

Historical Evolution of the “Expression” Problem in Design and Applications



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Abstract: *The expression of a design or an earlier work for a presentation or an implementation has improved in history. Today, the introduction of digital technologies in architecture and topology has led to the partial or complete abandonment of some of the methods used until recently in education and practice by the replacement of new forms of measurement and presentation. The expression of a new design or an already existing building or space is transformed by new production methods and products; as well as directing the production area and society to transform and develop. This article summarizes the brief history and present-day status of this two-way relationship.*

Keywords: *Descriptive geometry, Perspectives, Point cloud, Laser measurement, Photogrammetry, Pixel.*

Tasarımda ve Uygulamalarda İfade Sorununun Tarihsel Gelişimi

Öz: *Bir tasarımın ya da daha önce gerçekleşmiş bir eserin, bir sunum ya da uygulama için ifade edilmesi tarih içinde gelişmeler göstermiştir. Günümüzde de bilgisayarların ve programlarının bu alana girmesi, yakın geçmişe kadar kullanılan bazı yöntemlerin eğitimde ve uygulamada kısmen ya da tamamen terk edilmesine ve yeni ölçüm ve sunum şekillerinin bunların yerini almasına neden olmuştur. Tasarımın ya da mevcut olanın anlatımı hem yeni üretim yöntem ve ürünlerinden etkilenerek dönüşmekte, hem de üretim alanını ve toplumu dönüşmeye, gelişmeye yönlendirmektedir. Bu makalede, bu iki yönlü ilişkinin kısa tarihi ve günümüzdeki durumu özetlenmiştir.*

Anahtar kelimeler: *Deskriptif geometri, perspektifler, nokta bulut, lazer ölçüm, fotogrametri, piksel.*

1. INTRODUCTION

During a university trip, while visiting the Suleymaniye Mosque, a student asked if Sinan could have built this structure by combining the three aspects as plan, section, and elevation; with the same methods that we use today (Figure 1). We answered him “no”. Because at first, each different plan and cross-section should be drawn separately, then a key such as later’s descriptive geometry would be needed for the design to show their relationship between the plans, sections and elevation which are independent from each other (Figure 1) (the Scaled model in this example)



Figure 1. Miniature 1 Sinan built Süleymaniye mosque with a scaled model as shown in Nakkaş Osman's miniature. The model of Mimar Sinan and his work. Nakkaş Osman 1560 Dublin Library Ireland

2. "UNDERSTANDING" THE PAST WITH THE CULTURE OF TODAY

Expressing the designs which were realized in the past with different methods again through today's methods leads to problems. This is not only a problem of today, but has been a problem through the different phases of history and has manifested itself in different ways, for which solutions have been sought. The expression of a newly designed or previously constructed object/space has created problems that need to be solved both in terms of presentation and implementation, [1] because, it is insufficient to explain its environment, proportional dimensions and traces of its history.

On the other hand, the three- or two-dimensional expression of three-dimensional design in terms of shapes and opportunities, not only influenced the designers and their designs but also oriented the production processes [2]. The uncertainties arising from the inadequacy of the written description, [3] or the experimental particularities of the model by its difficulties in measuring and having precisions for application without technical drawings is left behind as a solution.

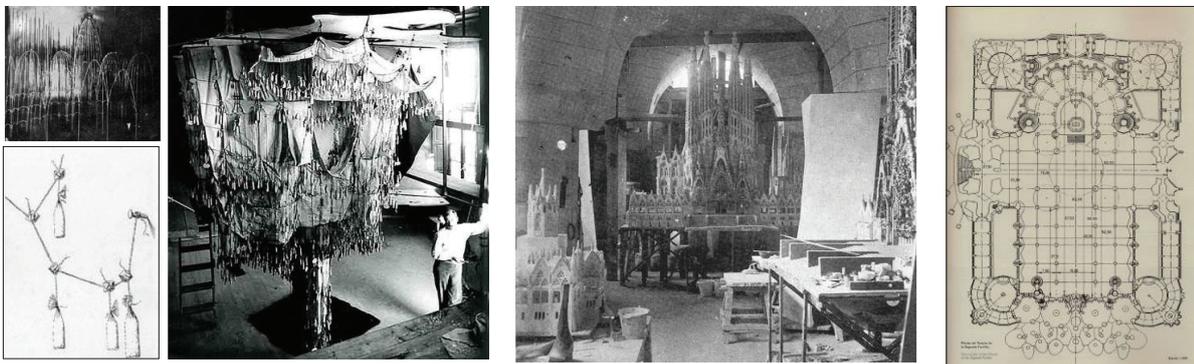


Photo 1. Left: Gaudi in his studio experimenting with force models. Middle: model and right: drawing's of Sagrada Família. A building like Sagrada Família realization is not possible without both models and technical drawings.

Today the drawing mathematics (geometry), thanks to its precision, permits the creation of a contract framework beyond presentation; it has also transformed all areas of design and practice starting from education till the stage of production. The development of the methods and tools of technology has been both the instrument and the driving force of the development of societies in this field [4].

Written scripts of the pre-Renaissance, later the scaled models and the stone builders' stereotomy (Figure 2) method (the method used to subdivide the stones to form a whole) are some of the historical examples of such developments.

