

**THE IMPACT OF DESIGN STUDIO'S  
SEATING ELEMENTS ON THE CREATIVE  
PERFORMANCE AND THE PRODUCTIVITY  
OF STUDENTS**

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Master of Science Thesis  
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This thesis titled “**THE IMPACT OF DESIGN STUDIO’S SEATING ELEMENTS ON THE CREATIVE PERFORMANCE AND THE PRODUCTIVITY OF STUDENTS**” has been prepared and submitted by **Ahmad AFARA** in partial fulfillment of the requirements in “Anadolu University Directive on Graduate Education and Examination” for the Degree of Master of Science in **Industrial Design** Department has been examined and approved on 25/01/2017

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## **ABSTRACT**

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Seats that are used at home, at pre/middle/high schools, at universities, offices, and workshops were discussed and studied ergonomically, anthropometrically, and dimensionally by a huge number of researchers and scientists, we could find a huge data and studies that indicates the seat's problems, notions, essentials, and the seats standard dimensions, even these available data may be used to help us in choosing and selecting the right seat that is designed to support the activity we aim to do in different spaces. Hence, design studio seats were not discussed loudly by scientists and scholars before, and there is no authorized or published data that discussed the design studio seats, thus this thesis intended, and aimed to spot the light on the design studio's seats and their impact on the design student's creativity and productivity when performing a design work.

For a design student, design studio work always encourages him/her to directly interact with any product and experience the users feeling, it encourages the design student to create, innovate and find solutions for design problems to improve product. Consequently, design studio is considered to be a tool of pedagogy that aims to teach design students to ideate, create, collaborate, and interact to innovate new products or projects, after getting the needed knowledge and critics. Introducing and discussing design students, design studio, and design studio education will be carried out throughout the content of the first chapter.

As time goes by, using of a seat is longer limited to be used by the royal society. Seats have been a superior product design through different eras, the seat design passed in a historical and cultural revolution and evolution in its design and production. Thus, seats have different types, each is to designed to serve and support the body in different types of activities and spaces. Henceforth, further explanation will be addressed in the second part of this thesis.

Seat's ergonomics is being a 'buzzy' word now a day, it means providing the seaters with the best facilities to enhance his/her level of performance and productivity while performing a work, while anthropometry addresses the physical ergonomics. Seat's ergonomics, anthropometry, and standard dimensions, discusses and find solutions that supports the human body with stating the guidelines for the human's healthcare in the workspace, that enhance the seated working human body to avoid risking health problems. Hence, design students physical and mental health problems in the design

studio was discussed as a root that may decrease their level of creative performance and productivity while working on a project in the design studio which is marked in the third chapter of this research.

From the author's educational background in interior architecture and industrial design, the author researched design student's creative performance and productivity in the design studio as a collaborative, interactive, and educative workspace, that enhances design students to ideate, evaluate and experience the users feeling from an emotional behavior base. Yet, an evolutionary discussion showing the seating elements in design schools and workshops from around the world between the years 1905 and 2015 were obtained and analyzed in chapter four.

A research which was assembled to two study types were implemented. In the first study type 6 different seats from 5 different design schools in Turkey were measured and analyzed. The second study type, was executed with a purposive sampling method, which was implemented in same 5 official/private universities in Turkey, between 125 subjects, surveying design student's ethically in order to evaluate their user experience, emotional behaviors, and health problems from using the seats they are using in the design studio they study and work inside, also a dimensional study resulting and showing the measured 6 seat's average dimension and were compared to the standard dimensions, showing the total differences dimensions between them that showed significant dimensional differences are carried out and showed throughout the content of chapter five and six

Last but not least, the research and study's conclusion, discussion, limitations and recommendations for further studies were given in chapter seven and eight.

**Keywords:** Design Studio, Design Studio Seats, Creative Performance, Productivity, Sitting and Seating, Healthcare in the Design Studio Classroom.

25 January 2017

25 January 2017

**STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES**

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with “scientific plagiarism detection program” used by Anadolu University, and that “it does not have any plagiarism” whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

.....

**Ahmad AFARA.**

Dedicated

*To my Father & Mother,*

who scarified to make it possible for me to complete this work, and being  
the reason of what I become today.

*To my Brother & Sisters,*

who have always been my motivation and happiness.

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“He has not thanked Allah who has not thanked people.”

- Prophet Muhammad PBUH –

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## **ABBREVIATIONS**

**CCOHS:** Canadian Centre for Occupational Health and Safety

**CTI:** Cumulative Trauma Injuries

**FIG.:** Figures

**IEA:** International Ergonomics Association

**MSD:** Musculoskeletal Disorders

**NIOSH:** The National Institute for Occupational Safety and Health

**OSHA:** Occupational Safety and Health Administration

**RMI:** Repetitive Motion Injuries

**RSI:** Repetitive Stress Injuries

**SD:** Standard Dimensions



# 1 INTRODUCTION

What do you think of sitting for 4-8 hours daily in a design studio classroom?!

Basically, the experience itself would enhance the student's productivity and would ensure as well that he'd be surrounded with positive vibes all day long.

Talking about designing studio classes, we'd clearly notice that it's not just another regular academic class, but one rather concerned with creating a whole new world, starting with Architecture to Landscape, Urbanism, Interior Architecture, Graphic Design, Industrial & Product Design and much more. Designing Studio classes revolve around studies performed so as to create and shape new solutions and spread them to the world.

A design studio class is a place where students, instructors, objects, digital and basic drafting materials, creativity and even productivity all gather in the same area. It is a great space where all professional designers and design students meet and collaborate to proceed to a new generation of inventions in design. In a design studio, both students and instructors are about to experiment and test the class room's objects daily, through ergonomics and design, while "students" barely talk and discuss such matters in design studio classes due to the nature of the work required by the projects at hand.

The health problem that the author had in his back and neck resulted in the emergence of the following question: Was the cause of the pain merely the hard work and the non-stop academic projects that he was always doing, or was it something else that he never thought of? Discussing safety and health in design was a great path that eventually lead the author to a greater topic

"The Impact of Designing Studio's Seating Elements on the Creative Performance and the Productivity of Students".

In this research paper the author will be studying and researching the influence and impact of design class's seating elements on the student's creative performance, creative thinking, mental health, besides student's productivity through ergonomics and physical health. To collect data, a survey with matrix questioning was conducted. Participants in this study were 125 undergraduate and graduate design students from three fields of design, from five universities in Turkey.

## 1.1 Problem of the Study

For many centuries, craftsmen, architects, designers, and others have debated about the issue of seating and sitting. Notably, the functions and comforts of seating have been debated because of man's natural inclination to design; the specificity of human body measurement's, its rapid changes with time, and man's needs for appropriate seating. Though the topic of seats in design studios may look ridiculous to debate about, many students and instructors do set it as a problem worth talking about.

*The real questions are: Does it solve a problem? Is it serviceable?*

*How is it going to look in ten years? Charles Eames*

Design students and instructors stay between three to six hours daily; a minimum of 15 hours weekly, at a design studio classroom, using the seats provided by the schools so that they are to be more comfortable. The major initiator for this research was the author's involvement as a student of design studios since 2009.

The exact purpose of this research was to answer the question: "Do the design studio's seating elements affect the student's creativity (mental health) and the student's productivity (physical health)?"

This project surveyed the requirements of student's mental and physical health, considering seating and sitting in design studios. Since this was an issue that affected many students' health conditions, including the author's back at the time of studying in the design studio classes, obtaining a more adequate understanding of the necessities which design and art schools lacked, while keeping the concept of anthropometrics and ergonomics, was essential.

Hence, once we understand the manner in which seats affect the student's creative performance and productivity, we will be able to find solutions for this problem.

## **1.2 Aim of the Research**

Stools are offered in a design studio classroom, but until now no data has been published on their use in the classroom and hence, it is still unclear whether those seats do have a positive effect on the student's physical and mental tasks while designing projects, as suggested by their manufacturers and offered by the architecture and designing schools. Therefore, the purpose of this study is to evaluate the impact of the available stool seat types on the design student's creative performance and productivity inside the design studio classroom.

The objective of this research was to prove that design studio's random seating elements has an impact on designing students mental and physical health, based on the needs of students. However, the aim of this research is not to design a brand-new seat, but to understand and point out the problems faced by design students using the school's seats; dealing with design students and surveying them in order to point upcoming research in the right direction, so that it examines the design studio's seats problems and their effects on students.

Merriam-Webster's dictionary defined the environment as "The circumstances, objects, or conditions by which one is surrounded." (*Environment - Definition and More from the Free Merriam-Webster Dictionary, n.d.*). Studying the seating elements in design studios gave clear indications and, hence an abbreviated explanation of the problem.

## **1.3 Research Question**

"Does the design studio's seating elements effects the student's creativity (mental health) and the student's productivity (physical health)?"

## **2 LITERATURE REVI**

### **2.1 Design Studio Education**

#### **2.1.1 Design student**

Design student: The person who has an interaction with an instructor during a design course, has submitted his graduation project, and hence was not taking the course at the time of interview (Özersay, 2012).

Design students are responsible for learning different design courses, theoretical and practical. A design student is not only responsible for developing new concepts for the projects he is working on within any course, but is also responsible for developing projects which deliver messages evident in the aesthetics of the design, manifest after coming up with innovative ideas. Design students can also refer to a system of academic-industrial projects, in which the student can train in market and business ethics to raise need for the project, along with its value.

Design student's skills must be tailored to suit different social cultures, while working on any design to get the best results. They always seek inspiration; creative and innovative designs to submit his/her skills as a project proposal which shows his/her abilities of providing solutions and/or finding a new easy industrial service that can guarantee a user's comfort, with the capability of consuming the very new technologies and materials.

The term design student is self-defining. It identifies the students who are studying in architecture and design faculties or within the faculties of fine arts; it also has an extensive meaning that includes cultural studies, sociology, visual arts, human behavior and ergonomics.

#### **2.1.2 Design studio**

Design is a small term of 6 letters, and yet it stands for something of enormous power. Design is about creating the new world, and about conceptualizing new ideas, objects, products, furniture, buildings, and much more. The concept of studio-based work has been central to practices as well as education within design disciplines such as architecture and industrial design for over a century (Fallman, n.d.).

Design Studio is an interactive work or learning space where architects and designers practice their educational or professional activities (figure 2.1.). A design studio in institutions and universities is an educational space. In the studio, instructors divide the design process into small tasks so that the process is suitable for student learning (Wilson & Watson, 2009).



**Figure 2.1.** *Design studio*

**Reference:** <https://csuart325.com/art-education-studio/>

Many students actually spend most of their time in the design studio, where they work, study, eat, and even sleep. (Oh, Ishizaki, Gross, & Yi-Luen Do, 2013) Besides design schools, individual educators will forever consider that the “Studio” is the most central element in every design student’s life.

Every space has its own requirements, and such a criterion applies to design studios. Early findings show that physical environment has a direct effect on classroom users. By extension, seats provided by design schools are very essential teaching/learning physical tools, and hence have a very important impact on the student’s creativity and productivity.

The physical surroundings of a design studio and the manner in which different material artifacts are arranged and presented is important to the designing activity and serves as an imprint within the students’ organizational memory. (Ackerman & Halverson, 1999)

### **2.1.3 Design studio as pedagogical tool**

To begin, the word pedagogy is drawn from the ancient Greeks, specifically Plato, and subsequently Aristotle, who were among the earliest educational philosophers. Plato and Aristotle felt that a just society relied on the education of its youth, and proposed a democratic system of student selection that involved the separation of children from their parents. (Long, 2012) The studio, as such, is an essential place for teaching and learning processes in design education worldwide. Based on the previous mentioned information,

higher education institutions, such as universities and art schools, have developed a diverse range of studio environments.

We can be sure that studios have been the training base of architects and designer since the nineteenth century at Paris's École des Beaux-Arts when they were first introduced. Regardless of the field of the design studies is practiced, designing studies have common features; therefore, design studios offer valuable lessons for teaching design in many domains starting with architecture, interior architecture and design, industrial and product design, graphic design, urban design, etc.

Some institutions, for example, make provisions for students to occupy an individual learning space, whereas others offer only the possibility to 'hot desk', with no personal working space to which the student can return each day This has an impact on how students experience space, their position within it, and how comfortable they feel within that space which they occupy. In addition, consideration of how a student is enabled to be 'creative' in that space using all the available resources has been persistent in the formation of the student-space dialectic(Marshalsey, 2015).

In discussing "Design Studios as Pedagogical Tool", one must observe that design studios have been called the "Iron Chef", and for good reason. They have been very effective tools for ideation, which is a high demand two-way method used by most professional designers. It is a tool which synthesizes educational interactive-collaborative activities in one space, offering student-to-student and student-to-instructor interaction with a proper space, and furnishing requirements in order to reach a suitable pedagogic educational environment.

Design studios prove to be instructive environments, which provide an inclusive variety of pedagogical theories, models, and disciplines in design education, empowering the quality of design studies and the value of interaction between students and instructors in most of architecture and design institutions and schools around the world, allowing teaching and learning models to last since the late 1890s; when the idea of design studios was first introduced, providing one-to-one collaboration between students and their instructors in one planned place, date and time.

A design studio course is an educational course which is conducted in a workplace, called "Design Studio" or "atelier" in French, for both students and instructors. Both students and instructors are engaged to develop and ideate new products or objects. The design studio is the place to actualize and integrate the information and skills learned from other courses (Demirbas & Demirkan, 2007).

At the course of design studio, design instructors may use their classrooms as testing-research laboratories, collaborating with their students, and answering their questions, in addition the ability to start a discussion, where instructors become critical tools, and students learn how to clarify and defense their opinion and get a straight ethical criticism.

## **3 SITTING AND SEATING**

### **3.1 What Is a Seat**

The word seat is derived from the Middle English *sete*; like to Old English *gesete* seat. The word known was first used is in the thirteenth century.

In the beginning, people used to sit on a bare ground, rocks, under animal skins, woven blankets or on carpets, which were the first seating elements, and now they are barley used in some cultures.

The seat has been always set by custom and manners. In antiquity, the seat was reserved for the kings representing a symbol of power, as in Europe, Asia and Africa; this seat, called the throne allowed the kings to dominate the people in the kingdom like sovereigns. Carpenters and artisans improved the seats designs, technique and seat types with time, until the Architects and designers were in the creative process of the seat's revolution, providing the ultimate shapes and the usage of new materials that has never been seen until then. With the new discovery of lighter materials, the ability to produce seats in series caused a drop in their price, and the seats users was also increasing. Currently, seats are essential for everyday use as a piece of furniture providing comfort. Now there are variety of seats, with shapes, size, colors, and different materials boosting the design needs and tastes.

Seats are a piece of furniture with a high surface, they are movable objects, intended to support a human activity which is sitting. They often come with four legs; but some shapes demand two or three legs only. Also, seats may be supported by backrests or arm rests. Moreover, seats can be a product design and is considered as a decorative element as well. In addition to the seat's functional role, every seat type has its own purpose; it reflects where it should be used and placed in.

### **3.2 A Short History of Seating**

#### **-Ancient history**

For long time seating, has been an important issue in human's life. The history of seating has an enormous number of documents, illustrations, and sculptures that return to at least the beginning of the Egyptian era around 3000 BC.

Despite the quantity of information documented on the types of seating, we cannot obtain but three major types of seats which have developed with time. These types are stated as the chair (which is the basically common seating element), the bench, and last but not least the stool (tabourete).

### **-The Egyptian Era (3100 - 475 BC)**

The old Egyptian furniture was lower in elevation than today's existing one, with beds being around 30cm high and the stools being significantly low by present-day measures. "As to the lowness of the seating pieces, the short stature of the early Egyptian people may have had some influence, their average height being only a few inches over five feet" (Baker, 1966) p. 21. It's noteworthy that their seats were high from the ground, requiring a footstool to support sitter's feet. A stool appears to be the earliest common seating piece of furniture developed and created at the early Egyptian Era, Figure 3.1.



**Figure 3.1.** *The Sekhemka statue.*

**Reference:** <https://s-media-cache-ak0.pinimg.com/236x/d3/f0/9d/d3f09d4369f49c9f0bd45bf2d22ed39d.jpg>

By the Second Dynasty, the stool appears to have differentiated into a new form reserved for royalty and high ranking members of society. It became more substantial in its construction, sometimes having a low back rest and was often higher than the stool. Sometimes a cushion was added, as it appeared frequently in historical records. Figure 3.2 shows an example of these early chairs.



