BES322239

Collaborative lighting design, from visualization to manufacturing using Forge API

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Description

Using Autodesk Forge API, manufacturers, engineers, architects and designers can build a collaborative ecosystem to address the lighting design process/industry efficiently.
This class focuses on interior design lighting and deeply analyzes its settings to prototype an automated system that can understand the photometric light preferences and do the computations required to determine the level of lighting needed for a certain space and the type of activities performed within a specific volume.

Our class also will show how we can enhance the BIM collaboration level and tackle how Generative Design can support not only the architects and the engineers but also the manufacturers to enhance their designs and produce more efficient luminaires with less resources, energy and time
From the fabrication perspective, the system will also be able to make use of the Generative Design technique to suggest the proper structure of luminaire and allow the end user to select the suitable design from a various options set.

We will learn how to integrate IES files with Autodesk CAD application and how to make benefit from the advanced rendering capabilities to achieve accurate visualizations that can be adjusted and updated in real time using Autodesk Design Automation API for 3ds Max.

Furthermore, using Forge Design Automation API for Revit, the chosen design will be automatically translated into BIM data from which we can generate electrical plans and simultaneously calculate the number of light fixtures to generate the Bill of Quantity (BoQ).

Finally we were taking into consideration how we can develop the system in such a way that can support sustainability to save our precious environment resources and save the cost and time that could be wasted in an unproper light system design.

In this class, we will demonstrate how we used the Design Automation for Revit and 3ds Max API to:

1. Define the automated system that evaluates the IES light requirements to simulate design criteria at real time using Forge.
2. Evaluate the light amount required for a specific space where certain activities are performed using Forge Design Automation.
3. Describe how Design Automation can link design and practice to generate electrical design sheets and QTO schedules for BIM.
4. Learn how to organize and represent essential abilities of Generative Design to customize a sustainability framework.

Speaker(s)

Mustafa Salaheldin

A diverse disciplines subject-matter expert and one of the few professionals in the Digital Transformation field who has a strong technical experience in Building Information Modelling (BIM) and is mastering the full-stack application development at the same time.
Mustafa joined Atkins Middle East and Africa, part of the SNC-Lavalin Group in Canada, as the Data Science Manager.
In the middle of the pace of technology he held the responsibility of looking at applying new techniques like Machine Learning (ML) and Artificial Intelligence (AI) to make use of the capacity of the machines to help in solving design issues and provide optimum designs.
Previously when he was working for Engineering Consultants Group (ECG) in Egypt as the head of BIM R&D, he started up the BIM implementation and automation.
Besides he has a Bachelor of Science in Computer and Systems Engineering, he is a LEED GA certified, Autodesk Expert Elite, Microsoft certified applications developer and Autodesk Authorized Developer.

Imad Hanna

Imad is an assistant professor at the American University in Dubai, a confident and competent Interior Architect with extensive experience in working on a different range of projects ranging from design to execution. He graduated from the University of Holy Spirit USEK (Kaslik-Lebanon) as an Interior Designer and accomplished his Master in Interior Architecture in 2008-2009. His interest in mixing architectural concepts with the latest technologies made him an expert in the Digital Design Fabrication field. Imad is a 3d studio Max (Autodesk certified professional) and (Adobe Certified Expert).

He focused on researching new and innovative platforms, applications and theories in Interior Design and architecture as well as worked on developing and implementing educational technology curriculum for delivery of classroom using a combination of Autodesk Software.

He Received a certificate from Harvard "Teaching and learning strategies for higher education "

Along with several certificates of appreciation for being an active member in the NASAD accreditation so as for his contribution to the success of the CIDA – Council of Interior Design Accreditation at the American University in Dubai. Imad is a member of the research committee at the American University in Dubai, an Associate member of the American Institute of Architects (AIA), the Association of Professional Interior Designers (APID) and the Interior Design Education Council (IDEC)

Introduction

Light design is a very interesting topic as it brings together art, science and technology. It is a very vast topic that includes space design, luminaire design and light source design as well as it involves a lot of professionals from different fields that collaborate in different ways to accomplish the design.

No doubt that light impacts people at work, at home, at school and at play, not just indoors but also outdoors and by achieving a lighting system with a good design, we can improve the aspects of the human experience by providing a better understanding of the form, the space and the materials as it affects our senses, our emotions, our health and well-being.

That is how we get inspired, and wondering how we can provide a creative, energy-efficient lighting solutions for all types of projects by making advantage of modern digital technologies to prototype a platform that can deliver well-planned lighting schemes that are fully integrated with the architecture, provide visual comfort and are adapted to the needs of the end-user and in the same time it can create spaces that are inspiring and responsive and on top of that guarantee a sustainable design that can help vendors fabricate the light system with less resources and low cost with high quality.

BIM is one of the key factors that can influence the design process of any project and one of the main aspects of BIM is collaboration between different stakeholders and sharing information in a proper continues way. BIM was our second element of inspiration as by collaborating with architects, interior designers, electrical engineers, contractors and vendors, we consider lighting from the beginning of the design process and integrate aesthetically appealing, efficient lighting systems, by using advanced technologies like generative design and design automation from Autodesk.

Our third element of inspiration was sustainability. We thought of a platform that can help us deliver just the right amount of light using the least amount of energy and let us count the number of light sources needed to deliver the required light. This results an elegant solution that protect our clients' budgets and save the environment by designing lighting strategically – whether to use the visual and emotional impact of light to strengthen brand experiences or to lower carbon emissions and save on energy bills.

BIM and Light Design

When we were thinking of building our platform, we were thinking from the BIM perspective. The BIM factor is especially heightened given the increasing trend of integration between lighting systems with the very fabric of the architectural and engineering systems that lighting cohabitates with.

We were taking into consideration using Design Automation, to find an easy way to integrate BIM software with lighting calculation and visualization software. That is a lighting scheme developed using a BIM software should be capable of delivering its performance data without having to get access to a third-party calculation software.

In terms of the overall lighting design and documentation process, BIM becomes an irreplaceable ally to ensure harmonious integration of project information, simplified coordination between trades and easy synchronization with lighting simulation and visualization software.

Also, we wanted to make use of the most obvious feature of BIM which is collaboration to manage projects that are most often of a large scale with multiple counterpart design teams, scattered across the globe. With that in mind however there remains much room for improvement concerning ease of drafting and detailing in the cloud using Revit.io.

By building our platform with BIM at the core we can achieve quick coordination for light fixtures, increase the collaboration level between designers, vendors and the end user, as well as produce drawings and views automatically from the platform, and resolve any clashes before sending the lighting system to the site.

It is also easy now to generate and manage the Digital Content of the lighting systems and produce the Revit Families with the proper characteristics defined by the designer, vendor and the end user in a centralized, maintained repository that can be shared among different contributors in the project.

Finally, no doubt BIM maybe still not mature enough, but as it continues gaining territory within the global design market, propelled primarily by new code requirements, geographically dispersed design teams and tighter deadlines, it's a matter of time before many of its disadvantages are resolved.