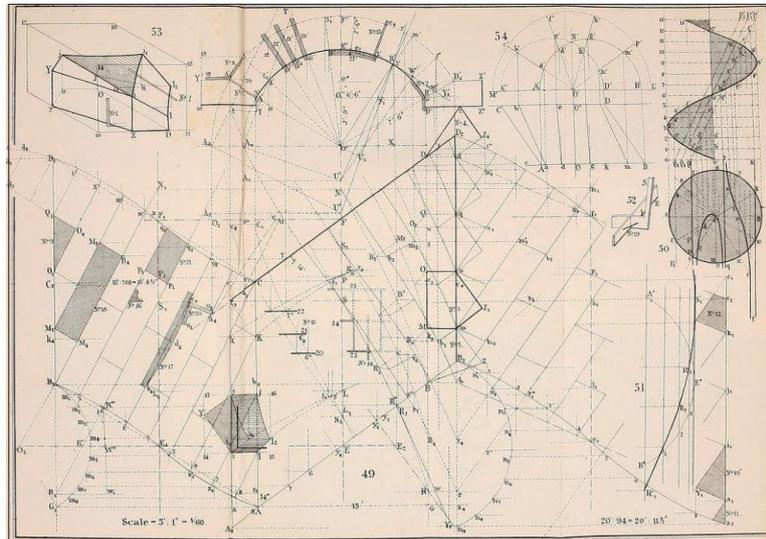


Figure 2. Stereotomy: Problems in stone cutting. For students of engineering and architecture 1875 Warren, S. Edward (Samuel Edward), 1831-1909 New York: J. Wiley and son Image from page 144

The development of the perspective and representative drawing methods that became theoretical during the Renaissance period, opened the gap between architectural design and construction, has re-shaped the production. With the industrial revolution, new expressive methods were officially settle down: perspective and parallel projection [5]. In Beaux-arts school, it became the main axes of education because of the reasons arising from the production process of this period. (Prototypes, standards, regulations...) (Figure 3).

The scalable expression of object or space, are the dominant means of different periods of these historical developments [6]. Throughout history, the development of expression methods has been effective in societies by creating a scientific information field. Nowadays, the roles of computers in this field have brought great innovations to our globalized world thanks to increasingly science and technology. The process with the "trio" of plan/section/elevation are characteristics of modern periods of architecture [7].

The effect of the industrial revolution's production models on architecture has led to the spread of descriptive geometry and perspective. For centuries, it formed the education of design professions. Also, it became a formal process and ultimately shaping production. The influence of production models of the Industrial Revolution on architecture also led to the popularization of descriptive geometry and perspective. Its education, its use in official transactions and finally its direction of production remained the dominant method. [8]. During these periods, the model was used either for projects of very mixed

structures (e.g. oil refineries) or presentation of a design for various purposes and written descriptions that are limited due to the cost estimations and reports.

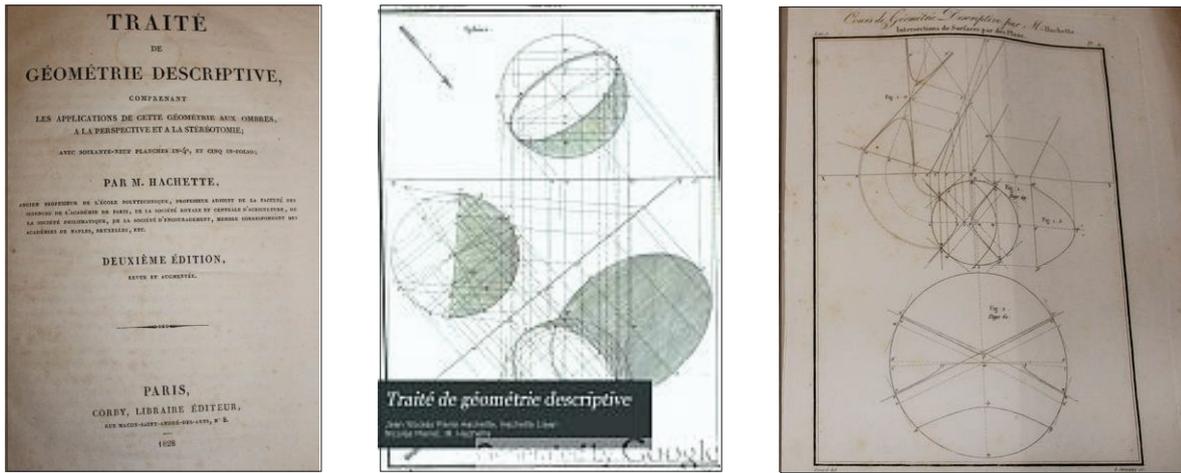


Figure 3. French mathematician Jean Nicolas Pierre Hachette (N: 1769) from the book *Traite de Descriptive*. Middle: *Parallel projection of spheres with their shadows on perpendicular plans*. Right photo: *Cutting the surfaces with plans* [3].