**Figure 3.2.** *Akhenaten Nefertiti and their children.*

**Reference:** <https://userscontent2.emaze.com/images/c39766aa-c3ba-4896-8aaa-a7a4cf243770/51c91533-7b96-4882-9c8c-de85bd76bf63.jpg>



### **-The Aegean Era (3000 - 2000 BC)**

The Aegean region represented a development center in that time, supporting seats and mostly chairs. Nonetheless, there are very few archives documenting this period to show the types of the seating types used. One exceptional miniature of a sitting harp player was noticed. (Figure 3.3.) This style had no bond to the Egyptian one. The Aegean seats have very few records; in fact, this period's seating types remain mysterious.



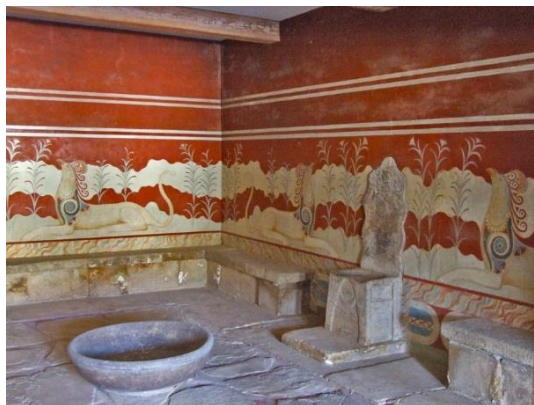
**Figure 3.3.** *Aegean stool c. 2000BC.*

**Reference:**[http://mblogthumb2.phinf.naver.net/data33/2008/8/19/133/histor11\\_dolo3.jpg?type=w210](http://mblogthumb2.phinf.naver.net/data33/2008/8/19/133/histor11_dolo3.jpg?type=w210)

### **-The Minoan Era (2000 - 1000 BC)**

When observing the excavated ruins of the Palace of Minos at Knossos, we recall some of the Minoan seating history. This period of the Minoan Era was the first step towards civilization in the European world, earning urban life and a well-developed city; the Palace Knossos's was "surrounded by fine houses, villas and artisan's residences". (Baker, 1966) p. 240

The throne of Knossos was constructed of stone and surrounded with stone benches as well (see figure 3.4.). During this period, stools existed, and were just similar to the ones made and used by the Egyptians.



**Figure 3.4.** *Minoan Throne and Benches.*

**Reference:** <http://www.pasthorizonspr.com/wp-content/uploads/2013/01/minoan1.jpg>

## **-The Greek Era (750 - 475 BC)**

The craftsman of the early Greek era created well finished classical seats designs starting from chairs and all the way to stools and thrones.

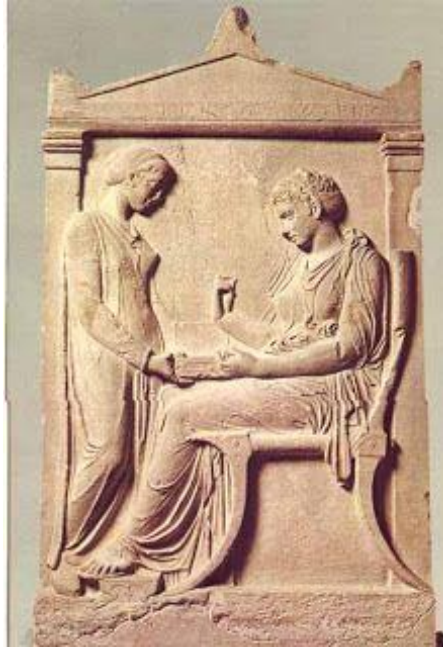
"...sometime in the early part of the Fifth Century B C the chair acquires a broad horizontal back slat at the top that encircled the shoulders of the seated person, and a fixed form of the classic chair is established...The backs of some chairs sweep back in an exaggerated curve...while others are straighter." (Baker, 1966 19)

Seat's design gives the impression of a Greek base, based on the Egyptian thrones. The seat's legs were mostly curved in shape, with a "back composed of three uprights fitted into a curved board at shoulder level" (Hayward, 1975). In this period, craftsmen and designers offered a great production of a new type support for the back of the seats. The seats at that time were light in weight, and allowed the user to move and arrange them in a flexible way.

Greeks developed the designs of seating elements like couches, chairs and the basic stools, taking the pieces into a whole new level. In addition, Greeks added a support to seats, which would be considered as the first nations of comfort. Seats usage became a daily routine for the wealthy Greeks.

The furniture of this period remained virtually unchanged from the 'Early Greek period'. "The Classical era, as it pertains to furniture and architecture, continued without a break in Greece and the Roman world until the time of Constantine; and, although interrupted for long intervals, its influence has continued until today" (Baker, 1966).

Also, there was no furniture survived, but figures of the Greek vases paintings gave us an idea of the Greek seat designs. A recurring image shows a chair of a great elegance probably of a kind possessed only by the wealthy. It has a slightly curved back supported by corner uprights that continue the elegantly curved rear legs. The seat is an open square of round wooden members webbed with some material, probably leather. Both front and back legs take a strong outward curve, the characteristics of the "Klismos" chair type (see figure 3.5.). The form suggests curved animal parts that may have been used in early versions of the Klismos. It is not a structurally logical form and raises questions about how such chairs were made to have adequate strength for the purpose (Pile, 2005).



**Figure 3.5.** *The Klismos chair.*

**Reference:** <http://msthomashistoryclassroom.weebly.com/unit-3-the-greeks.html>

### **-The Roman Era**

The Romans kept on the Greek Furniture without any further development, but some slight editions. Romans added ornaments and some decorations to the designs they kept on from the Greek's era.

Nevertheless, the roman continued to use stools. It was considered as a seat of honor and symbol of legal authority; it was used by high magistrates or by the emperor. Bronze was the material most common for this stool. The major stylistic feature of many of these stools is the double reversed curve(or curved X-form) (Blakemore, 2006)

In Rome, the chair was a 'seat of power', though the throne became distinguishing in its design and structure. (see figure 3.6. / 3.7.)



**Figure 3.6.** *stool from Curule Form. Double Reversed curve. Legs end in head of fowl. Museo Archeologico Nazionale, Naples.*

**Reference:** <http://aragonromano.ftp.catedu.es/furnitur.htm>



ROMAN STATE CHAIR.

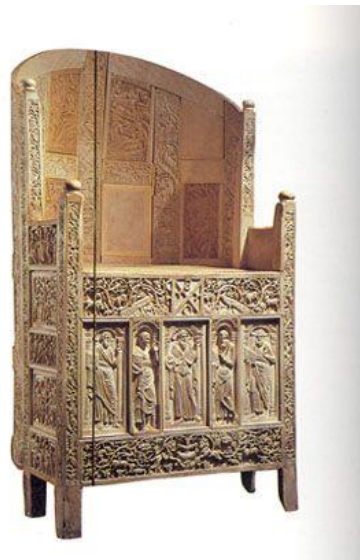
(From the Marble example in the Musée du Louvre.)

**Figure 3.7. Roman Throne.**

**Reference:** <http://www.furniturestyles.net/ancient/roman/>

### **-The Byzantine**

When the nomads plundered Rome, they found chairs that made no sense to them: the statues, the thermae, the inlaid furniture, and all the instruments of a different culture. The habit to squat on the ground remained in the byzantine era. Classical arts were not completely absent; however, the Christians took those classical arts and adopted them to their designs, "...much of the legacy of antiquity was abandoned. All those lovely subtle curving shapes seen in Greek and late Roman furniture, the rounded backs and the sweeping sabre legs have vanished" (Hayward, 1975). Seats took the architectural shapes of this period, but comfort doesn't appear in this period's consideration. Hence, the concept of 'aesthetic', rather than comfort and physical satisfaction, was pretty popular in the developing monastic societies. (see figure 3.8.)



**Figure 3.8. Byzantine Chair.**

**Reference:** <https://classconnection.s3.amazonaws.com/62/flashcards/653404/jpg/maxthrone.jpg>

### **-Early Medieval Eras**

Our evidence for early medieval interiors comes mainly from illuminated manuscripts and books (Pile, 2005). Furniture served two purposes in the medieval period: utility and to denote hierarchal position. Seat furniture—chairs, stools, and benches— reflected the hierarchal nature of medieval society. A chair was a seat of authority and the most important person in household sat in a chair (Blakemore, 2006). Figure 3.9.



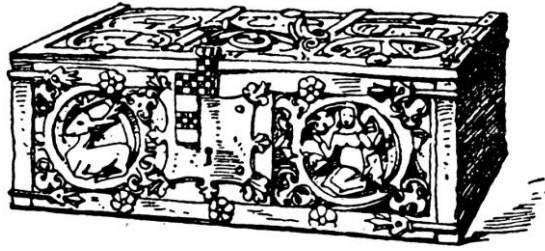
**Figure 3.9.** *Chair, Flemish 15<sup>th</sup> century. The Metropolitan Museum of Art, The Closters Collection Purchase, 1947.*

**Reference:** History of interior design & furniture: from ancient Egypt to nineteenth-century. Robbie G. Blakemore.

### **-The Gothic Era**

At the Gothic era, “people sat on the bare floor and used cushions. They sat on stairs and steps leading up to the high posted beds. Romanesque chests... where for sacred purposes and much too high to have been used as seats. As chests became lower, we find them aligned along walls. They filled the role of chairs and couches.”(Giedion, 1948).

Chairs at this period remained angular in its shape with a high support back. Ascetic ways of monasticism unnoticeably shaped the gothic period in its own way. Chair’s functionality became more unique; and new designs appeared, such as the revolving chair between the fourteenth century and the sixteenth century; where the figures show that there were well designed. (see figure 3.10.)



**Figure 3.10.** *Gothic Chest.*

**Reference:** [http://etc.usf.edu/clipart/51000/51062/51062\\_gothic\\_chest\\_md.gif](http://etc.usf.edu/clipart/51000/51062/51062_gothic_chest_md.gif)

### **-Modern History**

By the sixteenth century, improved chair designs were created. This indicated an image of the European style; different to that of the nineteenth century, where the American impact dominated on its appearance.

Right till this moment, we are still mostly using or improving the designs of that period. However, with the countless papers, books or documents which witnesses seating elements, styles, and improvements through history, this paper shows the most remarkable improvements of sitting and seating elements through history.

### **-The Cabinetmaker Era**

Chairs became a very common piece of furniture in the sixteenth century all over Europe. Chairs, which were made by cabinetmakers for the nobility and wealthy men, became more significant in their designs and fashion. Frame construction, curves and backrest appeared to support the sitting comfort of the seat, thus it became lighter in its weight. It has been described as a “work of art”. "Typologically speaking, it was the return of a forgotten standard: To create a support for the body that would allow highly relaxed posture. Posture and the chair are one" (Giedion, 1948). Seats designs expressed the taste of the wealthy class showing their luxurious life. Napoleon Bonaparte had a classical influence on furniture, recovering the Greek and Roman styles of furniture. Classical designs at that time were known as the Empire Design; which recalled the concept of backrest and armrest.

Here's the chaise lounge comes, an early Greek and Roman renaissance couch, but with new conception of comfort. Upholstered armrest and backrest were adapted by craftsmen, without any absence of beauty and fashionable tastes of that period. The medieval era's design styles were completely absent, where the rich class only was able to afford owning the new upholstered seats. It was recorded that benches and stools were commonly used by the population.

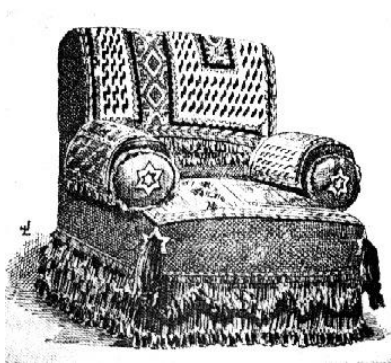
Later, within the growth of the Industrial Revolution, chair seat appeared to be a popular seating piece of furniture to the community. But now the machines began cutting to a

fraction of their former cost, not only cotton goods, but also every product used in art and adornment."(Giedion, 1948).

Architecture formed a new notion giving each interior space a specialization by bedrooms, living rooms, kitchens, and dining rooms; they were all separated in which each had its own specific objects and pieces of furniture. Industrial productivity of furniture made chairs common to the society at that time, and chair seats were able to provide human's body comfort and support.

### **-The Upholsterer Era**

Through the upholsterer era, the chairs were generally comfortable than before due to the use of upholstery (Blakemore, 2006). The Upholsterer worked on the outline of the wooden furniture, padding them, and transforming the chair into a unique form called a "sofa" seat. Chairs at that time were called "Comfortables" because of the provided comfort. Springs appeared to be used when the spring makers and the upholsterers started to develop the new shapes and comfort for the sofa seats. (see figure 3.11.)



**Figure 3.11.** *Fauteuil-Coussin Comfortable c. 1880.*

**Reference:** <http://www.ramsaygourd.com/images/PGuX9O80-rgh-photo-asset-527fc5f25d03d8.95107678.jpg>

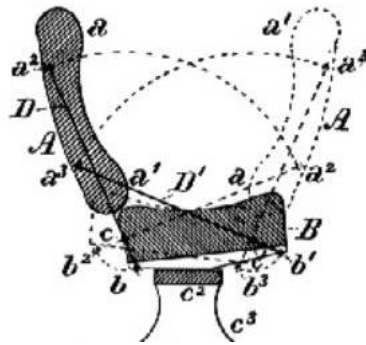
### **-The Patent Era**

Technologies in the industrial world grew rapidly and developed quickly along with the methods innovated by engineers, craftsmen and upholsterers. This besides the usage of new materials in furniture design giving the Patent era a huge growth.

The notion of designs of object's capability, object's adjustments, flexibility and functionality, were the very top interests of patent designers, engineers, and inventors at that period. Hydraulic cylinders to raise and lower the seat had come in by 1880 (Mang, 1979). They discussed objects and mainly the chair seat's problem of motion and comfort. (see figure 3.12.)

The capability and adjustability of seats were the main purpose of that period's designs; the designers and engineers showed the world a new full adjustable and motional seats starting by dentistry and barber seats to the rail way seats, providing the passengers with real comfort concept.

During 1870s, seventy categories of seats with different purposes were declared by the American Patent Office. Ergonomically, chair seats were being developed by anonymous designers after some of those categorized seats were listed to 'human physiology'.



**Figure 3.12.** *Train seat, 1885.*

**Reference:** <http://www.exmoorantiques.co.uk/images/Histor25.jpg>

### **-The Architect Era**

The beginning of the Twentieth Century was a time of revolution against the Patent furniture movement. Furniture, as time was passing, was becoming an essential part of the house and office settings, with function assuming lesser importance to form. The development of modern furniture parallels that of modern architecture and modern technology... Like architecture, furniture and home furnishing may symbolize the rise to power of a class, a social stratum, or a nation. Furniture and the rooms it is used in are so much a part of their owners that they indicate their social position and relation to others in a very direct way (Mang, 1979).

New materials in the form of steel tube, wire, and later plywood provided designers with new scope to innovate new designs with aesthetic notions. As a consequence, the way people sat was to alter again. Hence, seating rapidly became an essential part for living, in residential, retail, and office spaces with the beginning of the twentieth century.

During the first years of 1920s, architects put the seat design into a new concept emerging from the 'Bauhaus School'. Architect Designers came with new beliefs that approached how would the chair seats enjoy a visual aesthetic percept, and interact in the interior space, but not as seats functionality as it was in the Patent era.

Tentative materials were used at that period to engage architectural shapes with seats' structural forms. The notions of the Architect era remained until today, and their shapes still appear with us till now. Later, this era allowed the presence the 'Interior Architect/Designer' as a professional person to integrate the design between colors, forms and interior space perception. "...the steel tubing worked with the taut canvas to spring the seat, and the back and the arm rests. Unlike the American Patent furniture with its



mechanical mobility, this type uses the resilience, the springiness, of materials to provide a modicum of elasticity.” (Giedion, 1948)

Marcel Breuer worked on developing steel tubing chair seats (cantilever design) which is still used as a seating object till our current day; Breuer worked out his first steel-chair designs with the aid of a metalworking firm in Berlin (Mang, 1979). The diversity of designs made the sitter, as well as the designer take care of the seat’s aesthetics, taking a step backward for seats' functions, and generating a new concept called ‘Emotional Design’. (see figure 3.13.)



**Figure 3.13.** *Breuer Elastic Cantilever chair of 1929.*

**Reference:** <http://3.bp.blogspot.com/-sNUj-QfdOSw/VRL0FdbpntI/AAAAAAAAAL4/ydI9GhYLWKw/s1600/au0027b.jpg>

Straightaway, from steel tubing, the 'molded plywood' designs came, providing the designers a brand-new concept of shaping and curving complex styles in plywood. The well-known American couple *Charles and Ray Eames*, significantly made historical development of modern furniture, with molded plywood, which became very popular then, and have been broadly copied since 1940's. Eames has contributed at least three of the major chair designs of the twentieth century.... His work has influenced furniture design virtually every country and his mastery of advanced technology has set new standards of both design and production (Eames & Drexler, 1973). See figure 3.14.