Who should use our platform?

Lighting design is a combination of applied art and applied science. That requires different stakeholders to simultaneously work on the same project in different phases. In the following list we mention the main contributors in any lighting project and the role of each in using our platform:

Clients
It is very important to involve them in this process as early as possible because they are the key factor who will use the light, get impacted with it and the most important, they may be the one doing the installation and maintenance.
Getting the clients contribution in the early design phase can help the other stakeholders to make better decisions and create optimum design.

Architects:
They are concerned with the design of lighting systems, including natural light, electric light, or both, to serve client needs and in the same time space requirements. Architects must make sure that their design provide the proper enough illumination with no glare and ensure safety and security.

Interior designers:
They are more concerned with decorative lighting which can provide general illumination for an entire room, focus on a small area for task or hobby lighting, or be used to accent other lighting and provide additional ambiance, in addition, to provide the light color and shadow distribution that integrates with the furniture and the space materials.

Electrical Engineers
They must make sure the light source is providing sufficient amount of lumens with less amount of power consumed, delivering light fixtures optimum distribution which also make benefit of day light use by doing the required calculations.

Manufacturers
When it comes to fabrication, manufacturers must apply sustainability in their production, that is doing good luminaire or bulb design which allows reducing the resources waste, power consumption, reduce radiation emission, reduce cost and increase the life time of the product. This is not the only thing, also the final product should be easy to handle and install and it is preferable to be modular and multifunctional.

Contractors
Once the lighting systems design is finished, it is very important to run a quantity take off to determine the number of lighting fixtures, cables and switches that are needed for the project to purchase. After generating the quantity list, a bill of quantity is submitted and delivered for contractors for bidding.

Autodesk Forge Design Automation API

This class assumes that the audience are familiar with the add-in's development for Autodesk products specially Revit and 3Ds Max and in order to make the content clearer and can go deeply through some of the programming and technical topics, we must give a quick brief of the Autodesk Forge platform.

Mainly our platform is built on top of Autodesk Forge and extensively using Autodesk Forge Design Automation for Revit and 3ds Max. Both are in a public beta releases, which means that you should only use them for experimentation and proof-of-concept, and they should not be used for production applications and it is important to emphasize that any data uploaded to Design Automation workspace is subject to removal at any time.

What is Autodesk Forge Design Automation API?

The Design Automation API (V3 Beta) is a set of web REST APIs that provide the ability to use the core API's of your favorite CAD engines, in the cloud, leveraging the scale of the Forge Platform to run automated jobs. These jobs could be highly repetitive or frequent or could be larger problems that need large-scale processing power. With the Design Automation API, you can offload that processing to the Forge Platform, which can process those jobs at a much greater scale and efficiency.

How to make use of Autodesk Forge Design Automation API?

The main uses of the Autodesk Forge Design Automation APIs are to allow user to build cloud-native apps and services that run add-ins from web applications against certain CAD engine That way the user can manipulate the native design files, which could be through new content creation, existing content modification or information extraction.

In 3ds Max case, Design Automation API for 3ds Max provides access to the 3ds Max API running in 3ds Max Batch mode. Through Maxscript or Python and its extensive SDK, data can easily be processed for optimization, rendering and publishing. The user can do 3D data modeling, animation, rendering and simulation on 3ds Max files or any other format. The 3ds Max engine can be used to load/import data from wide range of sources.

Similarly, in the Revit case, Design Automation API for Revit provides access to the full Revit DB API, without the requirement of installing Revit on the desktop, the user can easily create custom Revit native content(RVT/RTE/RFA), automate model creation, explore and analyze model data, extract and produce automated reports, modify existing models to maintain company standards, automatically create documentation, and so more.

Note: Design Automation for Revit, DA4R and Revit.io will be used interchangeably to refer to the same thing. Similarly, Design Automation for 3ds Max, DA4Max and 3dsMax.io will be used interchangeably to refer to the same thing.

Autodesk Forge Design Automation API Model

First off, you need to create a client application, which will call the REST API endpoints. You can use any language, which can make REST calls. This client application will also do any interactive or response work you need like displaying some UI to the end-user for showing the progress or the result of the add-in execution, for example.

In addition to the client application, we will create one or more add-in/plug-in to execute against the required engine. The add-ins assemblies will be uploaded to the Design Automation service and your client application will refer to them when invoking the service. They can be kept private or public depending on what you want.
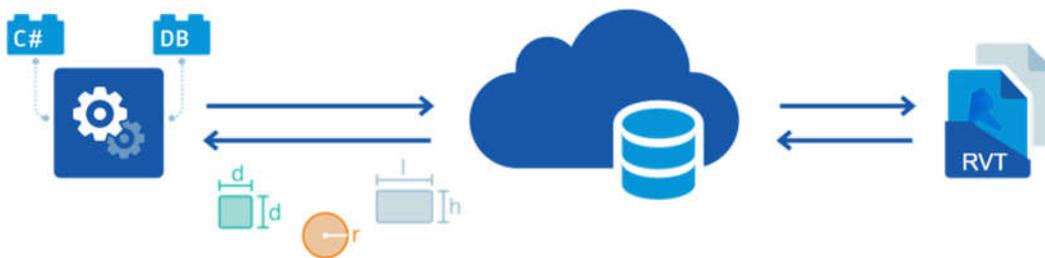
Fig.1.1 Architecture of DA4R
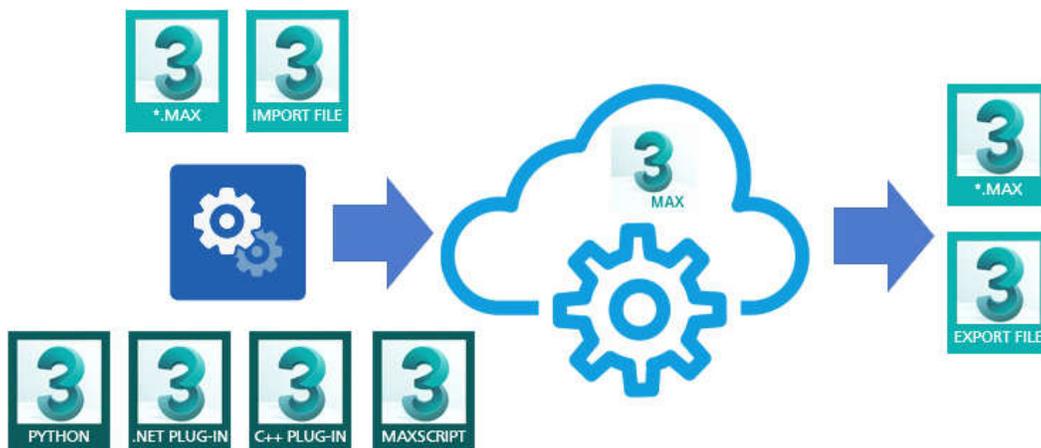
Fig.1.2 Architecture of DA4Max

How it works

In this section we will explain the mechanism behind executing an add-in/plug-in in the cloud. The first step is to create an AppBundle. AppBundle refers to one or more add-ins/plug-ins and can be used later by multiple applications. You can think of the AppBundle as a folder that holds all your executables and configuration or related files. The AppBundle will also specify the engine that will execute the add-in.

