Typical stages of the architectural design process (Myyrmäki Church, Vantaa, Finland, Architect: Juha Leiviskä 1984)

2 DAYLIGHTING DESIGN CRITERIAS

The typical **workflow** of designing the daylighting systems consists of two major parts: first, the **shape and geometry** of the daylighting system is decided and adjusted to the building design, then the **characteristics** of the transparent and translucent surfaces of the daylighting system must be also be determined.

Most of the daylighting design diagrams provide a so called **“implicit” solution for daylighting design**. This means that the efficiency of the daylighting system can be calculated **only** if all the properties (such as size, transparency, framing etc) of the glazing are available. A main disadvantage of these methods is that **multiple daylighting analyses** must be completes. The minimal glazed area of the opening **can not be efficiently calculated using such “implicit” daylighting diagrams**.

Skylights are cca. 3 to 5 times more efficient daylighting systems than **side-lights** and the characterisrics of the resulted **illumination distribution** of the **daylighting system** is determined by **various different parameters** including the geometry, structure, orientation, glazing, obstructions, light-well and other surface properties, cleaning, etc.



Illumination distribution caused by side-lights, skylights and combined daylighting systems

3 DAYLIGHTING DESIGN DIAGRAMS

The **implicit** daylighting methods require an **assumed area** of the transparent surface for the **input** of the calculation. Designers must **first get familiar** with these diagrams and then complete calculations **several times** and slightly modify the glazed area based on the results of the previous calculations. The minimal glazed area **cannot be determined in a single step**. These diagrams provide only **rough results** and **cannot be efficiently used** by architects at the **conceptual design stages** of the project.

Daylighting design diagrams	Transmission of transparent surfaces	Transparent or translucent surface	Obstructions	Reflection of structure	Surface quality of obstruction (shiny or matt)	Geometry of skylights
Waldram Diagram	**yes**	no	no	no	no	partly
Daniluk Method	**yes**	no	**yes**	**yes**	no	partly
Grünn Method	**yes**	no	no	no	no	partly
CIE 16. publ. "skylights"	**yes**	no	no	no	no	partly
CIE 16. publ. "Monitor"	**yes**	no	no	no	no	partly
CIE 16. publ. "shed"	**yes**	no	no	no	no	partly
TTI TS–A5 Prism m.	**yes**	no	no	**yes**	no	partly
TTI TS–A5 Skylight. e.	**yes**	no	**yes**	no	no	partly
Birch Method	**yes**	no	no	no	no	partly
B.R.S Method	**yes**	no	no	no	no	partly

Comparison table of daylighting design diagrams

4 SOFTWARE APPLICATIONS

There are numerous **software applications** and dimensioning tools that are able to perform c**ertain daylighting calculations** or simulations. Most of these daylighting design tools can be **effectively** utilized only at the **later design stages** and these also use **implicit** analyses methods. In other words **a more or less completed building design is required** to run the daylighting calculations. Most of the computer aided daylighting software solutions **can not** determine the **required minimum transparent area** of a selected daylighting system.

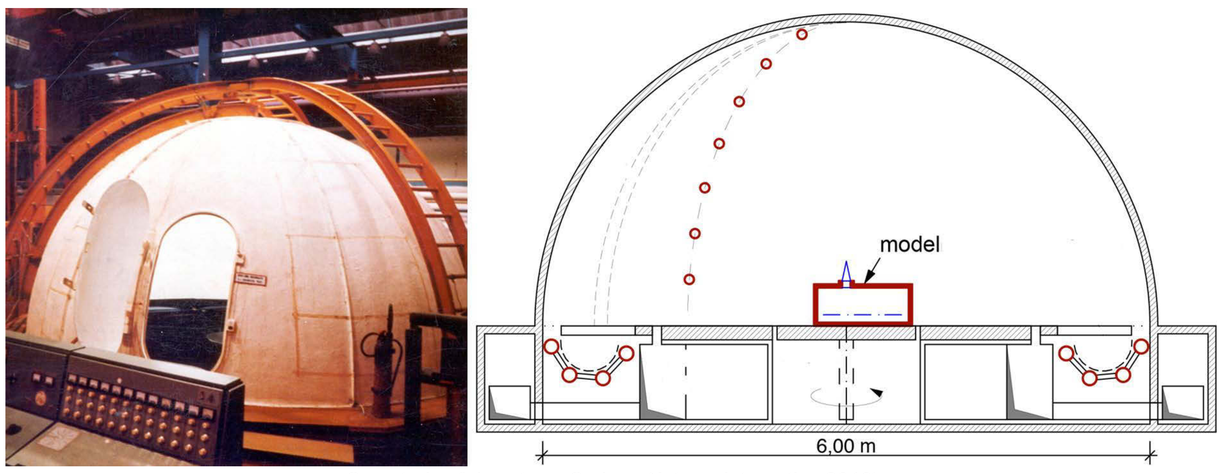
Building Information Modeling (BIM) **software solutions** have been developed to help architects. These BIM solutions can deliver and maintain the architectural design documentation sets, create photorealistic renderings, sun-studies and can also exchange design information with rendering or light design applications. These applications however **are not capable** to help daylighting related design decisions **at the early design stages**.