**Figure 3.14.** *Eames plywood chair.*

**Reference:** [https://pbs.twimg.com/media/CIMoktjWMAEHV\\_m.jpg](https://pbs.twimg.com/media/CIMoktjWMAEHV_m.jpg)

### **-The Industrial Designer Era**

Regarding furniture manufacturing, seats design manufacturing became a serious business. With more and more useful objects being machine-made and the artist-craftsman dying out, a new concept was needed to describe the activity of giving form to industrial products. The term coined was “industrial design,” and among the first to use it was Henry Cole (1808-82) (Mang, 1979). New values of design philosophy arose from ‘Industrial Designers’ and they assured that the mass production will be an added value to the consumer’s needs and lifestyle.

Seats in other meaning had become a common part of society’s daily life. Enhancing their designs in the market, producers were challenged to enroll their design styles in the market, working on the styles acceptance and adaptation by the consumers.

The industrial designer does more than tracing curves. The studios of the leading design firms then, had at least 100 draftsmen employed to undertake market research, re-organize the stores, as well as the design of the building. Thus, they must've been decorative artists, architects, and organizers in one time. In addition, the merchandiser, dictator of taste in the United States, was their only consideration... Now in the time of full mechanization, reform takes place under the dictatorship of the market. All other considerations are secondary(Giedion, 1948). Figure 3.15.



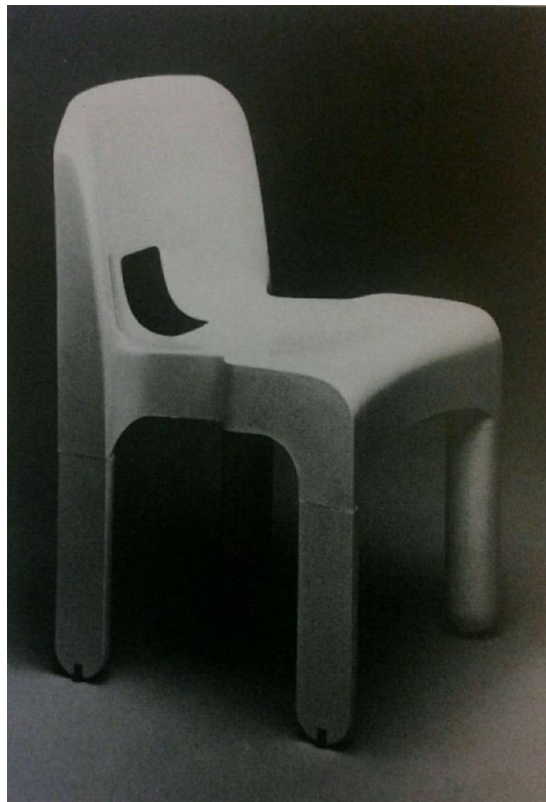
**Figure 3.15.** *Richard Riemerschmid. Machine-made chair (ostensibly the first).*  
**Reference:** History of Modern Furniture, Karl Mang 1978.

### **-The Post-Modernist Era**

As seats flooded in the market, they were often divided into three different types; where each type meets its consumer' respectively: seats designed for home, seats designed for institutions, and finally, contemporary art seats. New materials emerged again to be used by 'Industrial Designers' then. Such as plastics, foam, and urethanes were processed by designers to bring new methods of seat designs. Both form and techniques had to be evolved from the new materials. Plastic, with its almost total malleability, demanded a new aesthetic (Mang, 1979).

Almost all of the designers were attracted to furniture designing, but only Industrial designers of that era were able to think of seat designs as a problem solving, between producers, technology, and modern materials assuring the consumer's durability facing design developments.

It was noticed that seats' style came from simple geometry, generally structured with curved backrest, thin seat and legs, with high legs for kitchen seats. Seats were meant to be designed carefully in order to meet the interior styles trending in this era by materials and colors. (see figure 3.16.)



**Figure 3.16.** *Joe. C Colombo. Stacking plastic chair, 1965. Manufactured by Kartell.*  
**Reference:** Furniture design” Book (Smardzewski, 2015).

Moreover, seats had been designed to tell a lot about its owner, seats of the post-modernist era were able to show the social class rank and the style of its user, in fact, designers made sure to use it to develop significant designs commercially applicable. On the other hand, seating manufacturers were in the middle of introducing the market's to low-cost mass product seats, targeting the society's middle classes, allowing the seat to be commonly universal object.

Institutional chairs were generally designed to be stackable and movable, it was also durable with a good price. Those types of seats were used in schools, universities, and conference rooms.

Institutional seats were in general molded in one piece from plywood or thermal plastic like polypropylene supported by a metal frame. Those types of seats presented a classless sitting notion, without giving any attention to standards and anthropometric differences between one human to another, even between males and females.

Office furniture and specially office seating elements became a big challenge to 'Industrial Designers' since the beginning of the 'Post-Modernist' era, even the scientific community has evolved by studying human behavior and interaction with objects, beside anthropometrics of the human body, those scientists are the 'Ergonomists'. "...There are several chairs which are good and which...seem comfortable, but no one can agree which is the best since sitting remains a personal activity..." (Dormer, 1987 22) p. 92.

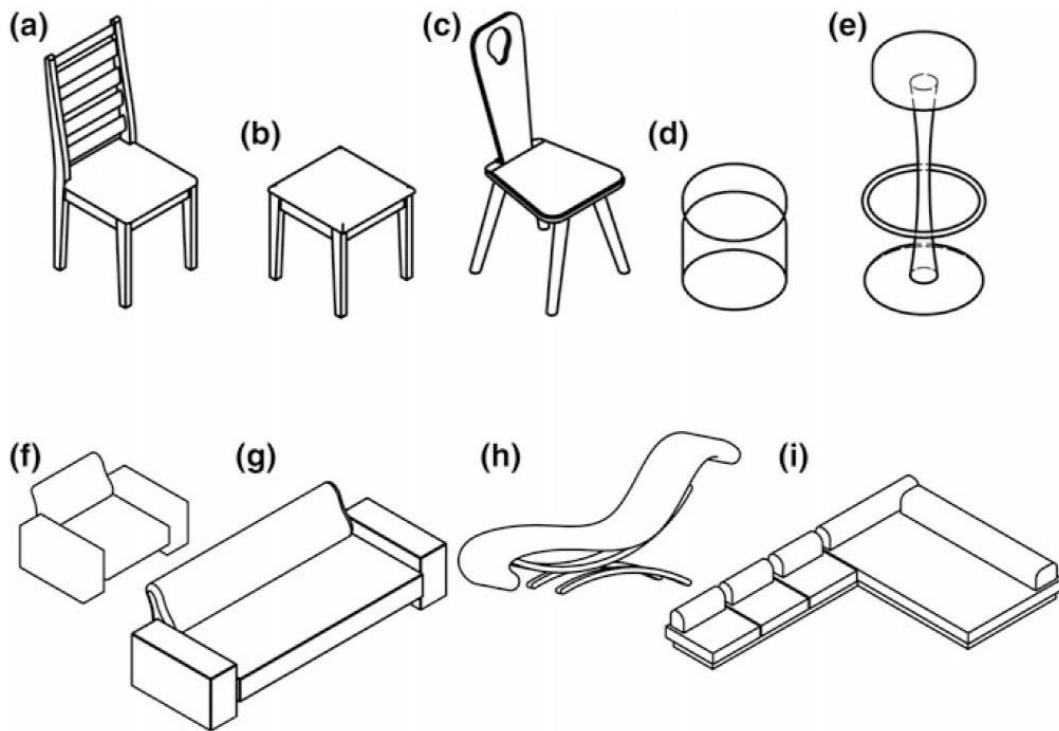
The argument of the seat's new notions has become the new researching symbol of 'Ergonomics' for sitting and seating.

In Fact, the researches of sitting and seating ergonomics is still a big challenge and a problem to be solved, looking for the best solution and offering the consumer and the market new notions of comfort and functionality and never away from aesthetics.

### 3.3 Types of Seating Elements

Talking about the seating types, we are able to identify the commonly used seats in different spaces like houses, restaurants, public places, offices, and schools; they are generally chairs, benches/sofas, and stools. With the various types of seats, each type is designed and customized to be involved and placed in its categorized spot.

Discussing the types of seats, we may notice that chairs are the most common used object as a seating element. Hence this is a short list of the most popular seating elements with single and multiple seating units according to “Furniture design” Book (Smardzewski, 2015). (shown in figure 3.17.)



**Figure 3.17.** *a chair, b tabouret, c stool, d pouffe, e bar stool, f armchair, g sofa, h chaise lounge, i corner sofa.*

**Reference:** “Furniture design” Book (Smardzewski, 2015).

## 4 SEAT'S ERGONOMICS AND ANTHROPOMETRY

### 4.1 Ergonomics of Seats

#### -Ergonomics

The word ergonomics comes from a Greek origin: ergos, work; noms, natural law. The word was formulated on 8 July 1949 by Professor Hywell Murell, in consequence of meeting working party, where they started a society to stand for “studying the human beings in their work environment”. The starting society came from different backgrounds mostly like engineering, human sciences, and medicine, where they worked together on a research, but with unknown term or name stands for the application they had been doing until they lastly settled down on “ergonomics”. According to the Polish Society of Ergonomics, ergonomics is an applied science aiming to optimally adjust tools, machinery, equipment, technology, organization and the material working environment, as well as objects of common use to the physiological, psychological and social requirements and needs of the human being (Smardzewski, 2015).

Where the International Ergonomics Association (IEA) published a definition for ergonomics: *Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.* (IEA 2009)

Also, the International Ergonomics Association (IEA 2009) offered a brief research on the ergonomic domains of specialization within the discipline of ergonomics, in which two of them are:

#### *Physical Ergonomics:*

*Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health.)*

#### *Cognitive Ergonomics:*

*Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.)*

Ergonomics is an interdisciplinary field where knowledge and theory are integrated to obtain understanding, practical tools, and technologies to address human needs in product design for the occupational environment and other diverse environments.

Contributing disciplines in ergonomics include physiology, psychology, biomechanics (sometimes considered a subset of ergonomics), physics, anthropometry, and general engineering.(McCauley, 2012)

- *Physiology*: Understanding how the physical aspects of the human's body respond to the workplace environment.
- *Psychology*: Understanding the intellectual aspects of human's body interaction in the workplace.
- *Biomechanics*: Professional biomechanics, studies the mechanical and motion appearances of the human body and the body's elements in the work environment, Concerning the mechanical elements of the living creatures.
- *Physics*: Describes the motion endured by several body parts and the forces adjusted in these body segments during every day's tasks and activities by using science laws and engineering notions.
- *Anthropometry*: An observational science that try to analyze the human body's size, shape and abilities through reliable physical measures aimed to find anthropological inspection.
- *General Engineering*: A ground work used to help citing the sorts of common ergonomic problems by developing proper tools, services, and product designs.

Nowadays, in our industrialized world, people frequently sit when they are awake. People around the world sit while eating, driving their cars or riding a bus to go to work, in classrooms, offices or while operating a machine. Even if sitting is about doing a zero% physical effort, people always search for the perfect seat to guarantee their comfortable sitting postures that don't affect their health, which is known as "ergonomically designed" seats.

What does it mean when the term "ergonomically designed" is used? Unfortunately, the phrase itself is extensively used and misused at the same time in marketing ads' storyboards and scripts. In particular, 'ergonomically designed' phrase is widely used in the market, especially for the perfect office furniture choices, which are mainly designed for the user's comfort (they may or may not be comfortable), and those products are economically expensive in a surrealist mean.

Discussing the comfort of the users, ergonomics of the human body's problems can be classified when they are evaluated to identify and categorize them by approaching the product/tool's and the human body's interaction. Performing only one task or movement for a long time and day after day such as sitting during office work, studying, drafting etc. causes physical stress to the performer's body, which can cause dramatic injuries.

Eventually, the responsibilities of professional ergonomists and designers include serving the humanity 'economically and ergonomically designed' products.

## **4.2 Anthropometry; The Physical Ergonomics**

Anthropometry (Gr. anthropos—human, metreo—measure), according to the definition in the encyclopedia PWN, is a group of technologies of making measurements of the body or skeleton of a modern and fossil human being, and it enables an accurate and comparable study of diversity and variability of measured characteristics of the human in his personal and evolutionary development. Knowledge of the human's dimensions, called anthropometric dimensions (Smardzewski, 2015). Anthropometry is a very important branch of ergonomics. (Pheasant, 1996)

Anthropometrics was widely measured by an anthropometer, which is an instrument consisted of four adjustable hollow tubes that suit into one another to formulate a solid rod when measuring. Nowadays realistic 3D full body scanners are replacing the anthropometers, since they can give almost a full detailed body measurement reports including the shape's dimensions, weight, and the scanned area, using improved computer software.

For decades, scientists, artists, and architects kept discussing and studying the human body's anatomy, mechanism, and the body's proportions in their work but the human body measurement had a slight change over years.

Initially, anthropometry was coined by in 1870, by the mathematician Quetelet, who was the pioneer of this field, and published his *Anthropometrie*. Anthropometry is an application to determine the human body's physical properties and the differences in the measurements for either individuals or groups.

This following paper is concerned with the sitting and seating anthropometry and ergonomic aspects, linking them to physical dimensions and body size, identifying the seat's standard dimensions and the activity by its users.

## **4.3 Sitting and Seating Essentials in Anthropometry**

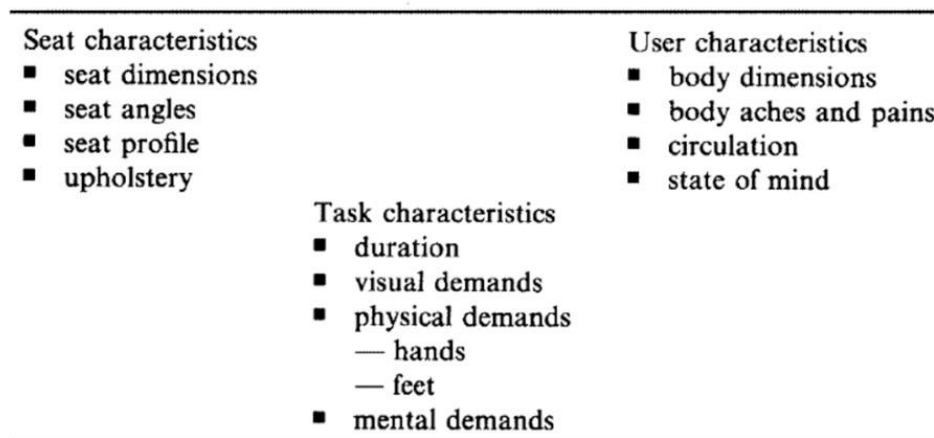
Seats design can be traced to antiquity. The stool itself as an example, a valued element of furniture, developed by the Egyptians back to 2050-3000 B.C. and the chair as far back to 1600 B.C. Regardless of the seats history, yet seating is still one of the most debated elements of interior space furniture. Industrial Designer Neils Diffrient once said "Chair design is the acid test for designers".

The difficulty is not with the design of a seat but with the impacts of the seat on sitting, considering the human body biomechanics which may be not effective to design approach. Paradoxically, a seat which is anthropometrically accurate may not necessarily be comfortable. However, if the seat design was completely not responsive to human body dimensions and size, the result clearly leads to uncomfortable seating object.



Seating essentials can be identified as the seat's comfort, even though sitting for long time is definitely uncomfortable, and the use of some seat types may rapidly increase the percentage of comfort of their users. The purpose of a seat is to deliver a feeling of comfort to the sitter, providing him/her a supported body posture that keeps him/her physically relieved for a rational period of time, and physiologically satisfied.