The second step is to define an Activity which is like a function definition, it specifies one or more apps, a set of inputs and outputs, and a product engine to run against.

The third step is to create a Workitem, this is a specific invocation of an activity, indicating specific input files and an output location.

The engine is the headless core of the CAD software in the cloud and it is what executes a WorkItem job and processes the actions specified by an Activity.
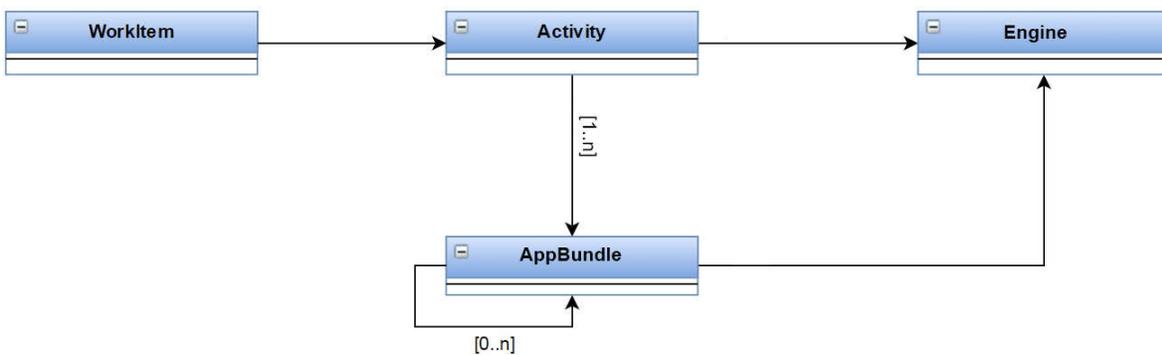

Fig.2 Forge Design Automation Architecture

There is no difference between writing a code using the DA API and writing the code for a regular add-in, they are almost equivalent except that in DA you don't have access to the UI components of the engine interface and you only limited to address the database.

Why Autodesk Forge Design Automation API?

The point of strength of Design Automation API is since it is a part of the Autodesk Forge platform that works on the cloud it can be easily integrated with the different Forge services.

Furthermore, you can make your add-in more powerful by giving it unlimited access to all other cloud service providers.

By connecting to other cloud services, you can use the advanced features like Lambda functions from Amazon and even plug your add-in to the ML and AI provided from Microsoft or Google for example.
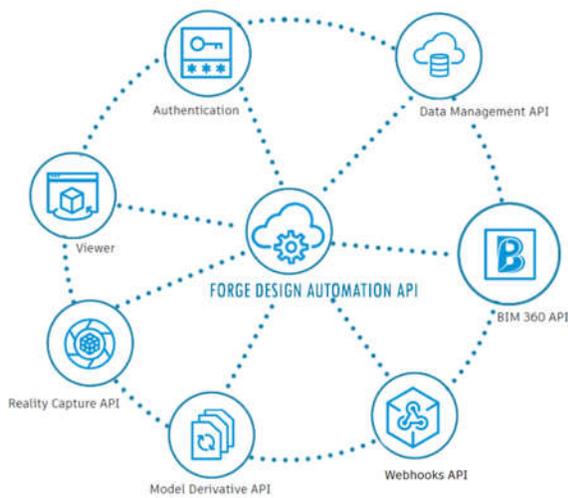
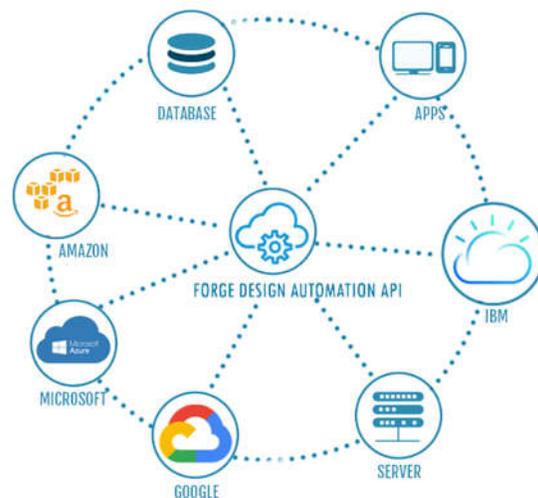Fig.3.1 DA integration in Autodesk Forge platform

Fig.3.2 DA integration with other cloud services

Using cloud services gives us the harmonization between digital operating model, predictive analytics, and a microservices architecture that allows digital organizations to quickly take customer desires and feedback and turn them into actionable, revenue-generating business solutions. As Artificial Intelligence or AI becomes more prevalent in business applications, these organizations can easily integrate Design Automation service of Autodesk Forge with AI to use rudimentary machine learning and improve decision making in big data analysis.

Evaluation of the IES light requirements to simulate design criteria at real time using Forge

So many CAD applications now support photometric light and make use of its parameters such as Light Loss Factor, Initial Intensity, and Initial Colour Control to create realistic lighting visualization and rendering with accurate calculation.

You can specify that the light distribution of a light source is photometric, by assigning an IES file to the light source. An IES file is an ASCII text file provided by a lighting manufacturer and it describes the intensity of a light source at points on a spherical grid, or in other words it describes the geometry of how the light comes out of the lighting fixture (the photometric web). Revit uses the IES file to make a photometric web to represent the light source.
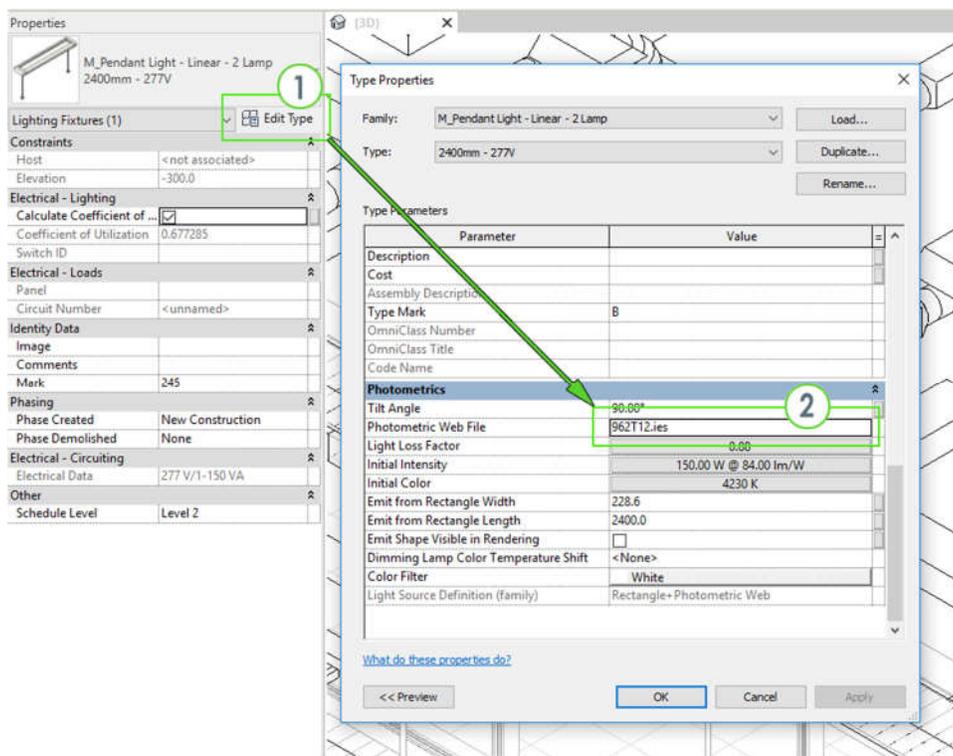