Sun study of downtown Sydney (Arterra Interactive 2010)

5 MODEL MEASUREMENTS

With the help of **daylighting** model measurements in the **artificial sky** all the **physical** characteristics - such as geometry and surface properties - of the daylighting models can be **measured real-time**. This provides the **most accurate** analysis results and it can also be applied at **any design stage**, yet it also **requires expert knowledge** and technical background to complete such investigations, and therefore it is **not always feasible** to conduct such daylighting analyses at every architectural design project.

These measurements can **justify** the selected daylighting system against the **regulations** and **building codes**. A **single model measurement** will not provide the required minimal size of a transparent surface but it **will provide a very solid** and most **accurate input** to determine the optimal characteristics of a daylighting system.

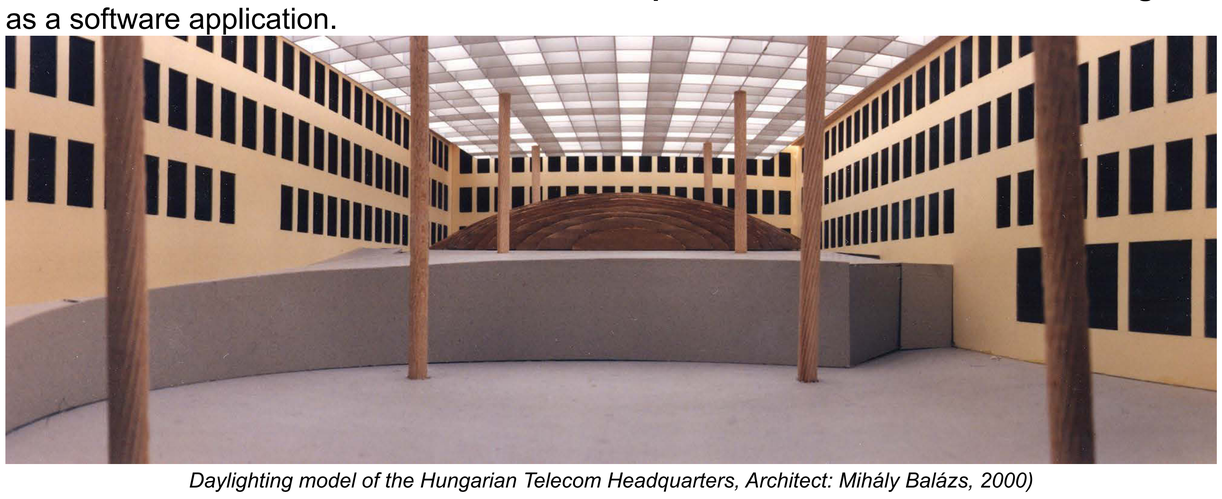


Sun study of downtown Sydney (Arterra Interactive 2010)

6 GENERATIVE METHODS

Prof. András Majoros PhD has developed the **“Majoros” generative daylighting design method**, based on **model measurements**. This **explicit method** can provide the **required minimal area** of the transparent surface of a typical rectangular interior space with **side-lights**. This tool is available **free of charge** from the website of the department (**www.egt.bme.hu/majoros**) it provides **accurate results** within **minutes** and does not requires deep knowledge in the field of daylighting.

My research is focusing on the investigation of **sky-lights**. The **existing skylight efficiency method cannot incorporate** certain properties of skylights (depth of light well, surface and glazing properties of the skylight system) while these properties **greatly effect** the illumination values by **over 10%**. Throughout model measurements, I have **identified the effects of the skylights systems** on the illumination values. The results of the model measurement are to be summarized and will be **provided for the architectural designers** as a software application.



Daylighting model of the Hungarian Telecom Headquarters, Architect: Mihály Balázs, 2000)