In other words, comfort (or more strictly the rate of onset of discomfort) will depend upon the interaction of seat characteristics, user characteristics, and task characteristics, see figure 4.1. (Pheasant, 1996)



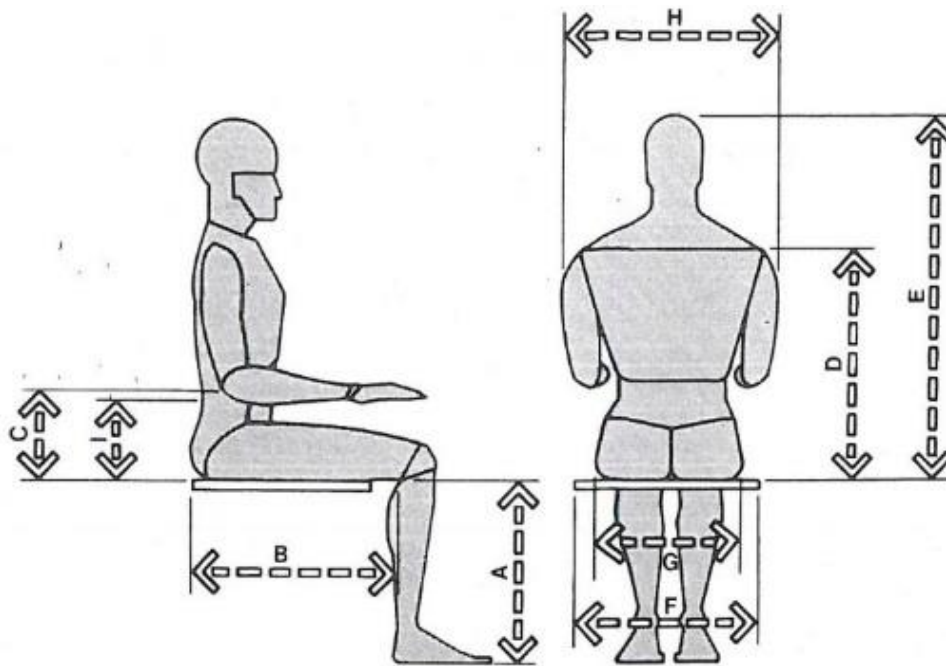
**Figure 4.1.** *Determinants of sitting comfort.*

**Reference:** Pheasant, S. (1996). *Bodyspace: anthropometry, ergonomics and design*. London: Taylor and Francis.

#### 4.4 Anthropometric Aspects of a Seat Design

With respect to the sitter's comfort, sitting is to a greater extent a dynamic activity more than a static one; anthropometrically based approach to specific seats design is rarely challenged. Even though, as stated previously, anthropometrically correct seats are not completely guaranteed for the sitter's comfort, but it is a necessity that seats designed should be created based on anthropometric data.

A seat designer is required to become familiar with the anthropometric data and its bond to the biomechanical and ergonomic essentials while designing any seat; working with these three concepts together assures solving all of the design problems. The basic dimensions required to design any seat includes seat height, seat depth, seat width, seat's backrest, seat's armrest, seat's cushioning, seat's footrest. The table below shows the essential anthropometric dimensions for a seating design. See Fig. 4.2.



MEASUREMENT	MEN				WOMEN			
	Percentile		Percentile		Percentile		Percentile	
	5	95	5	95	5	95	5	95
	in	cm	in	cm	in	cm	in	cm
A Popliteal Height	15.5	39.4	19.3	49.0	14.0	35.6	17.5	44.5
B Buttock-Popliteal Length	17.3	43.9	21.6	54.9	17.0	43.2	21.0	53.3
C Elbow Rest Height	7.4	18.8	11.6	29.5	7.1	18.0	11.0	27.9
D Shoulder Height	21.0	53.3	25.0	63.5	18.0	45.7	25.0	63.5
E Sitting Height Normal	31.6	80.3	36.6	93.0	29.6	75.2	34.7	88.1
F Elbow-to-Elbow Breadth	13.7	34.8	19.9	50.5	12.3	31.2	19.3	49.0
G Hip Breadth	12.2	31.0	15.9	40.4	12.3	31.2	17.1	43.4
H Shoulder Breadth	17.0	43.2	19.0	48.3	13.0	33.0	19.0	48.3
I Lumbar Height	See Note.							

**Figure 4.2.** Key anthropometric dimension required for a seat design.

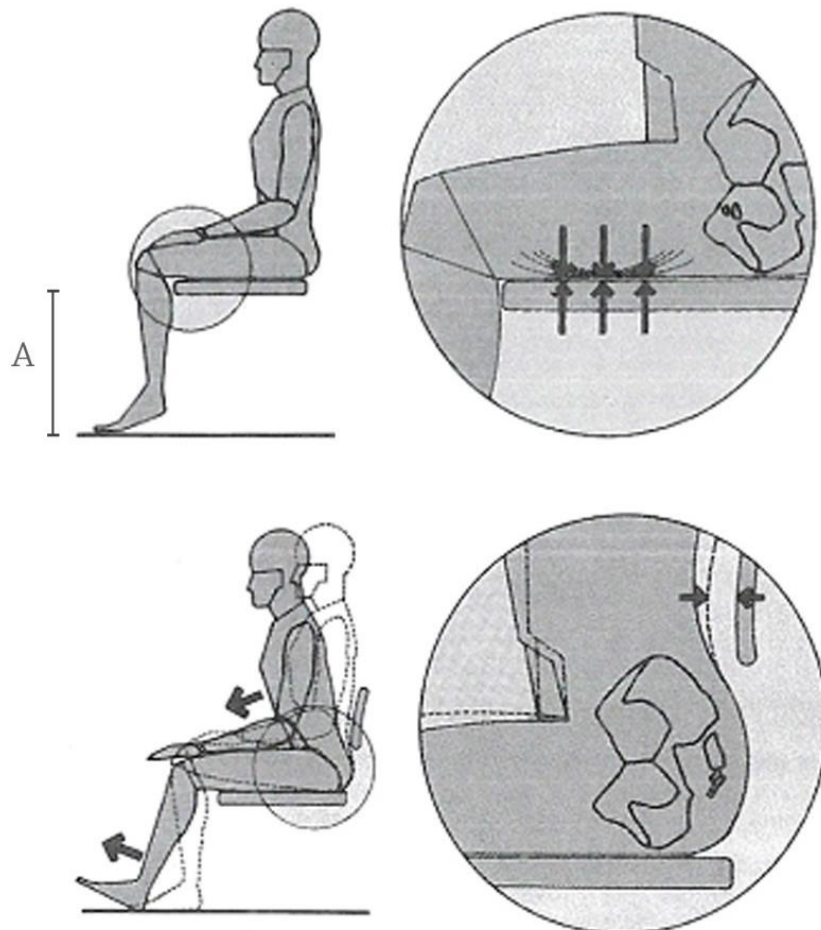
**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space

While the requirements for seats are the following basic characteristics: The surface of the seat should be situated horizontally. It is recommended also to tilt it towards the backrest up to the value of  $-5^{\circ}$  to  $+5^{\circ}$ ; The surface of the seat cannot be flat. It is recommended to use a bend at the front and back edge, so that the radius of rounding the front edge was significantly greater than the radius of rounding the rear edge; The depth of the seat should be adjusted in such a way that the distance between the edge of the worktop and the body's trunk amounts from 5 to 10 cm; and the backrest supporting the back should have roundings and be tilted from the vertical by  $5^{\circ}$  to  $20^{\circ}$  (Smardzewski, 2015).

#### 4.4.1 Seat height (A)

With the variation of human body's genetic, biological, and environmental factors that differs one to another, seat's height is one of the very essential considerations to design an accurate seat; as the seat's high increases, it motivates the feel of pressure on the bottom side of the thighs, while the resulted decrease in the blood circulation may root to inflation in feet and tingling sensations which is a core of discomfort.

With the decrease in the seat's height, it requires a larger leg room; the user will tend to *flex* his/her hips and the entire spine more; by cause of the distance and the center of gravity for the user's movement the user will face bigger problems with his standing up and sitting down actions. Whereas the ideal seat height, standardly varies from 42 to 45cm. See Fig. 4.3.



**Figure 4.3.** A sectional view of the seated figure showing the ischial tuberosities.

**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space.

#### 4.4.2 Seat depth (B)

A seat Depth is recognized as the distance from edge-to-edge in the case of a bench or stool seats, or from edge-to-back of the seat in the case of seats with backrests.

If the depth of the seat exceeded the buttock-popliteal length, the sitter will miss the ability to benefit from the backrest comfort with unacceptable remarkable pressure on the back of the knees. A deep seat depth may rise the user's problems of standing up and sitting down. Furthermore, the common basic seat depth measures between 43.9 to 54.9cm, while lower depth is still considered as a support, 30cm depth may be a satisfactory depth for a bench and stool users. See Fig. 4.4.



**Figure 4.4.** *A seat depth (Adjustable).*

**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustments>

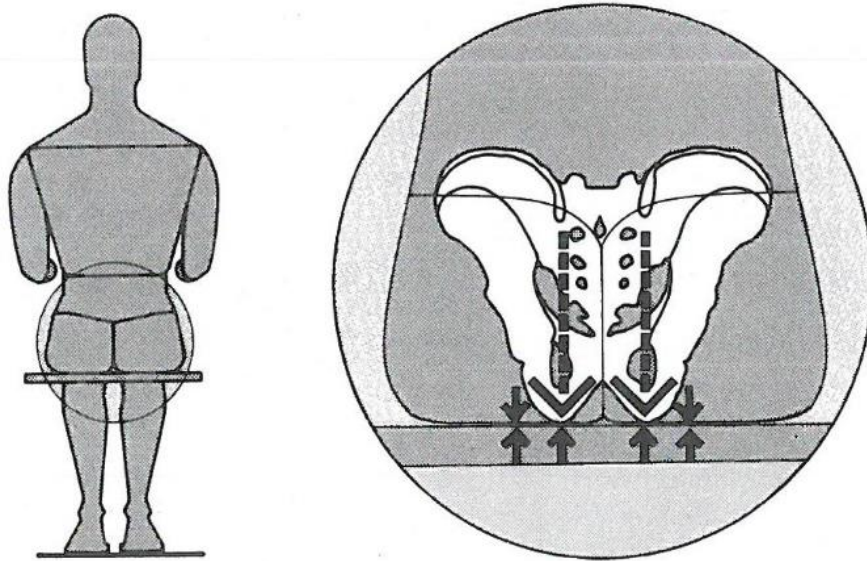
#### 4.4.3 Seat width (C)

For purposes of support a width that is some 25 mm less on either side than the maximum breadth of the hips is all that is required— hence 350 mm will be adequate. However, clearance between armrests must be adequate for the largest user... In practice, allowing for clothing and leeway, a minimum of 500 mm is required.(Pheasant, 1996) See Fig. 4.5. / 4.6.



**Figure 4.5.** *Seat width.*

**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustment>



**Figure 4.6.** *An enlarged posterior sectional view of the ischial tuberosities.*  
**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space

#### 4.4.4 Adjustable seat height (D)

Adjustable seats are called non-pneumatic for old office chairs models and pneumatic for the new office chairs models (fig. 4.7.). The core of adjusting the seat's height is necessary, it allows the users with different heights experience and achieve a perfect height with the work surface with a good sitting posture, without the usage of a footrest.



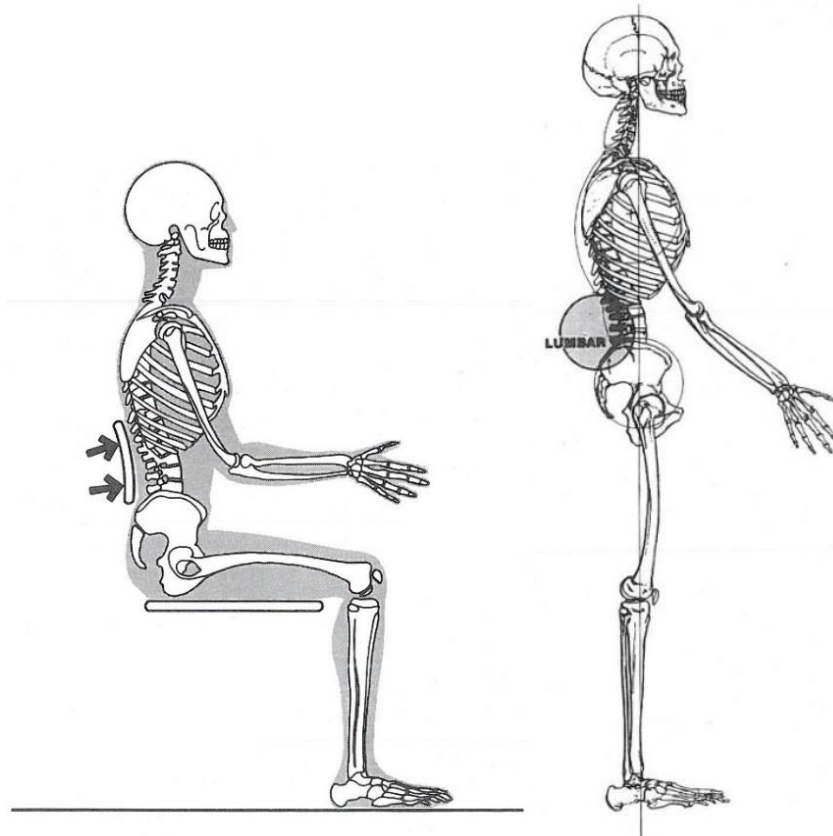
**Figure 4.7.** *Adjustable Seat height.*

**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustments>

#### 4.4.5 Seat's backrest (E)

Anthropologists considered that a high backrest is more effective in supporting the trunk, however in some conditions the flexible movement of the shoulders may be more important. There are three major varieties of backrest, each may be more effective than the other under certain situation: the low-level backrest; the medium-level backrest and the high-level backrest. The low-level backrest finishes beneath the shoulders level setting a free movement for the shoulders and arms, thus it affords lumbar support only, with a required backrest height of 40cm.

The medium-level backrest tends to support the upper back and shoulders. For the support of the upper back a total of 50cm is required, while for the support of the shoulders about 65cm is required. Usually it is presents in the office chair designs. The high-level backrest tends to the full support of the head and neck, with an overall height of 90cm requirements. (fig. 4.8. / 4.9. shows)



**Figure 4.8.** *Backrest supporting the lumbar region; the lumbar region.*  
**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space



**Figure 4.9.** *Backrest supporting the lumbar region.*

**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustments>

#### **4.4.6 Adjustable backrest angle**

The adjustable backrest is usually essential for work chairs. It self-calibrates automatically or manually adjusting backrest lifting conforming to the user's weight with the allowance of different sitting positions and angles, and usually it comes with a lumbar pad support to achieve a high comfort level. Scholar determined recently that the best sitting posture angle raised to 135°. See fig. 4.10.

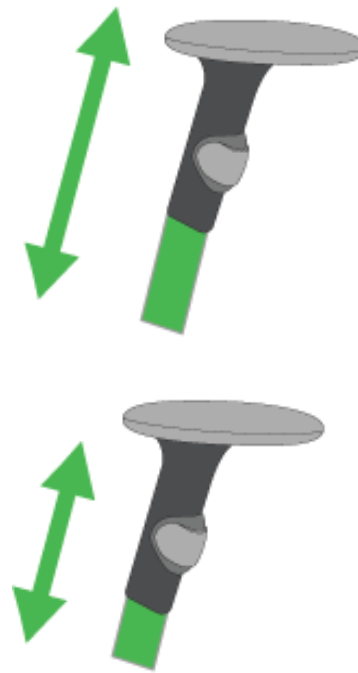


**Figure 4.10.** *Adjustable seat backrest.*

**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustments>

#### 4.4.7 Seat's armrest (G)

An armrest is considered to support the user's postures and assist the action of standing up and sitting down. Armrests may be plane or they may be padded, but with the same core to support the forearm, keeping in consideration that solid armrests may cause discomfort of the elbow bony parts where high sensitive nerves are formed (shown in figure 4.11.). About 10cm clearance between the armrest and the seat's backrest is to be required when designing a seat. If the chair is to be used with a table the armrest should not limit access, since the armrest should not, in these circumstances, extend more than 350 mm in front of the seat back. (Pheasant, 1996) Thus, a slightly lower height elbow rest is more recommended for a relaxing sitting posture. Mainly an elbow rest with a height between 20-25cm above the seat surface counts to be adequate.



**Figure 4.11.** *Adjustable Seat Armrest.*

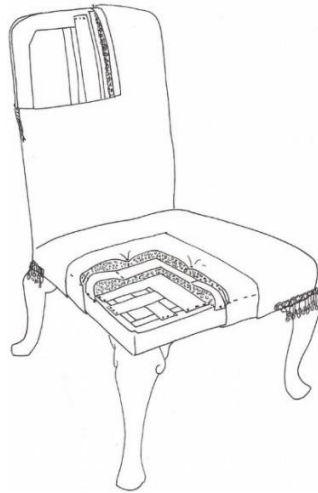
**Reference:** <http://www.posturite.co.uk/posture-learning-resources/why-ergonomic-chairs-have-so-many-adjustments>

#### 4.4.8 Seat's cushioning (H)

The main purpose of cushioning is essentially to distribute the pressure, due to the weight of the body at the point of interface, over a large surface area (Panero & Zelnik, 1979). Over stuffing, deep and softer cushion the seat surface when upholstered may cause the sitter discomfort, weakness and pain. As the buttock is considered to be an excellent sensitive area, proper upholstery is to be applied to the seat. The consensus of ergonomic



opinion suggests the following: the seat surface should be more or less plane rather than shaped, although a rounded front edge is highly desirable; upholstery should be ‘firm’ rather than ‘soft’ (it is sometimes said that a heavy user should not deform it by more than 25 mm); covering materials should be porous for ventilation and rough to aid stability (Pheasant, 1996). See fig. 4.12.