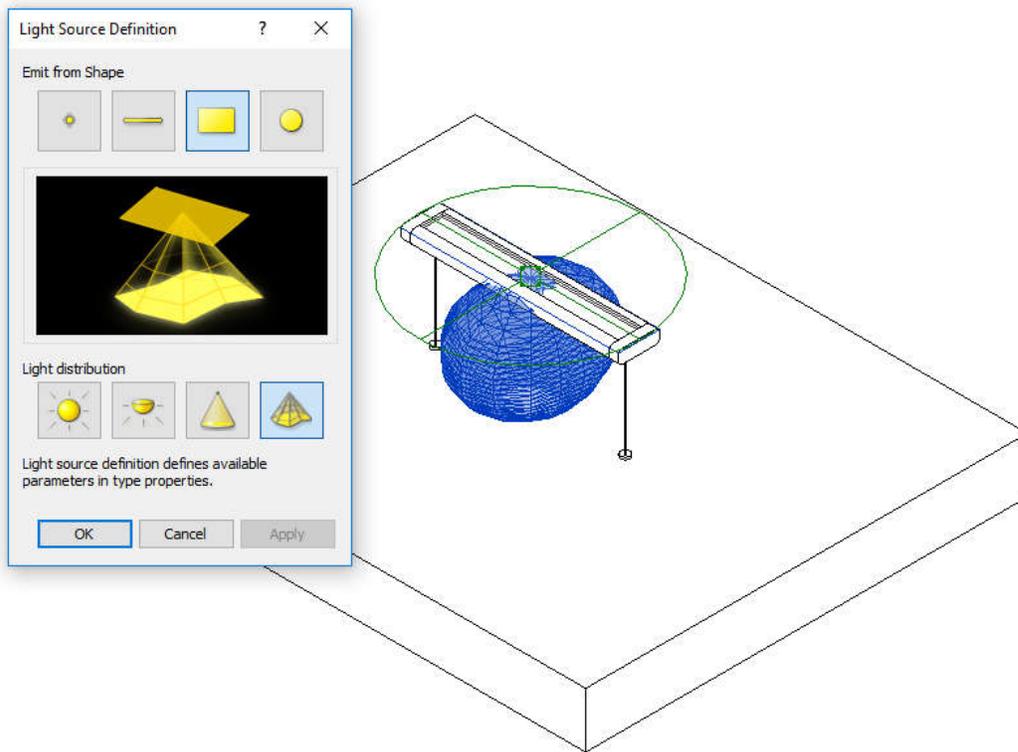Fig.4.1 Assigning an IES file to a light source in Revit

Fig.4.2 Defining a photometric web for a light source of a Revit Lighting Fixture Family

To get best results when creating a lighting fixture family, you can use an IES file to define the photometric shape of the light source then place the light source below the fixture opening so that it is not touching the fixture geometry.

Also, 3ds Max uses the IES file to generate more accurate lighting results in rendered images. As Photometric light objects are based on quantitative measurements of light levels and distribution, we can get a real-world lighting and accurate scene illumination when IES files are used with any rendering engine like ART Renderer, Arnold Renderer, or any other global illumination solutions. In the 3ds Max, photometric lights are the default choice for creating lights.
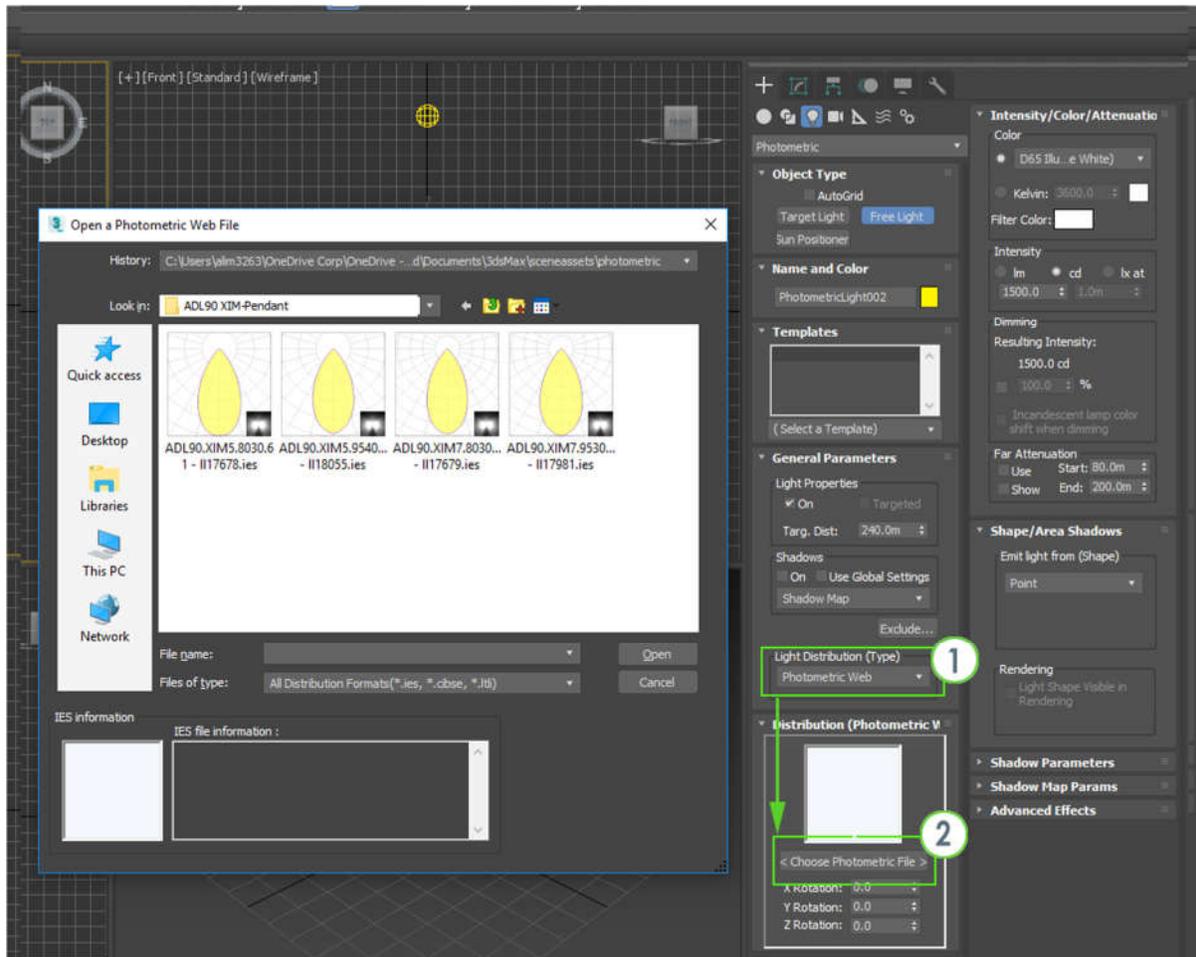