3. CONTEMPORARY PROBLEMS OF “THE EXPRESSION”

The problems arising from inadequate expressions of the plan, section, elevation triad facing the developments in today's materials and techniques are tried to be solved by the development of digital media and particularly virtual reality. Thus, how designs will affect their environment can be questioned in advance. Besides, a very large area was opened from cost calculations to building physics applications. It is possible now to construct models with 3D printers. All these bring great convenience starting from design to production (Figure 4). As a result of its deeply affected design education, leading to the development of new materials, techniques and changed the curriculum in the education of design professions [8].



Figure 4. Cultural Center Changsha Shi, Zaha Hadid Architects, China
Photo: Virgile Simon Bertrand

On the other hand, parallel projection and perspective, even if they have lost their importance over time and have been removed from most education programs, still maintain their dominant position in the “expression” of the projects.

The fact that the perspectives have certain rules that form a common technical language, ended up creating a huge variety of perspectives (Figure 5) depending on their usage.

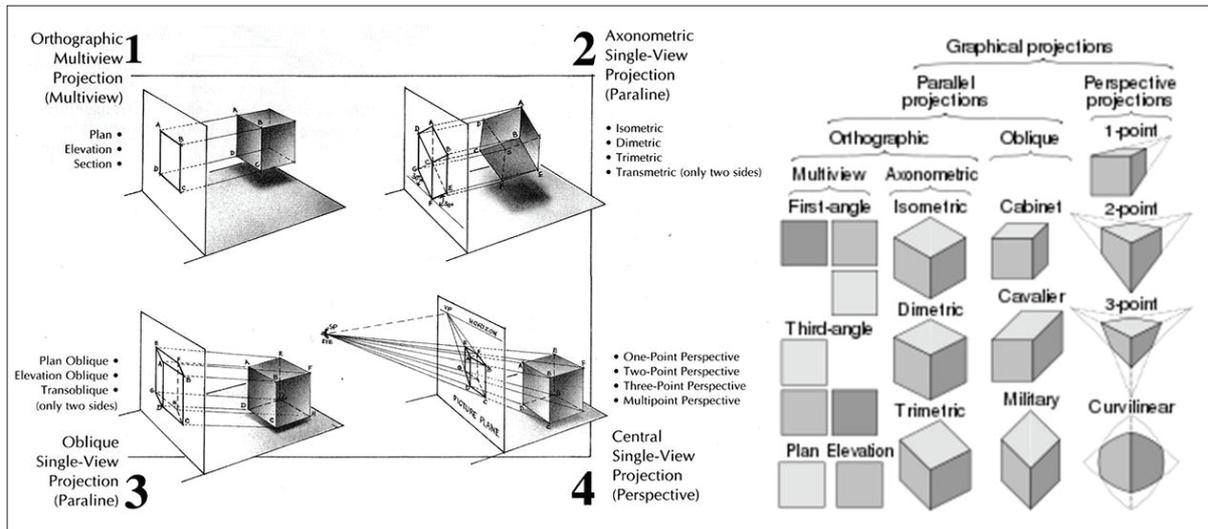


Figure 5. Left perspective shadows (*Dibujo Técnico*), Right Perspectives (*Freeclipart*)

Different perspective types can be categorized as orthographic, axonometric (isometric, dimetric, trimetric), and oblique views. In opposition to the descriptive geometry, the perspective representation has advantages that parallel projection cannot provide, and these remain as one of the most effective forms for understanding a complicated object or space.

The linear perspectives, the repetition of the drawings by reducing the eye perception, led to the emergence of different types of geometries such as spherical projection perspectives. For example, today spherical geometry is used in determining aircraft routes and determining flight paths. Although perspective provides a realistic appearance due to its proximity to our eye perception, descriptive geometry is required for dimensioning.

4. TRANSITION FROM PERSPECTIVE TO DESCRIPTIVE GEOMETRY; DIFFERENT SOLUTIONS FOR PERSPECTIVE CORRECTION.

It is seen in the On-site photo (Figure 6), software such as Photoshop... programs can eliminate vanishing points and restore parallel projection. It also allows the photograph to be enlarged proportionally according to the measurements and enables a transition from photograph to drawing with acceptable margins of error.

These programs provide the base which can be used to make descriptive drawings and measurements on photos. However, they are far from showing the whole object or space. The representation of an object or space in two dimensions is sufficient only for this purpose and they are inadequate to explain a three dimensional whole.