**Figure 4.12.** *Chair upholstery illustration.*

**Reference:** <http://www.kategillconservation.co.uk/portfolio/investigation-and-documentation-project-18thc-upholstered-furniture-knole-sevenoaks%C2%A0kent>

#### 4.4.9 Seat’s footrest (I)

It was forever sounded like a very small detail, but the support of a footrest for the seat design can have a huge impact on the user’s comfort. The footrest may decrease the pressure done by a sitting body on the feet and legs. It is considered to be an essential implement for the design of school chairs and high seats like stools to support the body lifting in the case of using the height surface seats. It can be adjusted in its height if it came as a built in part with the adjustable seat height part. Fig. 4.13. shows a sample of a stool seat’s footrest.



**Figure 4.13.** *Stool seat with a footrest.*

**Reference:** <http://www.ianscottoofficefurniture.co.uk/images/P/educational-beech-wwoden-top-stool-with-footrest.jpg>

## 4.5 Sitting Postures

A particular position assumed by the body is a posture (Binder, Hirokawa, & Windhorst, 2009). The relative alignment of the body parts is called Posture. Posture is the position in which we hold our body upright against gravity while sitting. A good posture usually results from a good supported body and spinal alignment, which assists a complete healthy, comfortable, and correct sitting positions. Unhealthy sitting posture leads to cervical spondylosis and other related cumulative trauma disorders (CTDs) (Liu, Li, Zhang, & Ye, 2016)

Correct sitting positions generally may be considered to be a static posture that is engaged to straight and/or neutral sitting body positions; example: upright posture, declined posture, and reclined posture. A static (correct) sitting posture is measured to be a passive sitting position, that can be presented mostly in seats with backrests, neck support, and armrests, but never to forget that it may leads to inactive prolonged sitting health problems. Bad sitting posture can possibly cause deformation of the spine, which in turn can affect breathing, nerves, liver, kidneys and the circulation. On the other hand, static posture, as distinct from posture in movement, appears to be a relatively minor cause of spinal deformation (Unesco, 1979).

Static sitting as a passive sitting postures has been always compared to dynamic sitting which is well-thought-out as the active sitting positions, that with its special designed seats allows the seated person to move and keep active; the concept of a dynamic seating is to let the seater perform easier and move more while sitting. Yet, without controlling our sitting positions in any awkward sitting postures increases the risk of our health problems.

Awkward sitting positions occurs when the body is working with flexed or extended positions, it increases the fatigue, and rise body bones pressure and muscles stiffness, causing MSDs and stress, also it decreases the blood flow in the body causing chronic heart diseases.

As OSHA Mentioned on their website; *Examples of awkward postures include any task that may:*

- *pull the elbows away from the torso such as performing overhead work or reaching in front, to the side, or in behind the body;*
- *bending the elbow past about 90 degrees for prolonged periods of time;*
- *bending or twisting the torso to lift an object from low or distant locations;*
- *extending, flexing, or bending a wrist to the side while using tools or performing connection tasks;*
- *bending the neck backward or forward for prolonged periods while working overhead or on low surfaces; and*
- *bending the knee or ankle to work in a squatting or kneeling position.*

## 4.6 Physical Health Problems in Prolonged Sitting

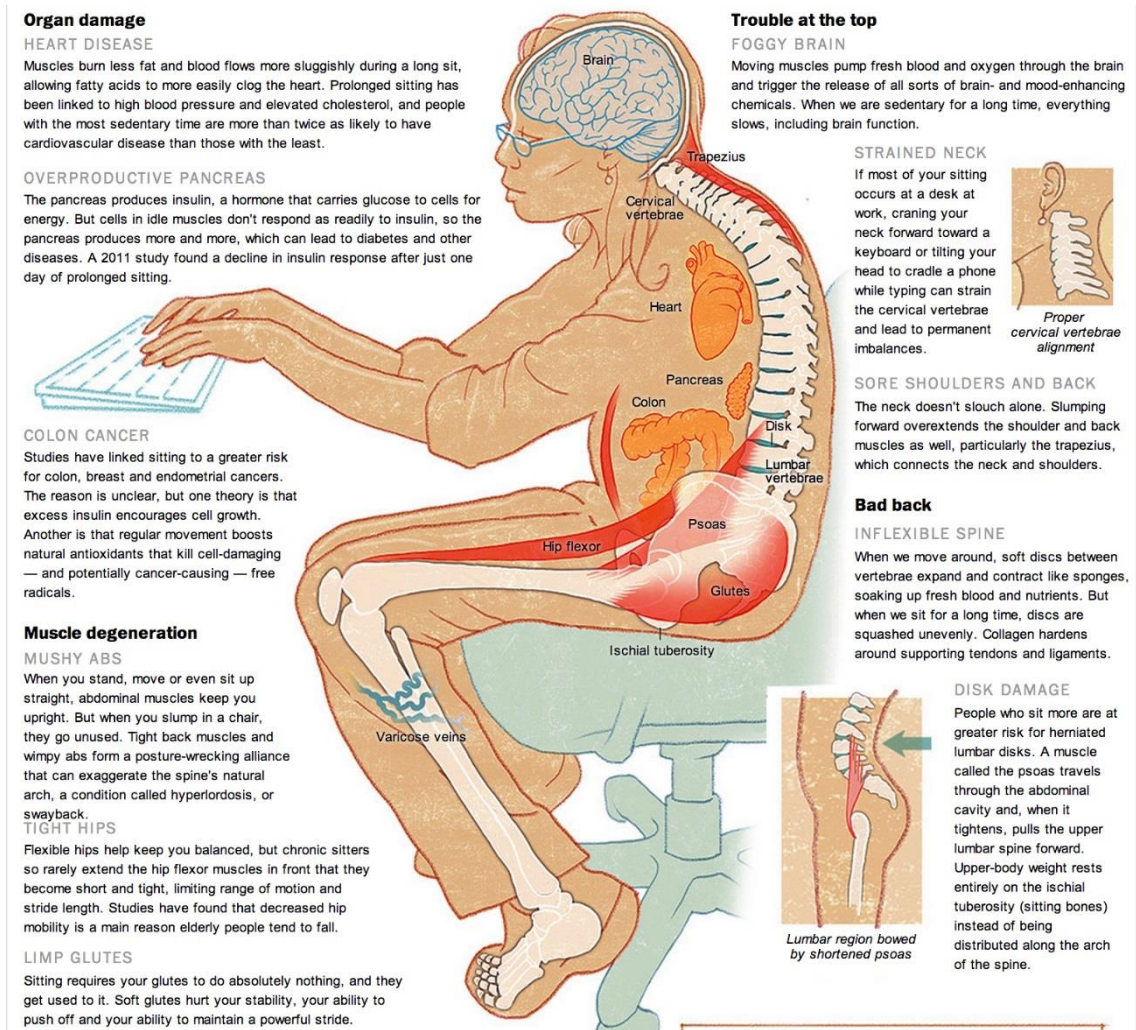
Sedentary, the term is derived from the Latin word *sedere*, to sit. It is the Work performed primarily in the seated position without exposure to vibration (Gebhart & Schmidt, 2013). It defines the long period sitting, as well defines the long period of inactive low energy activities. The hazards of high levels of sitting were first highlighted in the 1950s when J. Morris et al identified a twofold increase in the risk of a myocardial infarction in London bus drivers compared with active bus conductors...

The opportunities for sedentary behaviors in modern society, such as watching television (TV), sitting in a car or using the computer, are ubiquitous. As such, sedentary behaviors are an important facet of human lifestyle. Objective measures have demonstrated that the average adult spends 50–60% of their day in sedentary pursuits. (Wilmot et al., 2012)

Studies agreed that prolonged sitting results serious health problems; as an example most design student, who works generally in a sitting position, suffers from back, neck, and shoulders pain besides muscle soreness. Not only physical health problems arise, CCOHS (Canadian Centre for Occupational Health and Safety) mentioned that people with sedentary time, found to be also effected with poor mental health, metabolic diseases and heart disease, these effects are not connected to physically active people.

Even though sitting takes less muscular effort, muscles involves in holding the neck, shoulders and the trunk in a fixed sitting position. A fixed sitting position roots a squeezed blood vessel in the muscles, and reduces the blood stream to the muscles while working them. Thus, the lack of the blood supply sources weak muscles that leads to muscle soreness. As a result of a long time sitting, the blood stream and the heart activity slow down. This insufficient blood stream leads to high pressure on the bottom of the thighs if the seat was too high, which can worsen the injury and can root numb legs, swollen, and varicose veins. Not only the duration of sitting is responsible for the illness, but also a poor body posture can increase the risk factor. A poor posture, can be achieved because of seats height that's not suitable with the sitter's body size and shape.

Sedentary may cause dramatic physical health injuries, the core of ergonomics categorized and referred those injuries as *MSDs* 'Musculoskeletal Disorders' (OSHA and NIOSH uses this term), and also can be defined as *RSIs* 'Repetitive Stress Injuries' /*CTIs* 'Cumulative Trauma Injuries' /*RMIs* 'Repetitive Motion Injuries'). These painful injuries grow increasingly over weeks, months, and years. Studies by Nachemson & Morris (1964), Okushima (1970) and others have confirmed that intervertebral disc pressure is 35% lower when standing versus sitting (Pitman & Ntuen, 1996). See fig. 4.14.



**Figure 4.14.** Prolonged Sitting Physical injuries.

**Reference:** <http://media2.policymic.com/8f81459f7b2ae34b52afe88e869c9247.jpg>

## 4.7 Musculoskeletal Disorders / MSDs

*MSDs, or musculoskeletal disorders, are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system. They can affect nearly all tissues, including the nerves and tendon sheaths, and most frequently involve the arms and back... MSDs do not include injuries resulting from slips, trips, falls, or similar accidents.* (U.S. Department of Labor & Occupational Safety and Health Administration, 2000) The central body parts that can be damaged by MSDs are arms, hands, fingers, legs, wrists, back, neck, and shoulders as a result of working under consequences of repetitive work, tough or static postures, fast motion, vibration, and stress.

These injuries usually effect the upper body parts like neck, shoulders, hands, forearms and elbows, and caused by repetitive or awkward actions. These injuries develop gradually causing cramps, weakness, stiffness, and pain in tenderness to tendons, nerves, and muscles and can last for several days of pain and several months without proper treatment and medication. Repetitive activities are not the only reason producing RSIs, also poor awkward sitting body postures can be included, besides working in stress worsen it and causes poor mental health. Recently, long time incorrect sitting postures were found to contribute to cervical spondylosis, lumbar diseases and other so-called 'chair diseases' (Liu et al., 2016)

The most injured physical body parts in sedentary are the neck and shoulders, the back, and the arms and wrists and the thighs; (see figure 4.15.)

The neck and shoulders strain can be resulted from the incorrect posture while looking at the work surface while sitting on either very high or very short seat, placing a very high pressure on the neck and the shoulders to result a muscles and joints pain, tension, and sometimes can result headaches.

The back (the lower-back and the upper-back) pains and injuries in the back's muscles and discs are resulted if improper sitting or from sitting on unsupported seats for long time. Stiffed and dysfunctional joints are resulted of the awkward postures and sitting positions for several hours every-day. Improperly and prolonged sitting postures strains the spine's ligaments and produces stiffness in the joints. Nevertheless, sitting prolonged with the feet not touching the ground may also lead to back pains and injuries.

Talking about arms and wrists injuries and disorders, are the result of the constant repetition or pressure while performing the work. Those injuries and disorders may be formed as bones and muscles weakness between the neck and the hands, tingling, craps, and numbness. These untreated and medicated injuries may cause a permanent nerves damage.

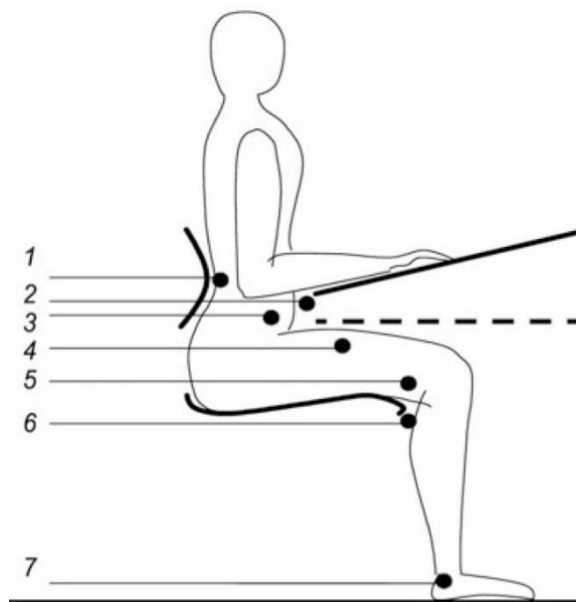


**Figure 4.15.** *MSD's Body Pain Location.*

**Reference:** <http://kawahealth.com/wp-content/uploads/2016/04/joint-pain1.jpg>

According to Jerzy Smardzewski, there is seven primary criteria must be taken into account, when designing school furniture and they are illustrated in fig. 4.16.

1. The backrest of the chair should stiffly support the back at the height of the lumbar region, below the shoulder blades.
2. The height of the front edge of the table must correspond to the height of the bottom surface of the bend forearm in a position when the arm is placed vertically.
3. To guarantee freedom of movement, the distance between the edge of the table and pupil's body needs to be determined, as well as the distance between the lumbar support and the seat.
4. Distance between the lower surface of the table and the thigh must be ensured.
5. The part of the shank near the knee cannot put pressure on the front edge of the seat.
6. A clear space between the back part of the calf and front edge of the seat must be taken into account.
7. The foot must rest on the floor. The seat and table height should be adjusted to the thickness of the shoe sole, around 2 cm.



**Figure 4.16.** *Preferential points to dimensioning school tables and chairs.*

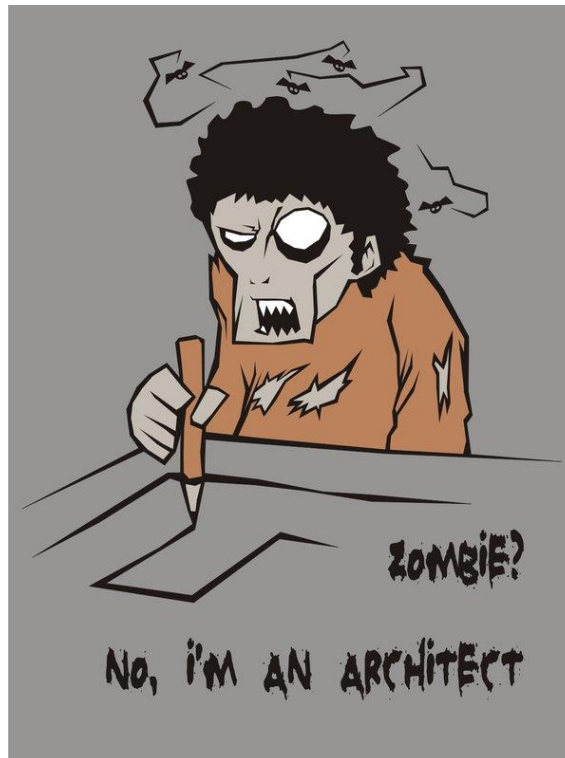
**Reference:** Furniture Design book. Authors: Smardzewski, Jerzy

#### 4.8 Mental Health Problems in Prolonged Sitting

Debating the mental health in sitting, and as we mentioned previously, that sitting prolonged is determined to be a bad aspect of the physical health, like muscles and nerves weakness, weak blood circulation, and chronic diseases. Late findings not only mentioned that sitting is a core of weak physical health, but prolonged sitting is also effecting the mental health. A total of five studies (four cross-sectional, one longitudinal) examined the association between overall sitting time and risk of anxiety in adults, with all but one finding a positive association between sitting time and anxiety risk (Megan Teychenne, Sarah A Costigan, & Kate Parker, n.d.).