Fig.4.3 Defining a photometric web for a light source in 3ds Max

Create an IES definition visually

Now we understand the importance of IES file and the main role it plays in the lighting design process. In a classic supply chain, the IES files are only generated by the vendors and provided as a matter of fact to the end user who could be a visualization designer, a light engineer or an architect. Thinking out of the box, we wanted to make the supply chain digital in essence that making it more flexible and work in the opposite direction, meaning instead of receiving the IES (or the photometric light characteristics) from the manufacturer and deliver it to the supplier or the end user, we can give the end user the ability to create the shape of light, the color temperature, light intensity then send them back to the vendor as IES file and hence the manufacturer can fabricate the luminaire according to these user requirements.

In our platform we allow the user to create photometric light characteristics in two ways; first by allowing him to upload an out of the box IES file provided from a vendor then manipulate it, or by creating a new IES file from scratch by defining the light characteristics visually through a user friendly easy to use UI. By adjusting the criteria sliders or moving the graphs control points, a 3d geometry for the light distribution will be automatically created and updated in an Autodesk Forge viewer and send a command to the 3ds max engine to render the light scene. That way the user can monitor the effect of the characteristics adjustment simultaneously.
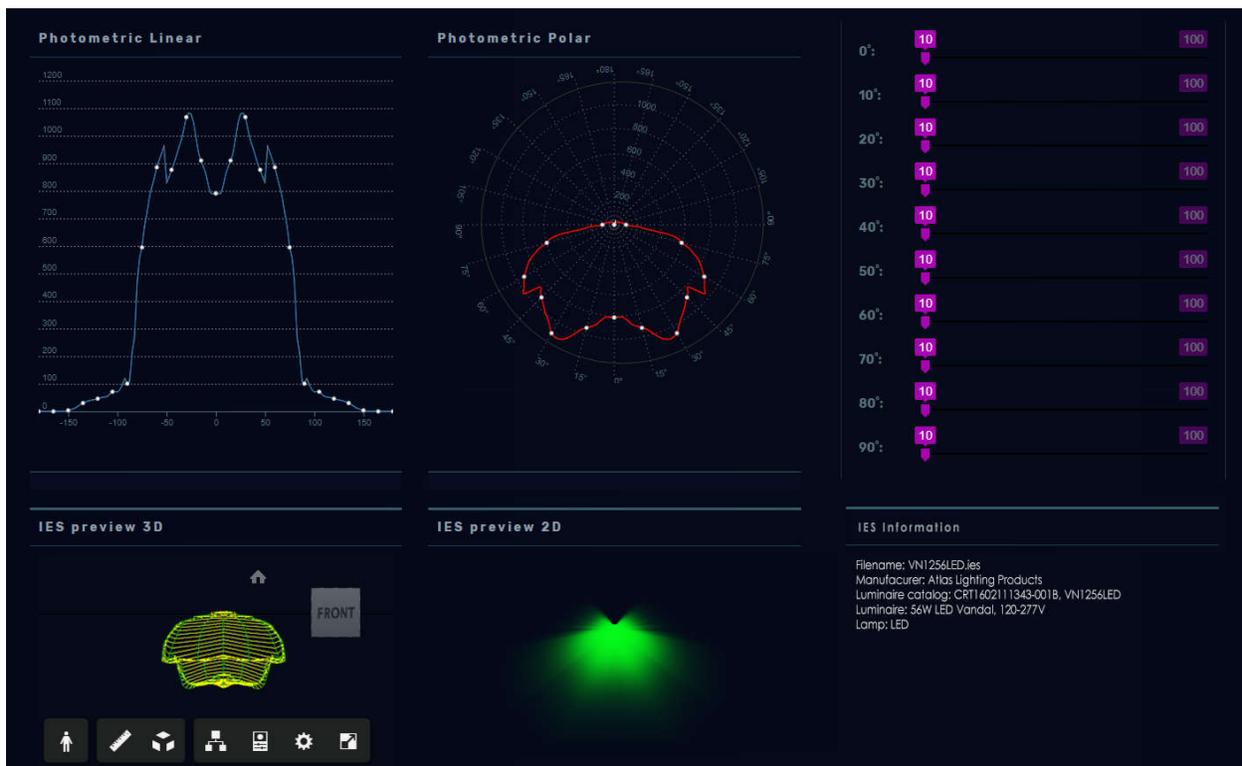

Fig.4.4 User UI of controlling the photometric light Characteristics through polar and linear graphs

Digitally manage your library content

There are two types of library content that can be digitally managed through the platform; first the IES files created or uploaded by the user, and the Revit families of the lighting fixtures that will make use of that IES files.

Whenever the user creates a new IES file, it will be added to the content library based on its category and it will be ready to get attached to the Revit Lighting Families. That way the user can keep track of the history of the files added deleted or modified and make sure the model and design is up to date and the calculations is consistent.
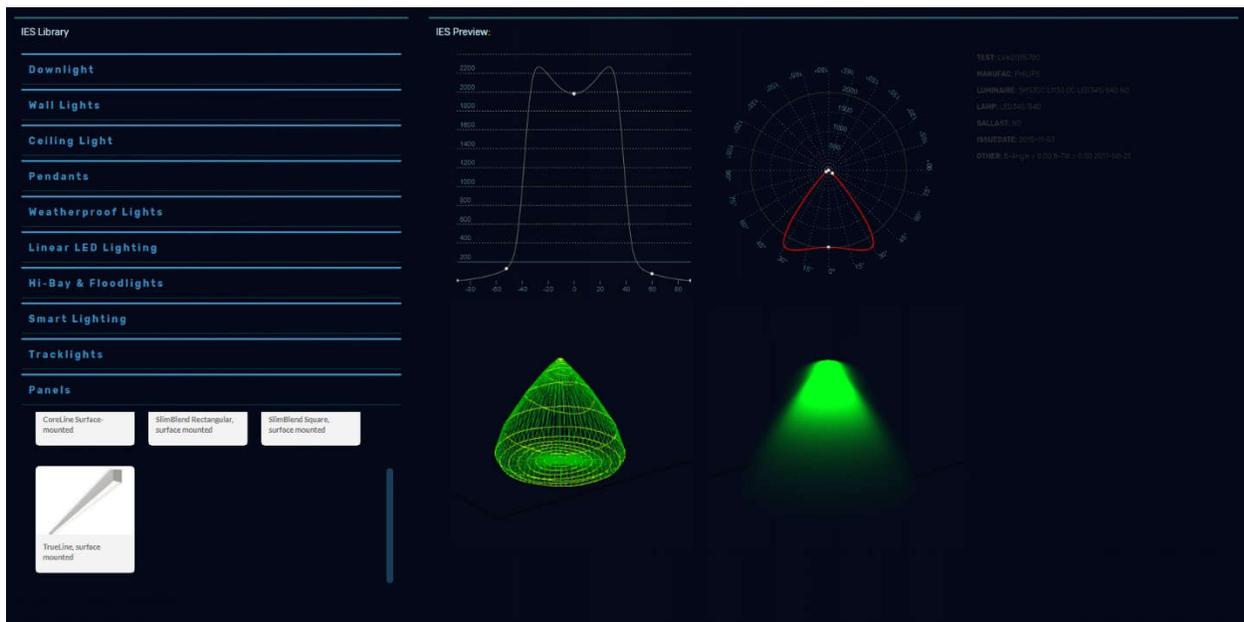