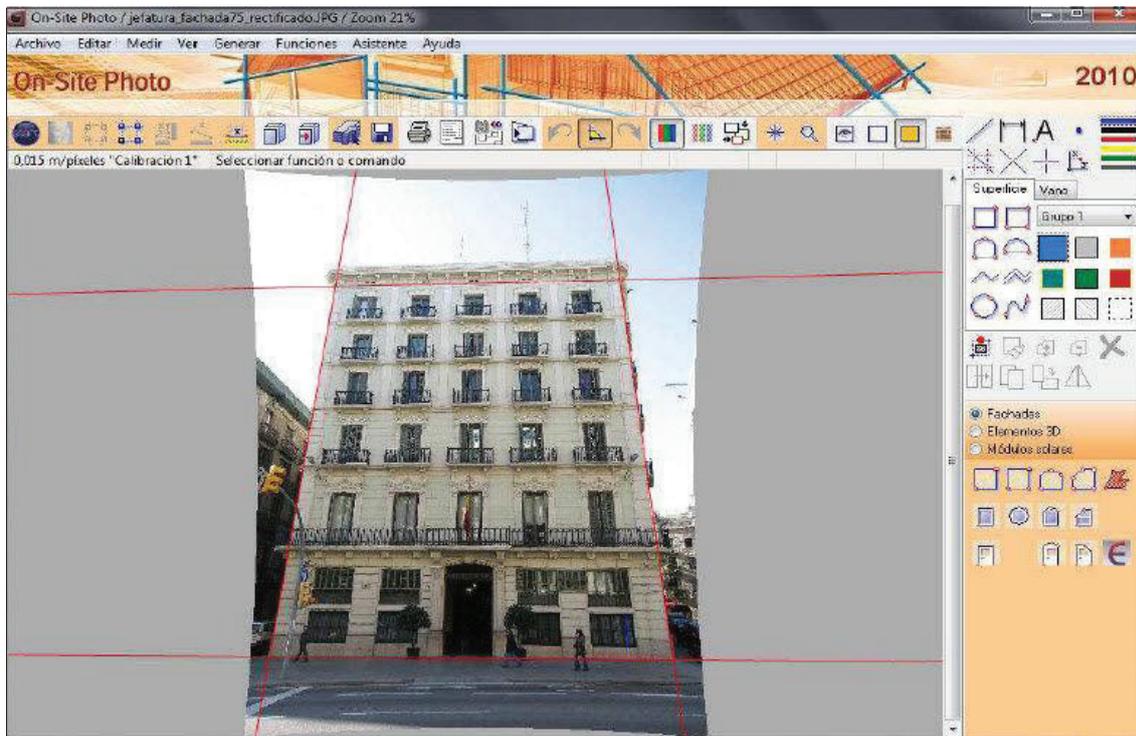


Figure 6. On-site photo program above. By aligning the perspective lines in the picture, it is possible to define a single surface of the facade consisting essentially of parallel lines.

The fact that several perspectives or photographs are not sufficient for the representation of the entity constitutes a problem today in the actions requiring a holistic approach. For instance, it is necessary for the three-dimensional presentations of the materials used, as well as for the processes such as to perform quantity takeoff and cost estimations in the computer environment in parallel to the development of the project.

For this reason, the combination of perspectives or the number of photographs must be extended to cover all surfaces of the object and to form a three-dimensional, scaled, proportionately defined 'whole' and to explain the dimensions and attributes of each element covered. In any case, both parallel projection and perspective can present only a limited part of the whole. However, the demand for the whole has increased today.

5. THE EFFECTS OF TECHNOLOGICAL DEVELOPMENTS ON ARCHITECTURAL AND DESIGN PROFESSIONS

Nowadays, all design and production offices and enterprises use computer programs. The development of these programs both boosts the productivity of the individual and increases production in terms of content and quantity [9]. The intended product is also suitable for agreed presentation models. These are the patterns required by both law, contracts and construction.

Even if it's supported by three-dimensional elements and renders the presentation by plan/section/elevation is in reality, stay relatively limited to abstract lines and descriptions. The representations of material, texture, color, environmental effects, temporal changes, all are limited. Images can be misleading. The resulting product and its environment may differ from the design or a

structure constructed with insufficient details can be quite different from its original or project. Nowadays, thanks to the opportunities provided by the computer, greater proximity can be achieved between the proposed, detected and the actual. However, the emergence and development of new information and measurement tools not only change this environment, but also enrich it.

6. REPRESENTATION BETWEEN THE PRESENTATION OF THE NEW DESIGN AND THE PRESENTATION OF THE EXISTING SPACE AND OBJECTS

The presentations used in the process that starts with the two-dimensional drawings of the designer, the implementation of designers' drawings and the two-dimensional expression of the “existent” show similarities in the scope we mentioned at the beginning.

Both have mental or material forms and are presented according to the same rules. Both use general and detailed expression scales. These details differ depending on the scales. Both are adaptable to an agreed-upon legitimately admit form. The intended product also must be convenient for agreed-upon presentation patterns. On the other hand, it is not possible to say that the new methods and materials which provide these opportunities are considered sufficient by different domains of professions [9].

7. FROM THE GEOMETRY OF PERCEPTION TO THE GEOMETRY OF REAL POINTS: NEW TECHNOLOGIES

“The Laser” (Light Amplification by Stimulated Emission of Radiation) beams found after the Second World War are used in many different fields as well as in measuring distances and angles. thereby, a higher sensitivity is achieved compared to the measurements made with meters or optical instruments, saving time and money and increasing the efficiency of the individual (Figure 7). Today we are using three different methods for the laser distance measurement in the function of the distance: 1. Interference Measurement Method, 2.Beam Modulation Telemetry 3.Pulse Echo Techniques.