Performing any daily work in an awkward sitting position can be a big reason of stressing either students or workers. Stress can affect organizations by causing high rates of absenteeism and staff turnover, disciplinary problems and unsafe working practices, as well as low commitment to work, poor performance, tension and conflicts between colleagues. In addition, stress damages the image of the organization...(World Health Organization, 2005); see figure 4.17.

Although; Poorer mental health was related to longer working hours outside university. Disturbed mental well-being and mental ill-health in students are significant inhibitors, if not barriers, to academic achievement and success. For many students, working at a design studio with prolonged sitting will weaken their capacity to focus and work well (Stanley & Manthorpe, 2002).



**Figure 4.17.** *Architecture Student Comic Illustration.*

**Reference:** <http://goodmorningnight.deviantart.com/art/Zombie-No-I-m-an-Architect-169427363>

As one student told the author recently in discussion:

*When I sit down to work, after about one hour of continuous work, my back starts to hurt me, and my mind fills up with complicated ideas and I sit there for hours forgetting about my health and worrying about the project in front of me.*

As the level discomfort increases with periods of working in prolonged sitting, this discomfort considered to be a notion to degrade the sitter's performance, and shift away his/her attention from the task he/she's doing. Although researches revealed that sitting prolonged for more than 6 hours a day working increases the risk of mental health problems mostly causing stress, anxiety and depression; scholars and researchers stated that studying prolonged sitting impacts on the mental health are still to be determined through interventional and longitudinal studies.

## **5 SEATING; CREATIVE PERFORMANCE AND PRODUCTIVITY in the DESIGN STUDIO**

### **5.1 Seating Types in the Design Studio Classroom**

Educational furniture has the critical importance relative to learning effectiveness and the health of the children as well as adults who continue to educate themselves in learning society of the 21<sup>st</sup> century. Although furniture is one of the most expensive and important components of education it is very after neglected and inadequately informed field (UNESCO, 2000). Staring at a sitting design student's physical movements for a while, it will reveal hundreds of changeable sitting positions. Countless scholars and studies argued sitting and seating ergonomically to reach the maximum user's comfort and healthy sitting position. Ergonomically designed seats is becoming a 'buzzword' and very effective on the marketplace of classroom seats production, which absolutely effects students as a tool that supports their health care in education.

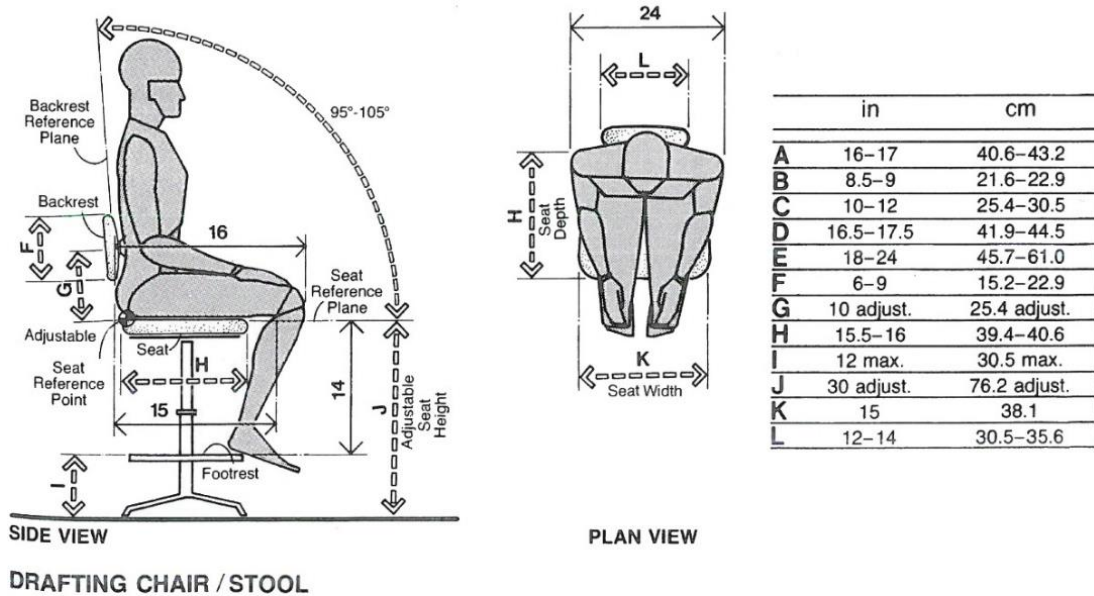
The very familiar design studio's seats, can be clearly observed as stool or chair seats, commonly known as a 'drafting seats'.

According to Merriam-Webster's Dictionary a tabouret is a cylindrical seat or stool without arms or back; OXFORD Dictionaries stated that the tabouret (the stool) originally came out in Mid-17th century: from French, stool, diminutive of tabour drum, which refers to a circular shape of the drum. The stool is a seat that comes with three or four feet, they are considered to be the oldest seats that were designed at the Egyptian era.



Alongside, the stool was considered to be the luxurious furniture for most of the first eras, and it is still presented till the current days

Ideally, worldwide architecture and design schools and institutions are providing design studios classrooms with stools with different features, and some are keeping on the basic method of the drafting stools. Fig.5.1. shows the drafting chair/stool standard anthropometrical dimensions.

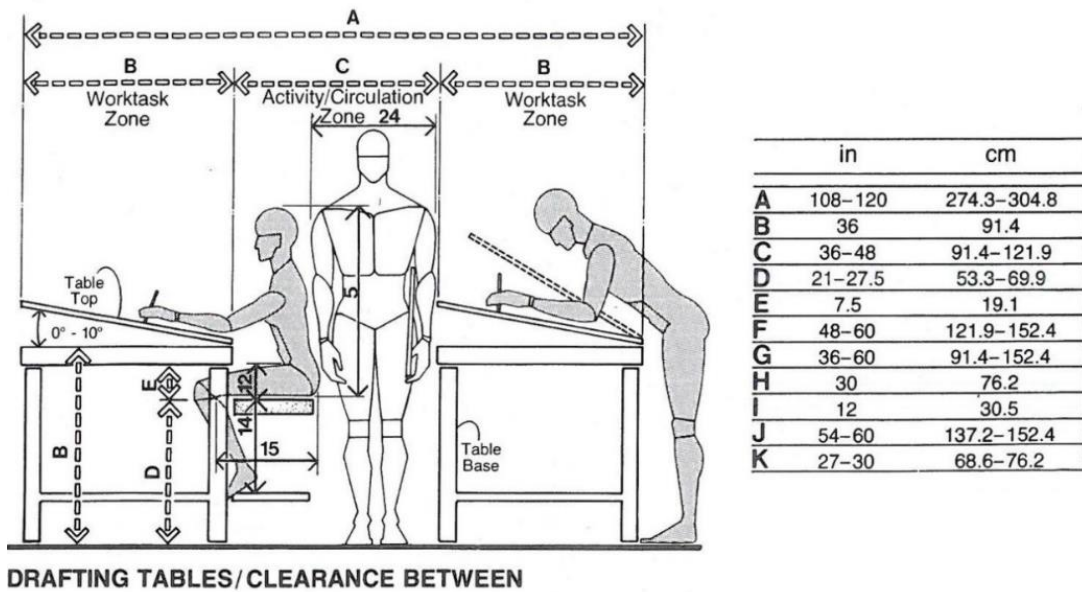


**Figure 5.1.** The drafting chair/stool standard anthropometrical dimensions.  
**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space.

The drafting seat, generally is not comfortable, but the concept of using the drafting seats in design studio classrooms, is to allow the student's easy movements, also its mobility engaged to its light weight, which can facilitate in converting the design studio classrooms arrangement into a multi-propose educational area in different courses disciplines.

Not only drafting seats are to be discussed, also the design studio drafting tables are engaged to drafting stools, in which the performed work is usually connects the function of the drafting table and the drafting stool together to obtain manual drafting or drawing.

The bond between the drafting table and the drafting stool presents when the provider or the educational organizations that are choosing and picking the design studio classroom's furniture are taking inconsideration the proper standard dimensions in furniture design that are to be involved to the given classroom interior area. This consideration plays a big role in the stool's and the drafting table features. See fig.5.2.



**Figure 5.2.** The drafting Table clearance between the passive and active activity zones.

**Reference:** Panero, J., & Zelnik, M. (1979). Human dimension & interior space.

However, not all of the educational institutions make the right decisions in selecting the correct furniture for the design studio classrooms, which may be considered as a decline to the classroom environment physical elements, and the student's health care in the design studio. Moreover, a decline is always to be obtained by the design studio students, through experiencing discomfort, lack in flexibility and back pains when performing a drafting activity with the provided stools and tables, where the stool height and the table height may differ and leads to students awkward sitting postures that absolutely effects their mental and physical health in the design studio. Hence, furniture in the design studio are all related to provide students with a functional, healthy, comfortable and enjoyable educational environment. Fig.5.2. shows the drafting Table clearance between the passive and active activity zones.

The design, manufacture and supply of educational furniture poses a series of interrelated problems: functional, aesthetic, industrial, economic, financial, management and administrative. Thus, the educational furniture project should be planned carefully (UNESCO, 2000), following the process recommended in the international standard publications, and researches.

## **5.2 Design Studio Seat's Analysis Based on Observations from Some of the Very First to The Current Design Institutions and workshops**

As the the aim of this research is to evaluate today's design studio's seating elements on the creativity and the productivity of the students, a decesion of a historical overview from the past design studios and workshops undertake in this part of the research.

This part of the litrature review, the reached information below are shared in historical order, The data obtained from the archived and photographed visual materials by :

- University of Illinois Archives;
- Rhode Island School of Design (RISD) archives;
- MOMA Publishing, 2009;
- Centre d'archives de l'IFA;
- Photo by Carl M. Mydans 1936;
- Courtesy of Cranbrook Archives;
- The Harvard University Archives;
- Ralph Crane photography /The LIFE Images Collection/Getty Images);
- Architectural Press Archive / Royal Institute of British Architects Library Photographs Collection;
- The University of Sheffield, ArtsTower50Brochure;
- Georgia Tech School of Industrial Design, webpage: History;
- metaformdesign.com;
- Nathan Umstead Photography;
- Photo Courtesy of Maysam AZZAM;
- Photo Courtesy of Dr. Saleh RIFAI;

NOTE: All the data obtained in this part of the research are only visual contents and the evaluations related to seating elements in the images are analyzed by the authour of the current thesis work.

- Observations and Analysis from Late 1880's

- Illinois University -1888



**Figure 5.3.** Illinois University Architectural Drafting Room, University Hall, 1888.

**Reference:** [https://archives.library.illinois.edu/archon/packages/digitalibrary/files/543/pl\\_0000165.jpg](https://archives.library.illinois.edu/archon/packages/digitalibrary/files/543/pl_0000165.jpg)

- **Place** : Illinois University, Architectural Drafting Room. University Hall.
- **Date** : 1888.
- **Archive** : University of Illinois Archives.
- **Seat Type (1)** : Chair.
- **Seat Type (2)** : Stool.
- **Form** : Cultural
- **Materials** : Wood.
- **Use** : Drafting (educational).

- **General Analysis:**

The obtained seats in the drafting room at Illinois University back in 1888 shows two types of seats in the architectural design studio. The found seats are both wooden, the chair seat size is recognized to be normal, it has a backrest but it has a total absence to some anthropometrical aspects like seat height and backrest adjustability features, armrest, cushioning, and a footrest. While the stool seat is noticeably exceeded high in its elevation, and it has a footrest, on the other hand the stool seat in this design studio didn't show the following anthropometrical aspects: seat's height adjustability, backrest, armrest, seat cushioning which may be a root of the seater's discomfort.

## -Observation and Analysis from 1910s

- Rhode Island School of Design (RISD)-1905.



**Figure 5.4.** *RISD, 1905 students are drafting.*

**Reference:** <http://architecture.risd.edu/wp-content/uploads/2012/12/1905.jpg>

- **Place** : Rhode Island School of Design
- **Date** : 1905
- **Archive** : Rhode Island School of Design (RISD) archives
- **Seat Type** : Stool
- **Form** : Bios
- **Materials** : --
- **Use** : Drafting (educational).

### - **General Analysis:**

Debating the Design studio (drafting room) at Rhode Island School of Design 1905, The seat type that was used is not obtained in fig. 5.4., but since the image does show a sitting student drafting at the down left corner, the seat used would be a stool, because of the absence of the back-rest and the small space of the design studio. The seat's height, we can analyze, is probably average. Material or other seat-features cannot be discussed based on the existing image.

## -Observation and Analysis from 1920s

- **ADGB Trade Union School-1919.**



**Figure 5.5.** *ADGB Trade Union School, Bernau - Barry Bergoll, Leah Dickerman, Bauhaus 1919: Workshops for Modernity, published by MOMA, 2009*

**Reference:** <http://www.oris.hr/files/g/1-1169/540x360-9/novo.jpg>

- **Place** : ADGB Trade Union School.
- **Date** : 1919
- **Archive** : MOMA Publishing, 2009.
- **Seat Type** : Chair.
- **Form** : Aesthetic + Novelty.
- **Materials** : Not recognized.
- **Use** : Drafting (educational).

### - **General Analysis:**

The ADGB Trade Union School's seat is aesthetically designed. The seat's height looks to be not engaged with the workspace height. The obtained chair comes with a backrest, with a total absence to obtain whether the seat's height or the seat's backrest adjustability feature. Nevertheless, the below chair doesn't have any armrest or footrest and the used materials are not clear and not to be analyzed.

## -Observations and Analysis from 1930s

- **P. Bigot (School of Fine Arts of Paris)-1933.**



**Figure 5.6.** *P. Bigot (School of Fine Arts of Paris): interior view of the studio, 1933.*

**Reference:** <http://archiwebture.citechailot.fr/img/filigrane/BIG/BIG-A-6/PB-PHO-091-01-12.jpg>

- **Place** : P. Bigot (School of Fine Arts of Paris).
- **Date** : 1933
- **Archive** : Centre d'archives de l'IFA.
- **Seat Type** : Stool
- **Form** : Bios
- **Materials** : --
- **Use** : Drafting (educational).
  
- **General Analysis:**

At the P. Bigot, School of Fine Arts of Paris, shows the students standing tall while drafting with no observation of any existing type of seats, which leaves us with the question of why they are drafting while standing and not using any type of seats like chairs or stools, and the other question of the workspace health-care.

- U.S. Resettlement administration. Architects' drafting room-1936.



**Figure 5.7.** Washington, D.C. Feb. 1936. Architects' drafting room, U.S. Resettlement administration. Photo by Carl M. Mydans.

**Reference:** <http://www.columbia.edu/cu/gsap/projs/call-it-home/html/images/18-21.gif>

- **Place** : P. Bigot (School of Fine Arts of Paris).
- **Date** : 1933
- **Archive** : Photo by Carl M. Mydans 1936; Columbia University's website.
- **Seat Type** : Stool
- **Form** : Bios
- **Materials** : Wood.
- **Use** : Drafting (educational).

- **General Analysis:**

The drafting room is known as a design studio in the mean days, fig. 5.7. shows Washington, D.C. Feb. 1936. In the Architect's drafting room, there aren't tow obtained seats, but stool seats, a basic stool, and a stool with a curved back-rest, both are made of a metal base and a wooden seat. With the same function as a drafting stool, the stool with the back-rest is probably used by the chiefs to give them the image of control, or to allow them to lead the drafters at the workshop.



## -Observations and Analysis from 1940s

- **Cranbrook University-1940.**



**Figure 5.8.** *View of the design department with students, 1940* Courtesy of Cranbrook Archives.

**Reference:** <http://cranbrookart.edu/wp-content/uploads/2013/09/1.Cranbrook-Academy-of-Art-Design-Department.jpg>

- **Place** : Cranbrook University.
- **Date** : 1940
- **Archive** : Courtesy of Cranbrook Archives.
- **Seat Type** : Stool + Chair.
- **Form** : Bios.
- **Materials** : Wood.
- **Use** : Drafting (educational).

- **General Analysis:**

The image below shows the design department at Cranbrook, featuring in the center Charles Eames crouching on floor. This design studio photo observation, can show two types of drafting seats. The first seat is a basic designed classic wooden stool, with four feet and three layers of feet joints and a seat. The second seat type can be observed on the middle table; only the backrest can be noticed with a round wooden shape.