Fig.4.5 User UI of the IES Library. Users can upload and browse the IES files and their Characteristics as polar and linear graphs and preview the photometric web and the actual rendering.

Evaluate the light amount required for a specific space where certain activities are performed using Forge Design Automation

It is very important to decide the amount of light needed for any building based on different factors like the location, daylight and the type of activities taking place in the facility.

Our system can calculate such factors and evaluates the amount of light and the type of luminaires needed for each room/space, by connecting to several energy analysis platforms and hence update the Revit model using the Forge Design Automation for Revit API with the proper type and numbers of lighting fixtures.
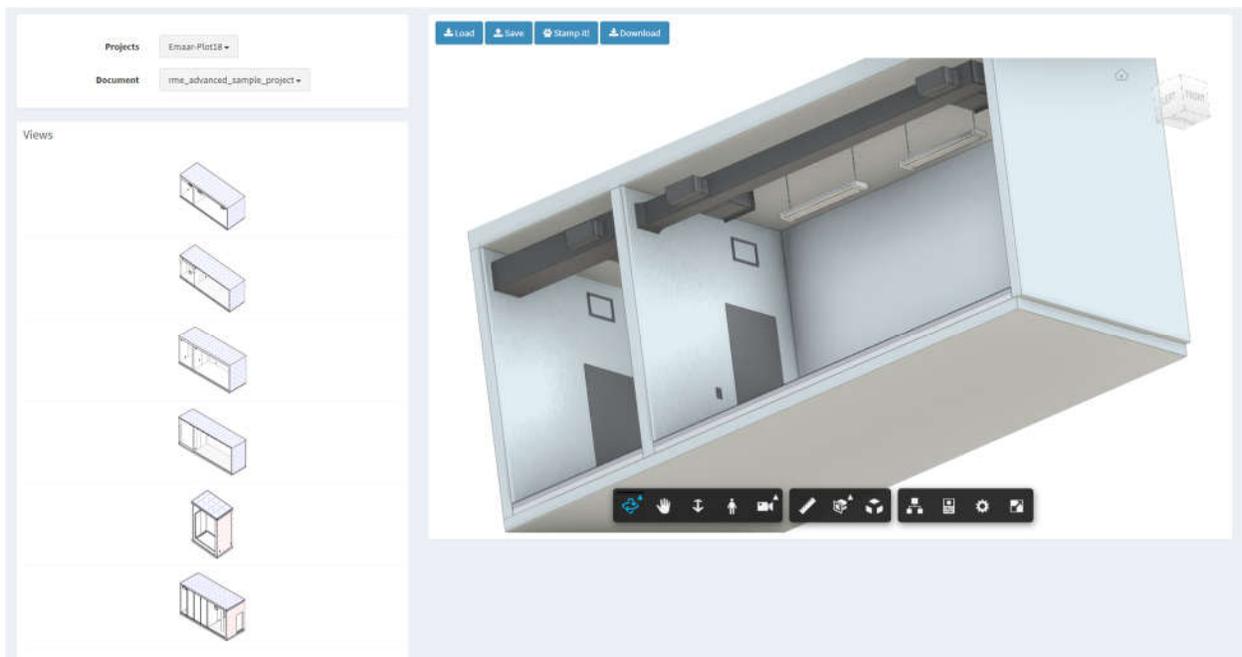

Fig.5 Updating the Revit model with Revit.io

Design Automation can link design and practice to generate electrical design sheets and QTO schedules for BIM

Once the user is satisfied with the final lighting distribution and lighting fixtures types, we can send another command to Revit.io to automatically generate the ceiling/floor plans sheets and moreover generates the BoQ needed for each plan or building.