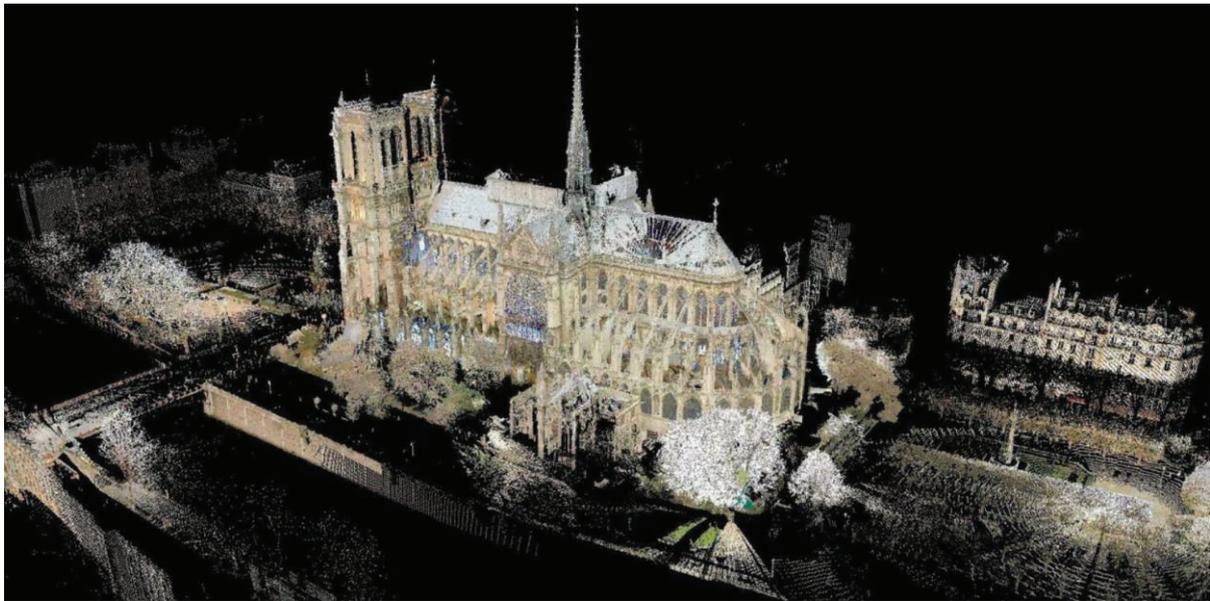


Figure 7. Laser technology and the point cloud representation of Notre Dame De Paris will help its restitution.

Since the post-war years, the laser technics pairing with computers and the introduction of measurements into specific computer programs have brought a new concept to laser measurement such as "point cloud". Point cloud refers to the name given to a cloud cluster obtained by placing laser measurements in space, sometimes referred to as millions of points. The fact that laser measurements give the location of many points with high precision constitutes the threshold of important developments in the industry, construction, architecture, cartography etc. These include more accurate measurements, more realistic applications, and compliance with environmental data.

The measurement of the laser beam is performed by varying methods depending on the distance. Among them are triangulation, phase difference or pulse method come to the forefront for measuring the distance very precisely. It is increasingly common to create point clouds by positioning a large number of points with laser measurement technique, or by positioning the pixels of the photos with photogrammetry technique, and in both cases colorize and fill the gaps between them by mesh. The importance of this method in architecture, industry, archaeology, cartography and many other domains is increasing as it has enabled approaching the whole more than ever.

The advantages of these methods are the possibility of precision and error calculations, the ability to detect changes over time, the ability to obtain high-resolution digital field models (DTM) and finally the ability to obtain scale models with 3-D printers. The fact that the number of points positioned with the help of the laser is very large provides a great sensitivity in measurements. Holograms are also another use of the laser to show the projects in space.

8. THE DEVELOPMENT OF PHOTOGRAMMETRY FROM PHOTO GRANULES TO COMPUTER PIXELS

The development of the photography from the granules that form the smallest units of analog photographs to the pixels of the computer environment enabled the addition of other features to these pixels. Now, we have the model of the cameras, the lens, it's identification number, the coordinates of the location where the photo was taken and the angle of the photograph. With the evaluations of pixels, the image of the point taken, angle of the photograph, and the distance to the spot where the photograph is taken is known and the spread of this to cameras integrated into mobile phones makes these possibilities available everywhere, any time.