- **The Harvard Graduate School of Design-1946.**



**Figure 5.9.** *Architecture class in Robinson Hall, The Harvard Graduate School of Design, 1946.*

**Reference:** [http://static.hwpi.harvard.edu/files/styles/os\\_files\\_large/public/future-campus/files/gsd\\_0.jpg?m=1429798563&itok=fw3AYu1d](http://static.hwpi.harvard.edu/files/styles/os_files_large/public/future-campus/files/gsd_0.jpg?m=1429798563&itok=fw3AYu1d)

- **Place** : The Harvard Graduate School of Design.
  - **Date** : 1946
  - **Archive** : The Harvard University Archives.
  - **Seat Type** : Stool.
  - **Form** : Bios.
  - **Materials** : Wood.
  - **Use** : Drafting (educational).
- **General Analysis:**

The Harvard School of design brought architecture, landscape, and urban design studies all together. As we can observe from the available photo, the architecture class (design studio) in Harvard Graduate School of Design in 1946, we can notice that most of the students are sitting while drafting, and just one seat model is obtained on the right side of the figure, the existing seat is a drafting stool, usually used by architects and-or designers to facilitates their movement. It is high in length with a basic stool shape of a round seat and 4 legs with joints, made to ease the student's needs while drafting. As we can see the stool is made from hard wood, and takes the classical shape.

-Observation and Analysis from 1950s

- The canvas-roofed design studio of Taliesin West.



**Figure 5.10.** *Wright supervises apprentices in the canvas-roofed design studio of Taliesin West seen here during the late 1950s.*

**Reference:** <http://www.gettyimages.fr/license/50862873>

- **Place** : The Canvas-Roofed Design Studio.
- **Date** : 1950s
- **Archive** : Ralph Crane photography (The LIFE Images Collection/Getty Images).
- **Seat Type** : Stool
- **Form** : Bios
- **Materials** : Wood.
- **Use** : Drafting (educational).
  
- **General Analysis:**

The canvas-roofed design studio of Taliesin West seen here during the late 1940s, we can analyze the seat type featured in the image above , in the middle of the image, the seat type obtained is used as a drafting seat, comes in a small bench seat. It is low in height, with a flat wood plate large in width, and a four-legged seat-plate holder.

## -Observation and Analysis from 1960s

- University of Strathclyde 1967.



**Figure 5.11.** *University of Strathclyde - the school of architecture's purpose built home (1967).*

**Reference:** <https://www.architecture.com/image-library/RIBApix/gallery-product/poster/school-of-architecture-university-of-strathclyde-glasgow-the-studio/posterid/RIBA81625.html>

- **Place** : University of Strathclyde.
- **Date** : 1967
- **Archive** : Architectural Press Archive (Royal Institute of British Architects Library Photographs Collection).
- **Seat Type** : Stool
- **Form** : Aesthetic-Novilty.
- **Materials** : Metal – Plastic and some unrecognized materials.
- **Use** : Drafting (educational).
  
- **General Analysis:**

Analyzing the design studio of the school of architecture built home at the University of Strathclyde 1967, the studio looks aesthetically improved from the studio's first introduction, the obtained seat in the right down corner of the image presents a stool, with average height relative to the height of the drafting table. It is for sure aesthetically designed, the stool as it obtained on the sitting drafter on the left side, the stool comes with a low back-rest. The existing stool is constructed of metal and with molded plastics or plywood. We can predict that the stool in this studio would have an applicable height modification, due to the industrial era that was produced in.

**-Observation and Analysis from 1970s**

- **The University of Sheffield-1970s.**



**Figure 5.12.** *The school of architecture's studios in the Arts Tower, The University of Sheffield in the 1970s/ArtsTower50Brochure.*

**Reference:** [https://www.sheffield.ac.uk/polopoly\\_fs/1.570122!/file/ArtsTower50Brochure.pdf](https://www.sheffield.ac.uk/polopoly_fs/1.570122!/file/ArtsTower50Brochure.pdf)

- **Place** : The University of Sheffield.
- **Date** : 1970s.
- **Archive** : The University of Sheffield, ArtsTower50Brochure.
- **Seat Type** : Stool/Chair.
- **Form** : Bios
- **Materials** : Metal/Plastic.
- **Use** : Drafting (educational).

- **General Analysis:**

From this following archived photo, we can barely notice the seat, because of the dark shades of the photo, hence the seat type observed in the school or architecture in the Arts Tower cannot to be defined; whether it is a stool with a backrest or a chair. Yet, we can notice that the seat has a back-support and a good/satisfying sitting surface. The materials used for structuring this seat may be either Metal or Plastic.

## -Observation and Analysis from 1980s

- **Georgia Tech School of Industrial Design-1980s.**



**Figure: 5.13.** *Georgia Tech's Department of Architecture Design Studio, 1980s.*

**Reference:** <https://id.gatech.edu/sites/default/files/images/top.history.jpg>

- **Place** : Georgia Tech University.
- **Date** : 1980s.
- **Archive** : Georgia Tech School of Industrial Design, webpage: History.
- **Seat Type** : Stool
- **Form** : Bios
- **Materials** : Wood + Metal.
- **Use** : Drafting (educational).
  
- **General Analysis:**

In 1940, Georgia Tech. University, Department of Architecture, started offering classes of Industrial Design as one of the first public universities in the United States of America. Reviewing the obtained figure above shows the industrial design studio of Georgia Tech, the seat type that is used is clearly a stool with visible height; it is not aesthetically designed, made of a round wooden plate and four metal-tube legs with joints; using a very basic drafting stool design.

**-Observation and Analysis from 1990s**

- **San Jose State University-1995.**



**Figure 5.14.** *Metaform's David Shaw Guest Lectures at San Jose State University  
March 2, 1995.*

**Reference:**[http://static.wixstatic.com/media/6a71e9\\_a3b92ae73875489ebfedd79e53f7edf3.jpg\\_srz\\_450\\_599\\_85\\_22\\_0.50\\_1.20\\_0.00\\_jpg\\_srz](http://static.wixstatic.com/media/6a71e9_a3b92ae73875489ebfedd79e53f7edf3.jpg_srz_450_599_85_22_0.50_1.20_0.00_jpg_srz)

- **Place** : San Jose State University.
- **Date** : 1995.
- **Archive** : metaformdesign.com.
- **Seat Type** : Stool.
- **Form** : Bios.
- **Materials** : Metal.
- **Use** : Drafting (educational).

- **General Analysis:**

Analyzing the available seat shown in the figure above, we can observe that the seat type used in this design studio classroom at San Jose State University, is a metallic drafting stool with a thin solid sitting surface; it is with four feet and a footrest joining them. Aesthetically it is considered as a classic stool design, and it may cause a sitting discomfort due to its solid sitting surface.

-Observation and Analysis from 2000s

- **Taubman College of Architecture and Urban Planning-2007.**



**Figure 5.15.** *Taubman College of Architecture and Urban Planning;*  
*Photographed by Nathan Umstead Nov. 5, 2007.*

**Reference:** [http://thinklab.typepad.com/think\\_lab/images/2008/03/07/designstudio.jpg](http://thinklab.typepad.com/think_lab/images/2008/03/07/designstudio.jpg)

- **Place** : Taubman College of Architecture and Urban Planning.
- **Date** : 2007.
- **Archive** : Nathan Umstead Photography.
- **Seat Type** : Stool.
- **Form** : Aesthetic + Novelty.
- **Materials** : Wood + Metal.
- **Use** : Drafting (educational).

- **General Analysis:**

The Taubman Collage of Architecture and Urban Planning design studio. Observing the seat type provided in this studio, we can notice a high drafting stool, aesthetically designed of metal and wood. It has a good wooden sitting surface with a back-support and foot rest. Noticeably, the seat height is relevant with the working surface height; and may allow the easy reach of the working tools.



## -Observations and Analysis from 2010s

- American University of Beirut, Lebanon-2015.
- Université Libanaise, Lebanon-2015.



**Figure 5.16.** American University of Beirut,  
Department of Architecture and Design.  
**Photo Courtesy:** Maysam AZZAM, 2015  
Seat Type (1)



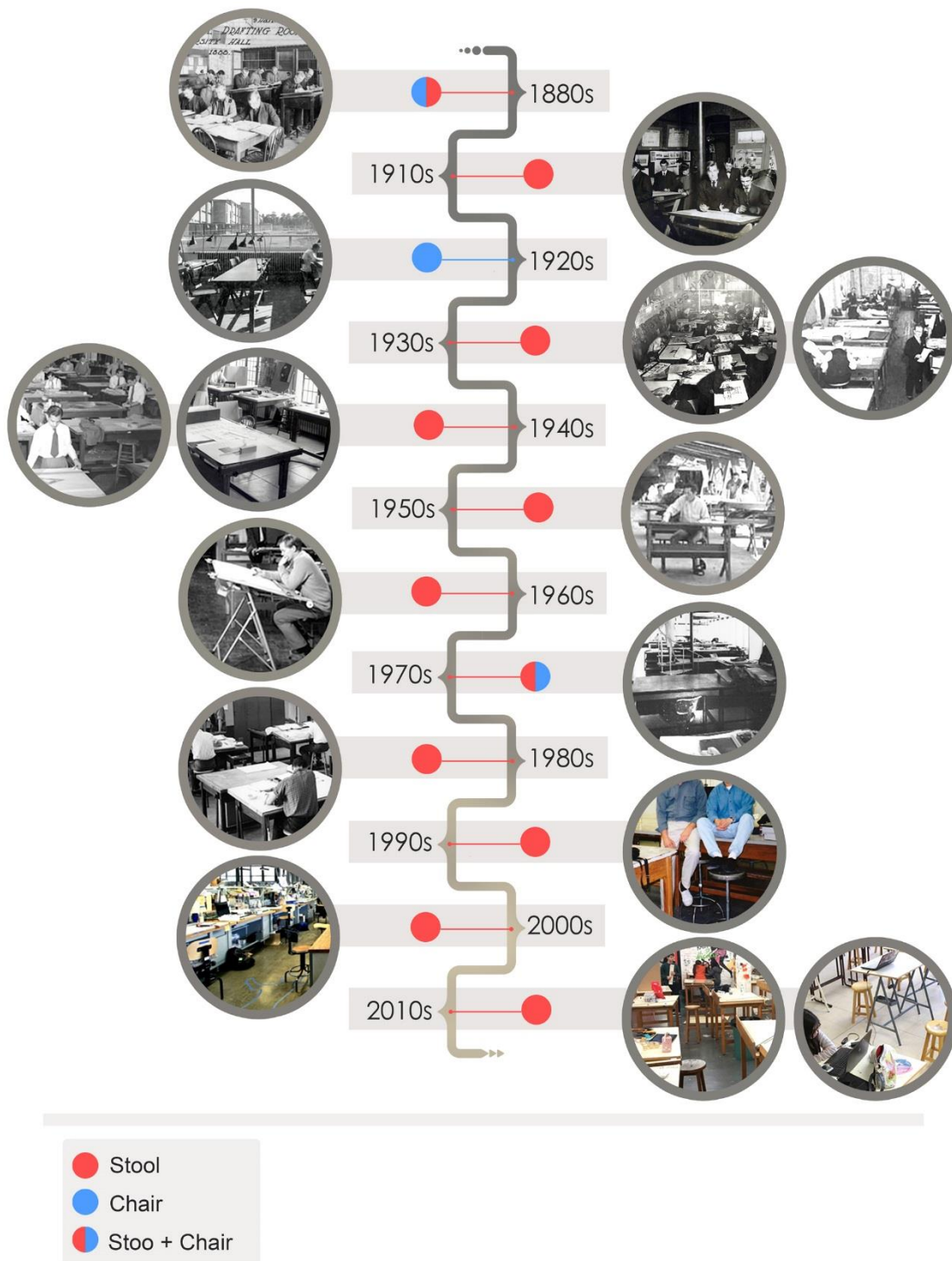
**Figure 5.17.** Université Libanaise,  
Institut des Beaux-Arts-01  
Department of Interior Architecture.  
**Photo Courtesy:** Dr. Saleh RIFAI 2015  
Seat Type (2)

- **Place** : American University of Beirut and The Lebanese University.
- **Date** : 2015.
- **Archive** : Photos courtesy by: Maysam Azzam (AUB) - Dr.Saleh RIFAI (UL).
- **Seat Type** : Stool.
- **Form** : Bios.
- **Materials** : Wood.
- **Use** : Drafting (educational).
  
- **General Analysis:**

Figure 5.16. / 5.17., shows two of the best schools of architecture and interior architecture design studios. Both of American University of Beirut and Université Libanaise design studio have almost the same seat type, both schools provide design studios with classic wooden drafting stools, with a solid and small sitting surface, with four feet and a height relative to the drafting table's height.

### **5.2.1 General evaluation of the previous observed and analyzed design studio seat's from late 1888 to 2015**

Because the aim of the research is to evaluate today's seating elements effects on the student's creativity and productivity in the design studio, with this evolutionary observation and analysis of the design studio's seating elements from a variety of design Institutions and workshops from around the world and across time, we can agree that the concept of providing the design studios with the same type of seat types was noticeably unchanged with time. In the previous figures, the drafting stool has been well observed as the main seating element in the design studios, it came in different classic designs and basic materials, very few came with back-support and footrests, with a total absence of armrests and height or backrest adjustability. The drafting stool is considered to be the essential seat type in the design studio, with no cited or mentioned data considering the used drafting stool as the best seat type or element to meet the requirements and needs of furnishing the design studio classroom. See figure 5.18.



**Figure 5.18.** *Evolutionary observation and analysis of the design studio's seating elements from variety of design institutions and workshops from around the world and across time.*

### 5.3 Student's Creative Performance in the Design Studio and Sitting

The term "creativity" is derived from the word create, which is the process of finding new ideas, tools, innovation, etc. Creativity is to go elsewhere with your mind, it is the use of the imagination to create something new, or to find problems that are hidden from other's sight. Creativity is an energy that is bigger than you, that finds its way within you, and comes through you. The creative process is a task that ends with new findings. Creativity is finding the answers of the questions we always ask: Why? Who? When? Etc. Creativity is revolutionary.

Design is a complicated and many-sided problem-solving task that requires "so many intangible elements, such as intuition, imagination, and creativity" (see fig. 5.19.). Hence, understanding the cognitive processes of the human mind is necessary to further learn about design thinking processes. Cognitive studies are also significant in the research about design studio. (Zeisel, 2006). (Nazidizaji, Tomé, & Regateiro, 2015)



**Figure. 5.19.** *Students working in the design studio.*

**Reference:** <http://www.designinsiderlive.com/boss-design-group-student-competition/>

In a design studio course, creativity is defined as the capability of the design students to solve problems, and to end up with new concepts, ideas and to find a way to execute and present those he/she came up with. In the design studio course, the student's creativity is understood as the sum of the creative ideas and findings that he or she found and have been evaluated by the experts (instructors). Design student's creative performance involves his/her ability to produce several original and new solutions for the given project problem. Yet both academic performance and creative behavior respond well to good hard work (Runco, 2014).

Design studio pedagogy issues are being raised, and the ideal design studio environment is still debated by researchers, where many industrial and organizational researches on creativity, concluded that the physical environment influences creative thinking. It is unfortunate that environmental influences on creativity were not fully appreciated in the social validation research just reviewed. This is because a great deal can be done within the classroom setting to encourage the creativity of students. In fact, some of the earliest empirical research on divergent thinking confirmed that the environment plays a critical role. Unless it is permissive and supportive, creative skills will remain hidden (Runco, 2014).

Yet, psychological and physical environmental elements play a big role in the student's activity inside the design studio classroom. In creative process, it is good for the designer to be relaxed, in a good mood... Good brainstorming and unusual, creative thinking require the relaxed state induced by positive affect (Norman, 2004). In general, when a user is not fully satisfied with a specific environment, physically or psychologically, he/she tends to search for the proper conditions (Lang, 1974) Performance in school depends on various factors, but they can be grouped in following three categories: "student characteristics, teacher impact and school properties" (Aleksandra Gajda, n.d.).