The generated BoQ can be exported as an Excel sheet and can be linked to any database source or cloud services like Google Sheets, that way the changes and updates could be bi-directional, meaning if you update the Excel sheet it will update the lighting model elements and vice versa.
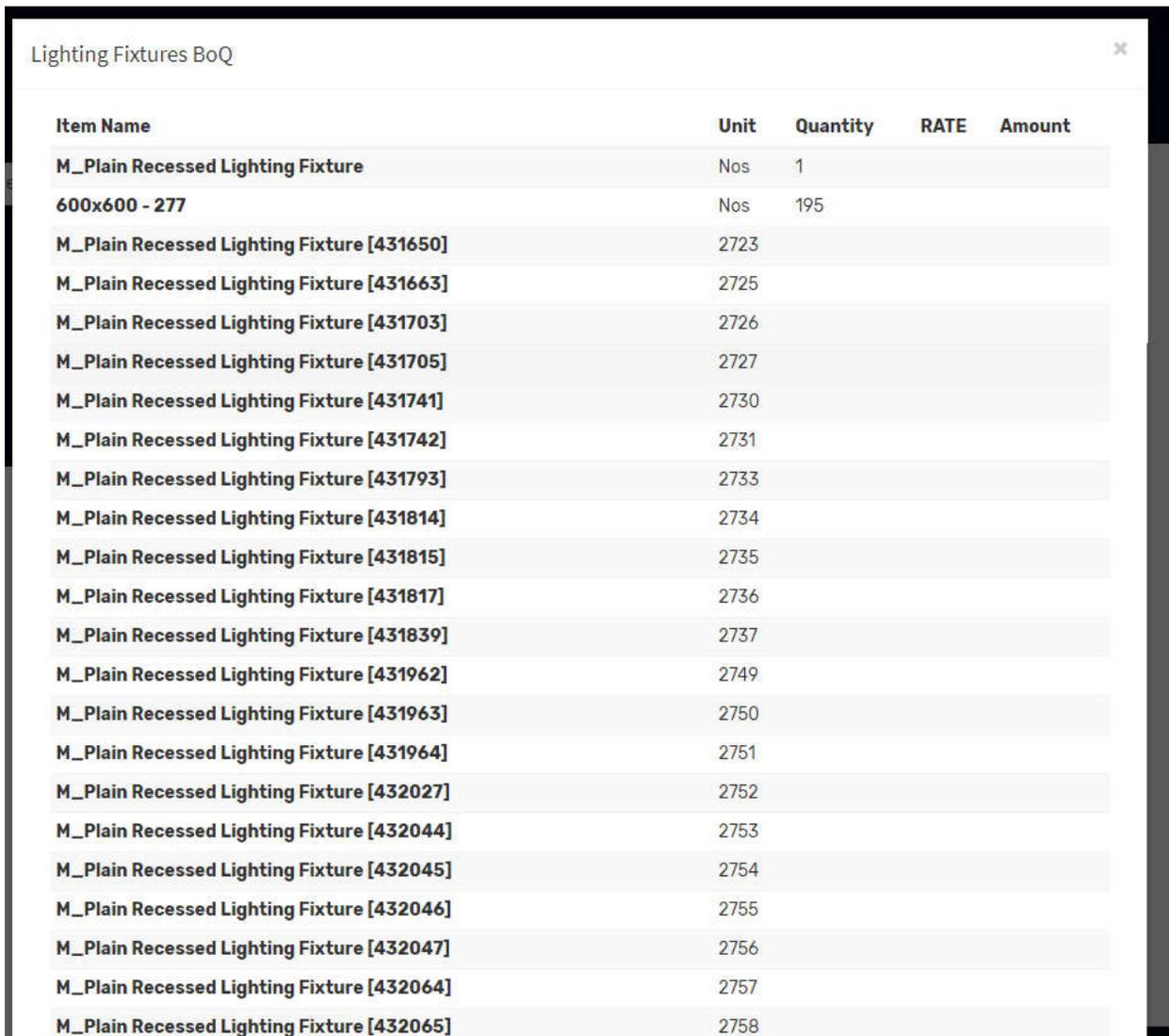
Lighting Fixtures BoQ					✕
Item Name	**Unit**	**Quantity**	**RATE**	**Amount**	
M_Plain Recessed Lighting Fixture	Nos	1			
600x600 - 277	Nos	195			
M_Plain Recessed Lighting Fixture [431650]	2723				
M_Plain Recessed Lighting Fixture [431663]	2725				
M_Plain Recessed Lighting Fixture [431703]	2726				
M_Plain Recessed Lighting Fixture [431705]	2727				
M_Plain Recessed Lighting Fixture [431741]	2730				
M_Plain Recessed Lighting Fixture [431742]	2731				
M_Plain Recessed Lighting Fixture [431793]	2733				
M_Plain Recessed Lighting Fixture [431814]	2734				
M_Plain Recessed Lighting Fixture [431815]	2735				
M_Plain Recessed Lighting Fixture [431817]	2736				
M_Plain Recessed Lighting Fixture [431839]	2737				
M_Plain Recessed Lighting Fixture [431962]	2749				
M_Plain Recessed Lighting Fixture [431963]	2750				
M_Plain Recessed Lighting Fixture [431964]	2751				
M_Plain Recessed Lighting Fixture [432027]	2752				
M_Plain Recessed Lighting Fixture [432044]	2753				
M_Plain Recessed Lighting Fixture [432045]	2754				
M_Plain Recessed Lighting Fixture [432046]	2755				
M_Plain Recessed Lighting Fixture [432047]	2756				
M_Plain Recessed Lighting Fixture [432064]	2757				
M_Plain Recessed Lighting Fixture [432065]	2758				

Fig.6 Sample BoQ generated by Autodesk Forge platform from a Revit model.

Essential abilities of Generative Design for sustainability customization framework

What is Generative design?
A goal-driven approach to design that uses automation to give designers and engineers better insight so they can make faster, more informed design decisions. Your specific design parameters are defined to generate many—even thousands—of potential solutions. You tell the software the results you want. With your guidance it arrives at the optimal design along with the data to prove which design performs best.

How we make use of GD in our platform?
Taking advantage of generative design means acknowledging that computers can do a better job with certain kinds of low-level analytical tasks, like checking to make sure all the lighting fixtures are providing the enough light, the power conducted is enough, or the type of glass in the luminaire is performing in the context of the overall energy goals.
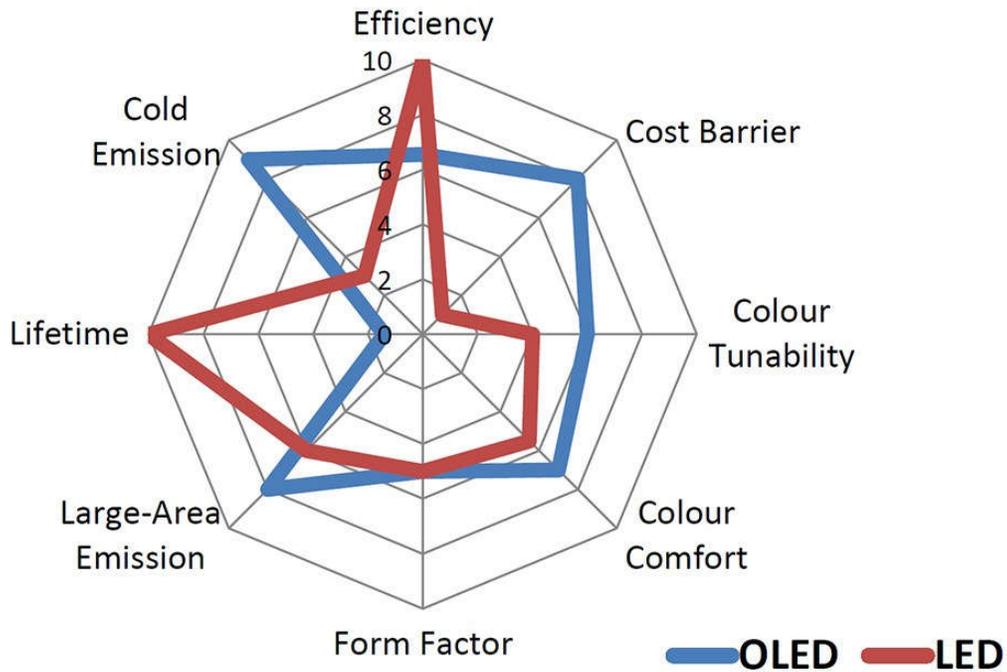

Fig. 7.1 A radar diagram that covers several different aspects of lighting design.

Doing this frees a designer to focus on creating sustainable and value-engineered buildings. The most critical point for both designers and manufacturers is how to make the optimum choice for their products from a set of several options. Here comes the role of generative design.