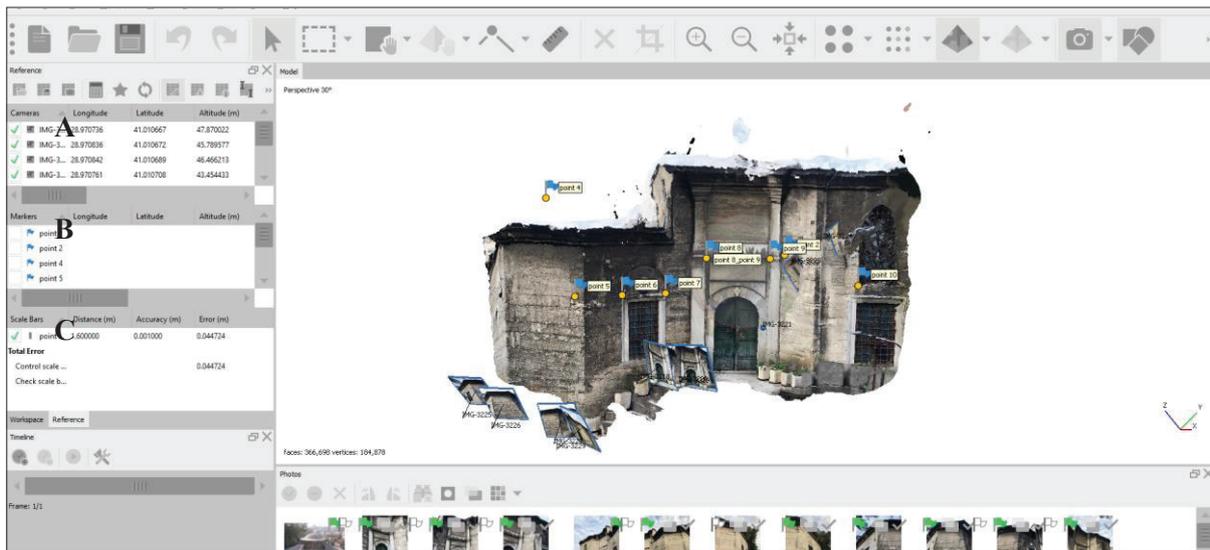


Figure 8. T.C Aydın University student work Nuruosmaniye Library A. The location of each photograph in the coordination system (latitude/longitude / altitude above sea level) with the margin of error. B. Reference points on the photo. C. Checkpoints between points, an error margin of measurements (4% in this example), photographs at inside bottom. (Survey And Advanced Communication Techniques III Course)

Just like the dots used in laser measurements, photos consist of millions of dots (pixels) so that they can be matched; images taken from different angles can be combined to provide a three-dimensional image of the object/location; making photogrammetry easier and cheaper than laser measurement (Figure 8).

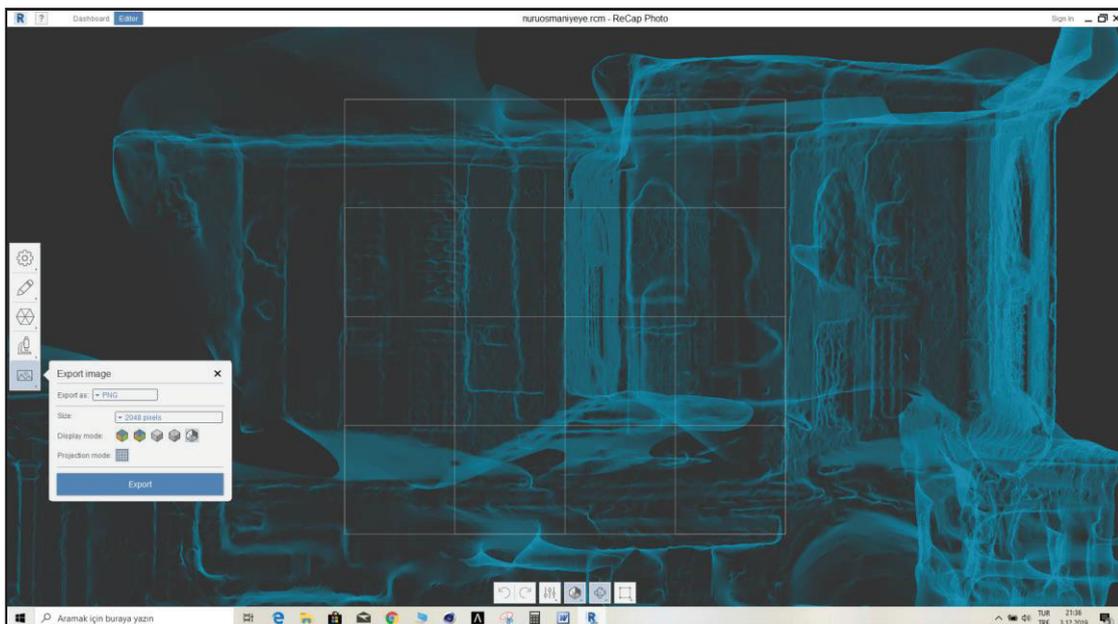


Figure 9. T.C Aydın University student work Three-dimensional pixel-based photogrammetry Nuruosmaniye Library (Aydın University Survey And Advanced Communication Techniques III Course)

Numerous programs using photogrammetry are now available for architects, engineers: Agisoft, Autodesk Recap (Figure 9)...etc. Also, three-dimensional drawing programs benefit from point cloud techniques. They started to use pixel information to create fixed points in the moving image, thus rendering a moving image and adding a new three-dimensional model. The conventional three-dimension design programs such as C4D, 3DS and MAYA, etc. allow this.

9. T.C AYDIN UNIVERSITY AND TECHNOLOGICAL DEVELOPMENTS

Photogrammetry techniques and their specific program usages are explained within the scope of the curriculums at the universities. (Agisoft, Recap, Zephyr...etc) They are shown to our students as practical, 3D models that are used for modeling the objects or places they have created in the computer environment (Figure 10). In this regard, studies are carried out in the industrial design and architecture in Survey and Communication Media Courses for 2, 3, 4-grade students among other departments [10].

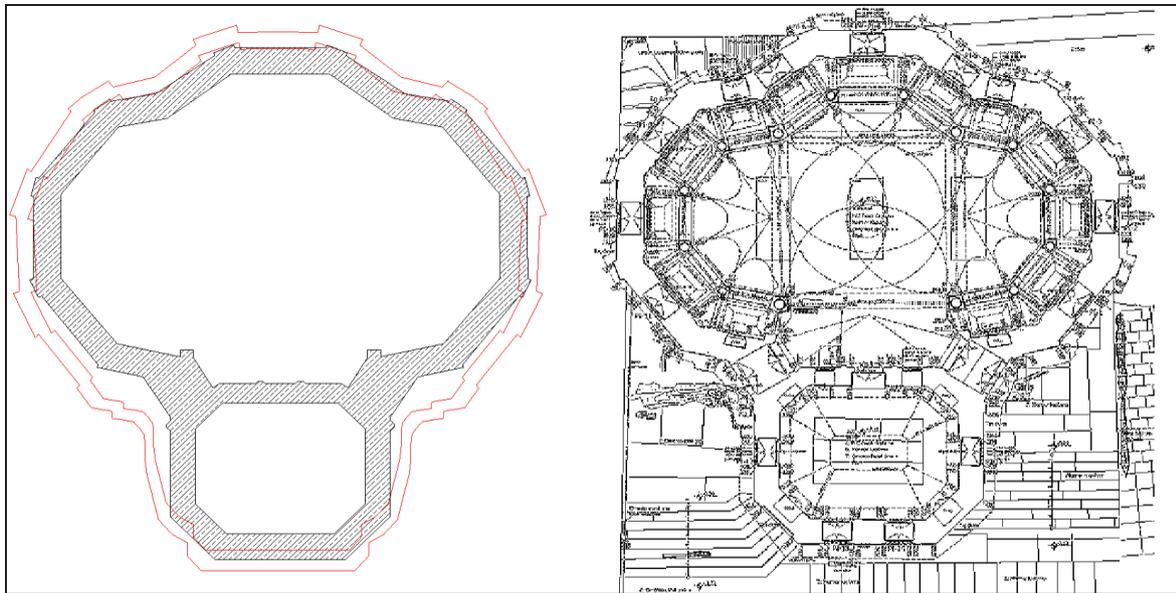


Figure 10. T.C Aydın university student work: Nuruosmaniye Library. (Software used in the study is Autodesk Recap program student version). Red contour on the left is the eaves drawing of the building obtained from the cloud, the hatched part is the walls drawing obtained from the measurement and the survey on the right. The difference increases at the bottom, where the number of photos decreases. (Survey And Advanced Communication Techniques III Course)