In our platform we used the generative design to generate different design options for lighting distribution to help the designers make better choices based on the visual results.
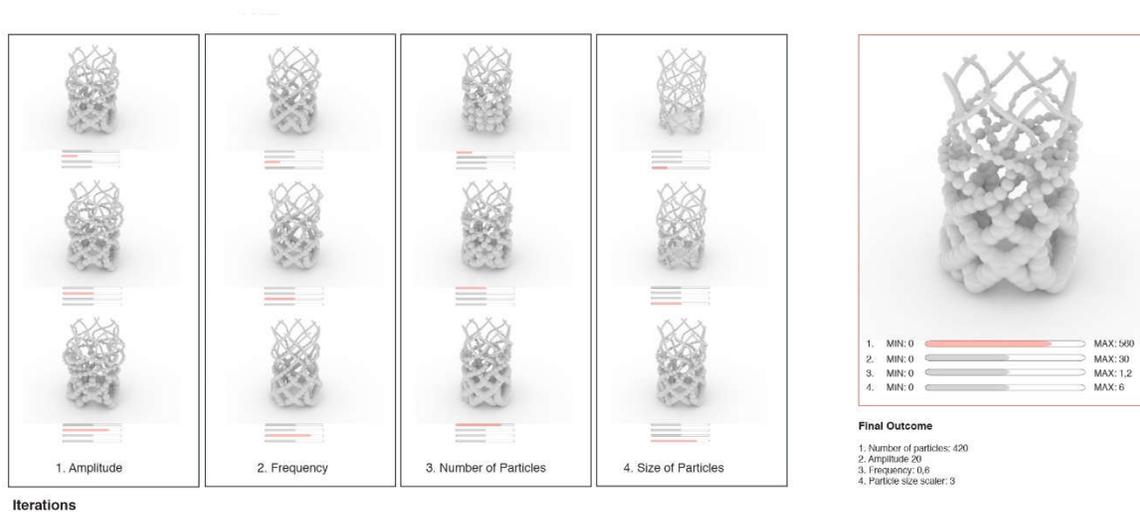

Fig. 7.2 CJW present their 3D powder printed table lamp based on the concept of the wave/particle duality of light. Image courtesy of CJW.

For the manufacturers, it is very easy now to select the shape of the Luminaire, the reflector material, number of light sources per luminaire that can achieve certain illumination level. Depending on the occupancy and amount of daylight coming through the windows in several times of year, generative design can suggest the best design configuration that can help us save more energy and reduce the CO_2 footprint and power consumption and increase the human wellbeing. One other point is how to reduce the material fabrication waste due to bad design.
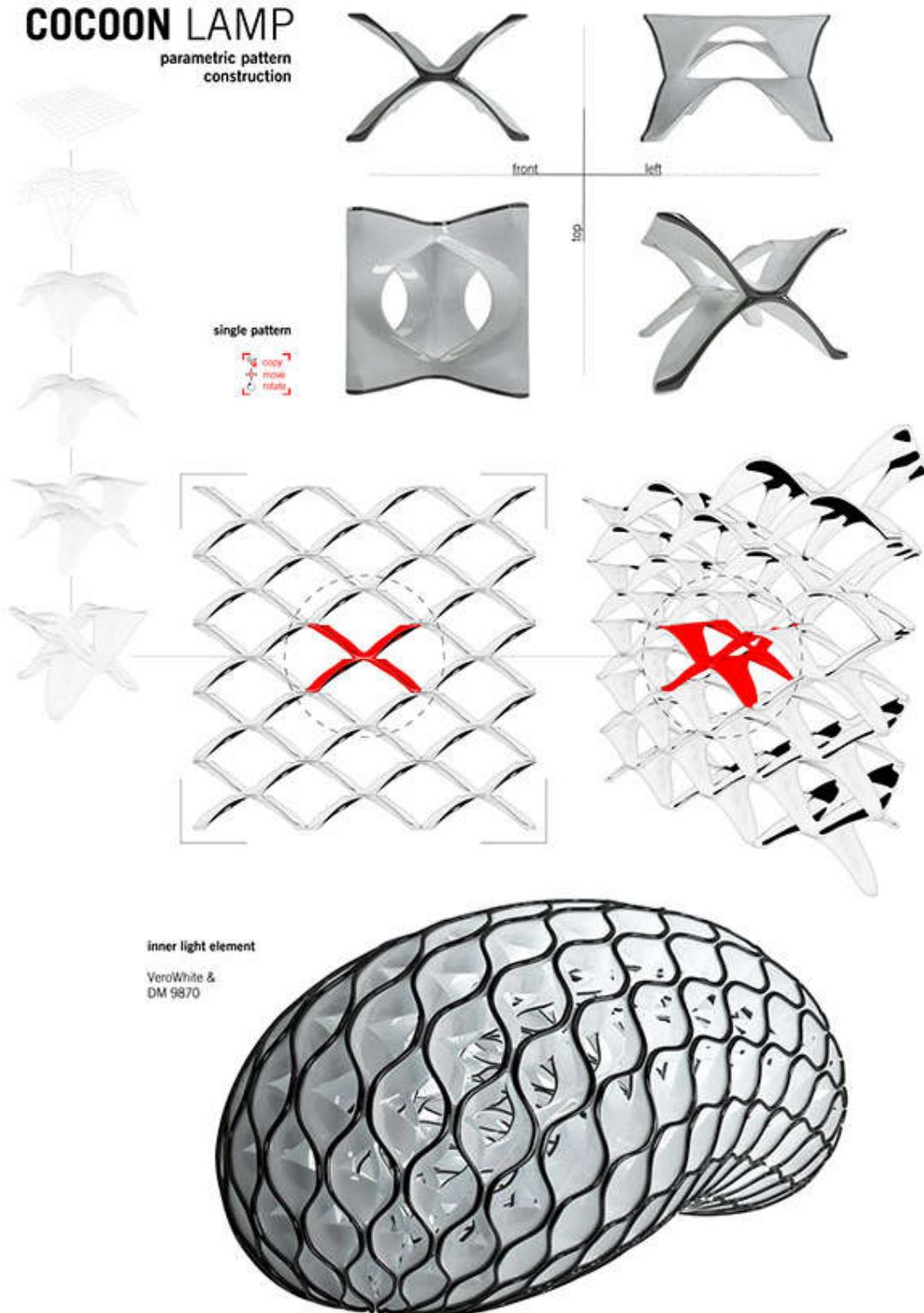
Fig. 7.3 The German designer Patric Günther project, Cocoon lamp.

Wrap up

Lighting design is an amazing field where art is blinded with science. There has been a dramatic change in the lighting design over the last couple of decades.

As we tried to show in this class Autodesk made it possible for us to access an affordable range of lighting solutions using advanced technologies like Design Automation and Generative Design through a wide range of cloud API that built in the cloud.

We have been through the holistic process of light system concept design from architecture concept design, going through interior design input to achieve matching light with decoration and human wellbeing.

It was obvious how Autodesk Design Automation API has helped electrical engineers to work collaboratively with architects in order to meet the client and the space requirements.

Finally, it is also very important to highlight the role of Generative Design in fabrication that can help the manufacturer maintain the sustainability through their products and protect the environment and save the clients budget.