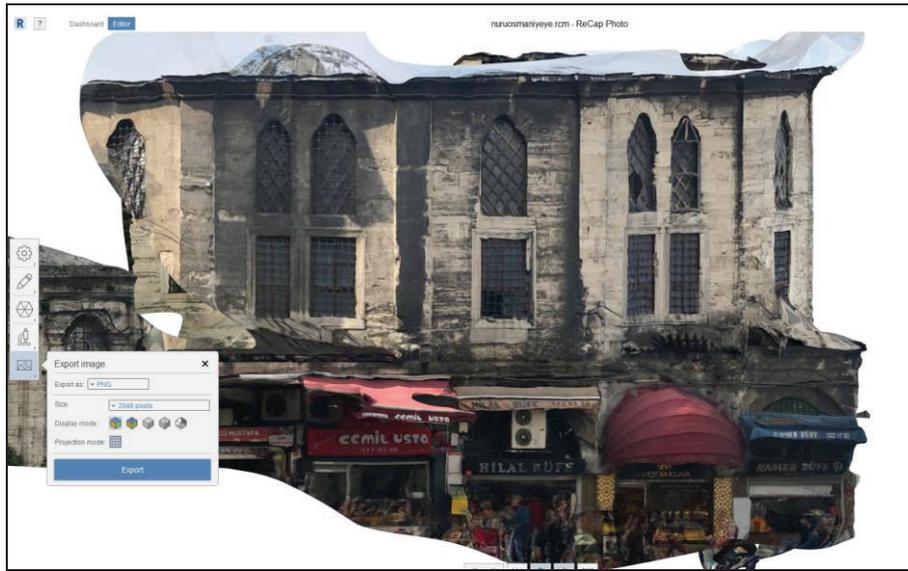


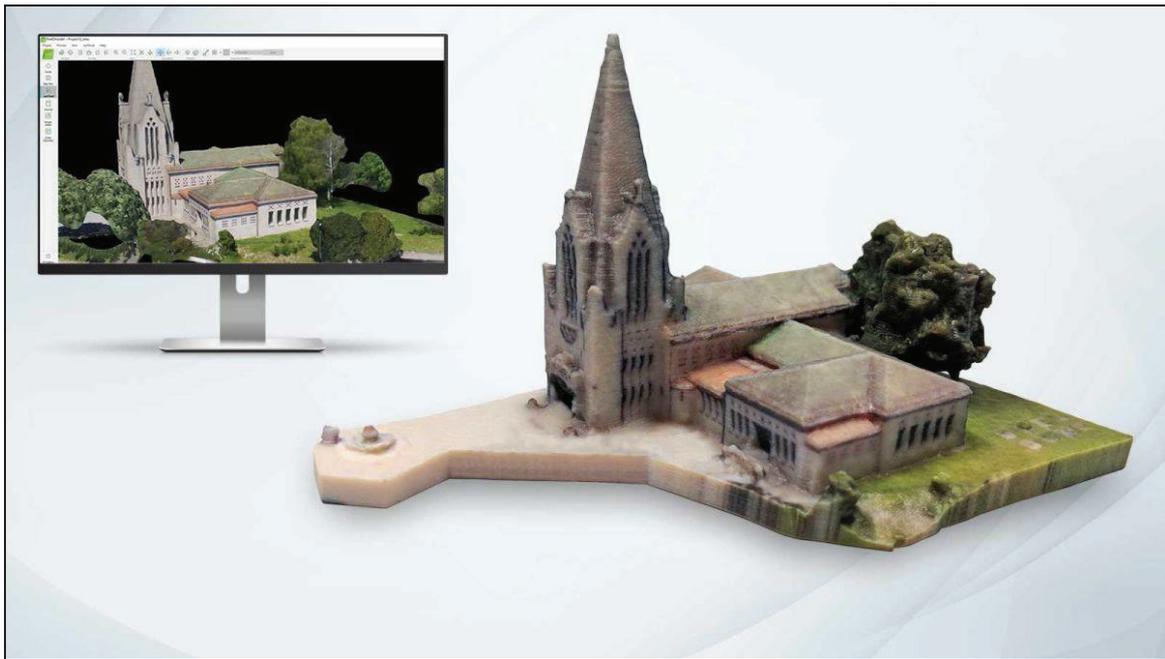
Figure 11. T.C Aydın University student work Nuruosmaniye Library solid model. 2019 Autodesk Recap software used in the study.

Here we see a three-dimensional model of one of our students' facades of the Nuruosmaniye Library (Figure 11), created by combining approximately 60 digital photographs. In this model, abrasions, distortions, faulty applications and faulty material selections that are difficult to show in the classical survey are far beyond the traditional outline drawings (Figure 12).



Figure 12. T.C Aydın University student study work The orthophotography photo of the Köprülü Library was formed by analyzing 394000 surfaces, 192000 intersections and pixels.

The development of a 3D printer in both material and dimension, increases the importance of measurement techniques (Figure 13).



*Figure 13. 3D Printed version of the model obtained by photogrammetry above.
(The Vomela Companies Chase Kasel December 2017 Pix4Dmapper)*

10. CONCLUSION AND EVALUATION

The written expression used throughout the history along with the drawings (e.g. the texts of Abbe Suger's Gothic cathedral should be), the model (e.g as shown in Mimar Sinan's miniature), the stereotomy used by stonemasons, the parallel projection of recent periods are not only methods that describe the imaginary or define what exists, but also forms types of expression that guide practice, define contracts, form the basis for legal processes.

Today, the presence of new production methods and materials and the fact that societies are more culturally and economically intensive and relatively developed has also increased expectations from design to the realization. Now, the trio of plans, sections, appearances is not enough to meet these demands. New methods are required. On the other hand, this triumvirate continues its professional and legal dominance. The newly developed techniques are only used as complementary aid of expression. But new technics as 3d scanning are not in usage enough yet.

In the education field, the pressure of these new requirements is felt intensely and the changes made in the education plans attempt to keep up with the developments in the technology and products. The work of man and machine are different. While the machine performs its function without questioning; man is shaped by his work. He internalizes it, makes it a subject of education and tries to improve it.

Today, compared to the huge amount of information generated by the development of technologies; the position, education, and formation of the majority are insufficient. A new kind of person who susceptible to the requirement of pieces of information at the same time to produce information, also to reach it, to be

able to use it for the development of human knowledge. Otherwise, the information stack remains only as a stack and cannot be used or evaluated. Failure to achieve this increases the inequalities in the world. In some areas, the situation is worse and people are pacified due to the lack of adaptation to this pile of information. People try to follow what is presented in front of them to accept, without question, without debate. It is more important than ever to educate people who will meet the new requirements in today's world where technology is developing faster than the societies.

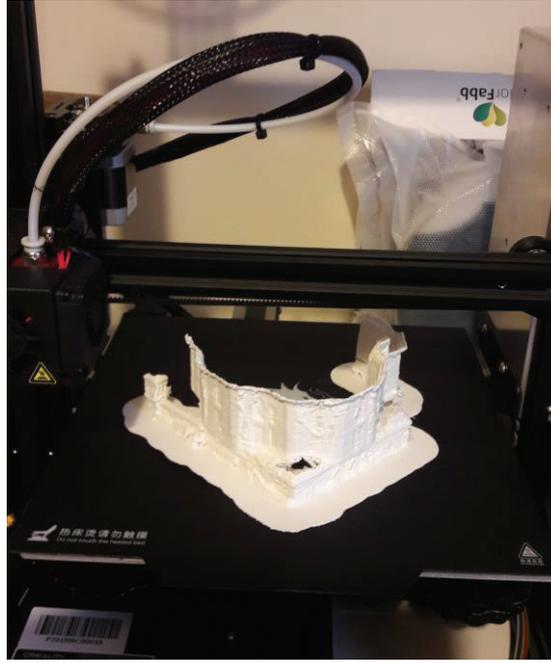


Figure 14. From photogrammetry to 3D printer

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