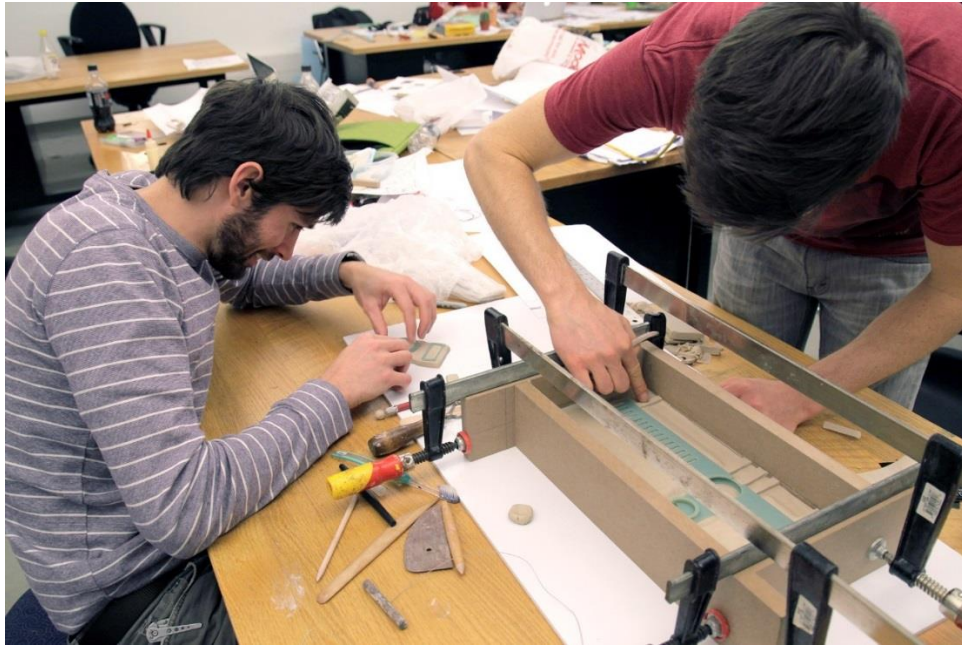
Thus, students in the design studio are noticeably spending more than 6 hours daily performing and working on their projects, yet, with what we mentioned in the previous chapter, that prolonged sitting risks the human and causes stress. Like so much in the health and creativity literature, it seems that stress and creativity have a complicated relationship, although there are conflicting views (Runco, 2014). Nevertheless, prolonged working in an awkward sitting posture in the design studio classroom also increases the risk of anxiety. Anxiety certainly can influence creative thinking and creative performance (Runco, 2014). It is tricky to design things that must accommodate both creative thinking and focus (Norman, 2004).

#### **5.4 Student's Productivity in the Design Studio and Sitting**

Productivity is derived from the verb 'Produce', to create; Merriam-Webster's Dictionary defines Productivity as the quality or state of being productive (having the quality or power of producing especially in abundance. Productivity has presented one of the most indistinct and puzzling phenomena for linguistic research over the decades (Jóhanna Barðdal, 2008). Figure 5.20.

In a discussion; questioning a formal architecture student, from Lebanon, the students answered the question of what do you feel when you are sitting on a drafting stool and working on your project in the design studio? his answer was:

*"I feel that the drafting stool is catching my whole body and tying me to it, I feel it even that I loving the project that am working on. I feel that I just want to finish working whatever I did. I always think that this feeling is effecting my productivity, I feel I could've done better, but this feeling leads me just working to finish the project no matter what I will generate and create. It is not satisfying my body's physical and psychological state of comfort".*



**Figure 5.20.** *Students Preparing a Product Model in the Design Studio.*

**Reference:** <https://design.ncsu.edu/human-centered-design-studios>

Hence, with the large range of individual, cultural, and physical differences among the people of the world, it is impossible for a single product to satisfy everyone. The only way to satisfy a wide variety of needs and preferences is to have a wide variety of products(Norman, 2004).

Talking about the design student's productivity seriously, it means looking at their classwork time and what they ended up with. We might ask questions about how to increase the quality of the design student's productivity. Before, let's ask ourselves what does effects the design student's productive performance at the design studio?

Academic productivity in the design studio is affected by a number of basic factors. The Factors affecting the design student's individual productivity may be measured by the student's acquired design and technology knowledge, project's size and creativity, and design studio classroom working physical environment. Design student's productivity could be either quantitative or qualitative.

Student's academic quantitative productivity in the design studio could be measured by the number of ideas, creation or concepts that he or she ended up with, while their academic qualitative productivity could be measuredwith the value and the originality of the ideas, and the work he or she came up with to the project's final submission.

Unfortunately, the problem in measuring design student's academic productivity in the design studio course mostly rely on the amount of submitted and generated solid designs within a start-end tasks. Hence, providing projects with a deadline for submission may affect the student's delivered design quality features, such as original creation, functionality, and mechanism.

Working on number of projects with different givens and disciplines; *as it is discussed in the previous chapter*; awkward prolonged sitting while working develops stress for the design students. Stress while working on original ideas in the design studio is always complained by most of the students. Most often, students face pressuring deadlines, increasing workloads, and new responsibilities. These circumstances are categorized as challenge stressors, or high-pressure situations (Eagan & Garvey, 2015). Stress can have a major consequence for the student's productivity. Stress while working in the design studio classroom appears to be a growing issue, it is the result of any emotional, physical, ... or other factors that require a response or change (Adaramola, 2012).

Managing stress in the design studio is the best solution to prevent the decrease in the student's productivity. There are three major approaches that can be used to manage stress:

Managing stress has three major approaches: Stress managing may be in finding the problem, taking actions and trying to solve it; or it could be emotional oriented in which we could do nothing but to collaborate with the stressor roots; and it could be in accepting the source of the stress and tolerate it.

## **5.5 Design Studio's Drafting Seat and Student's Emotional Behavior**

Seats are not animate; they have no brain or feelings. Yet, we collaborate with them. What is going on?

We, humans have tendency to respond emotionally to almost anything, even if it is animate or not. We, as creatures, we have been set to interact with everything, we interact with people, nature, music, arts and so on. Our interaction depends on our understandability of other's or solids responses. For example, automatically we can respond and interact with people's facial expressions effectively. Emotions are readable and can be predicted once we observe other's expressions.

*"Emotional responds are human behaviors".*

Human emotional behavior, interacts with the physical and psychological responses of almost anything or and everything. We may love something or someone, but correspondingly we may hate the way they react to us or interact with us. Our emotional behavior is a "lightning alert" that primes our muscles to take actions, we may love, we may be angry, sad, happy, ...etc. For example, when we are sitting prolonged our physical body posture may alert us when we feel back pain, it alerts us to change our seat or our sitting position. Behavioral design is all about use. Appearance doesn't really matter.

Rationale doesn't matter, performance does. This is the aspect of design that practitioners in the usability community focus upon... What matters here are four components of good behavioral design: function, understandability, usability, and physical feel. Sometimes the feel can be the major rationale behind the product (Norman, 2004).

While using any object, not only its physical factors affects our mood, also its psychological factors may affect our emotional behavior responses to any product we are consuming. Debating the design studio classroom, its physical environments may affect our mood when we are performing a work in it. Its physical area may be categorized in the studio's total interior area, setting and arrangement, lighting, and its furniture. Emotionally, we may be satisfied and or dissatisfied with any physical factors of almost anything or everything.

Although emotions are not a new topic in learning environments, the emerging technologies have changed not only the type of learning environments but also the perspectives of emotions in learning environments(Sarsar,2016). Discussing satisfactory in the design studio classroom, furnishing elements are always criticized by most of the design students; drafting tables and the drafting stools are the most complained physical objects in the design studio workroom. The emotional dissatisfactory in the studio classroom may be developed from by the physical dissatisfaction when the students are performing a drafting work.

The experiences that people have are unique for each individual. If we can access those experiences, we can use them as information and inspiration for designing new products and services. To study these experiences several methods can be applied (Vink, Konijn, Jongejan, & Berger, 2009). And thus, in a discussion between the author and some industrial design students at Anadolu University, Turkey, a student said:

*“our school’s drafting stool design, fails when I lose my capability to perform my drafting work for a long time, I feel back, neck, and shoulders pain. This pain feeling blocks my thinking abilities to perform well... I stress out and I lose my focus on what I am doing... I hate it when I am drafting and I keep changing my body positions between sitting, standing, and flexing while I’m working”. See figure57.*

Another online conversation between the author and a formal design student at Beirut Arab University, Lebanon, brought this discussion:

*-The author: What is the missing feature/s in the drafting stool that you sit on in your school’s design studio?*

*-The Student: (laughing) a well-designed buttock support; it could be a good cushioning method for the seat’s surface. Also, a back-rest that can support my body without being afraid of falling.*

*-The author: Afraid of falling!?! You don’t trust your seat then*

*-The student: Sure, I don’t trust my seat, when I flex and stretch my body when I’m sitting I always get afraid of falling or sliding from the seat.*



In particular, design student's may trust any apparently attractive functional object, they think that those objects will perform according to their expectations and allow them to perform their work tasks well without paying any cost, thus, prolonged sitting may cost the students low physical and mental performance while drafting. Trust is an essential ingredient in cooperative, human interaction(Norman, 2004).

Emotional behavior and product's trust always meets when people, test and experience existing objects, to result a feedback, and allows designers to learn what kind of improvements can be done to meet the user's needs. Yet, Students in the design studio classroom are to trust their physical environment elements, the furniture must meet their needs and expectations in order to be trustable; Trusting design studio's furnishing elements may increase the student's mental and physical academic performance.

## **6 RESEARCH AND SURVEY**

### **6.1 Research Methodology**

First and for that reason, a survey of 20 questions was prepared and answered by the students, after obtaining an oral and written ethical explanation about the purpose of the study, those questions are concerning emotional, physical, and psychological behaviors between the design students and the design studio's drafting seats that they are currently using. It was both, a cross-sectional and evaluation study. In this research study, purposive non-probability sampling method was implemented. This research sampling method gives more emphasis on the criteria of the subjects than their number. After discussion and agreement with the thesis supervisor, 125 students were perceived as a reasonable number for this study. Criteria wise, and for more credibility, subjects were chosen from five different universities in Turkey (Anadolu University; Middle East Technical University; Atilim University; Gazi University; and Istanbul Technical University), of 25 students from each school, from three different studying fields that are engaged in design studio courses and classrooms (Industrial Design; Architecture; and Interior Architecture) in December 26-29 2016.

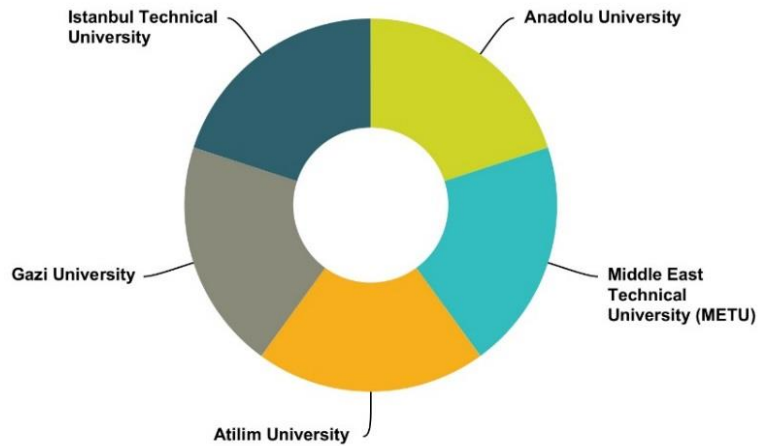
With the implementation of the purposive non-probability sampling method, the studied participants were perceived as well representatives of the population in the design studio course/classroom.

This survey was conducted with a private-paid account by the author on [surveymonkey.com](http://surveymonkey.com), and all the data collected were analyzed by the author's own account on [www.surveymonkey.com](http://www.surveymonkey.com) using descriptive static method. This cross-sectional study was implemented by a digital based survey questionnaire of a total 20 questions, related and involved information on the respondent's, age, gender, current studying year, experience with the provided design studio seating elements in their institutions, general design studio seats and their sitting postures, general health problems in the design studio (physical, mental), anthropometrical aspects of the design studio seats, numbers of hours

the respondent's spends working in or for the design studio course, and their satisfaction of using the provided seats by their educational institutions. Questions pertaining the impact/risks of sitting on the provided seats on their level of comfort, creative performance, and their productivity were also included.

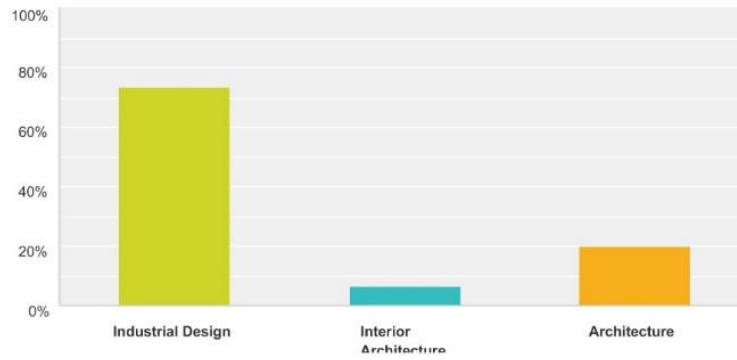
After the survey study, on-site photographed observations were made and the results were evaluated. Hence, measurements of the used 6 different tables and sitting units in the universities were determined and compared with 3 types of standard dimensions from different ethical references.

NOTE: All the analysis and the results of the research are conducted and shared in the part below.



Answer Choices	Responses	
Anadolu University	20.00%	25
Middle East Technical University (METU)	20.00%	25
Atilim University	20.00%	25
Gazi University	20.00%	25
Istanbul Technical University	20.00%	25
Other (please specify)	0.00%	0
<b>Total</b>		<b>125</b>

**Figure 6.1** Survey Participated Universities Statistics.

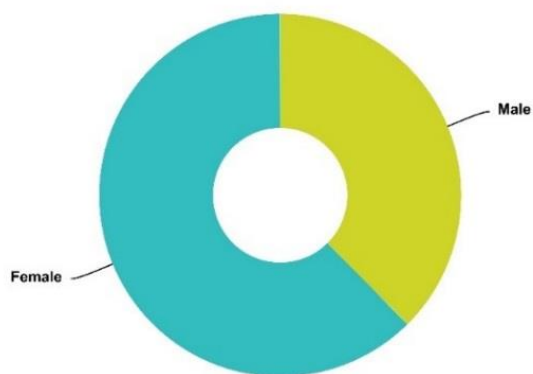


Answer Choices	Responses	Count
Industrial Design	73.60%	92
Interior Architecture	6.40%	8
Architecture	20.00%	25
<b>Total</b>		<b>125</b>

**Figure 6.2.** Survey Participants Studying Fields Statistics.

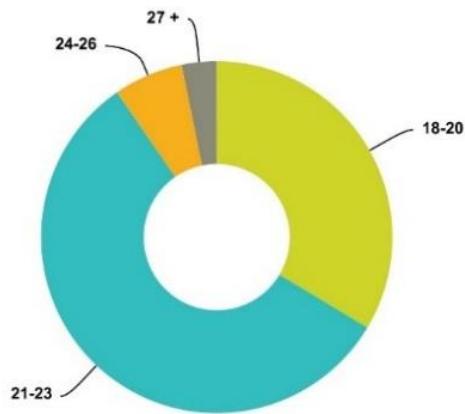
## 6.2 Survey and Participants

After receiving the approval and permeation for conducting the study, 125 pair of 47/male (37.60%) and 78/female (62.40%) see fig, 6.3. between the age of 18-27+ as shown in fig. 6.4. of undergraduate and graduate program design students participated in this survey fig. 6.5. The students were recruited from five official and private educational institutions, three universities in Ankara (Middle East Technical University, Atilim University, and Gazi Univeristy), one university in Istanbul (Istanbul Technical University) and Anadolu University in Eskişehir, Turkey. The digital based survey was written in two languages, English and Turkish concerning the native language in Turkey.



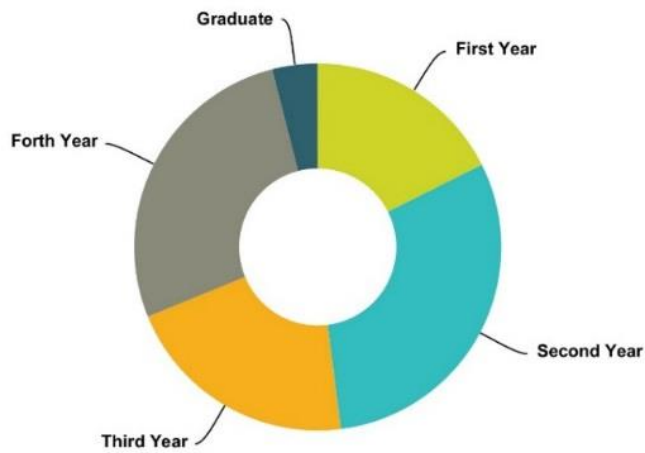
Answer Choices	Responses	Count
Male	37.60%	47
Female	62.40%	78
<b>Total</b>		<b>125</b>

**Figure 6.3.** Survey Participants Gender Statistics.



Answer Choices	Responses	
18-20	33.60%	42
21-23	56.80%	71
24-26	6.40%	8
27 +	3.20%	4
<b>Total</b>		<b>125</b>

**Figure 6.4.** *Survey participants age statistics.*

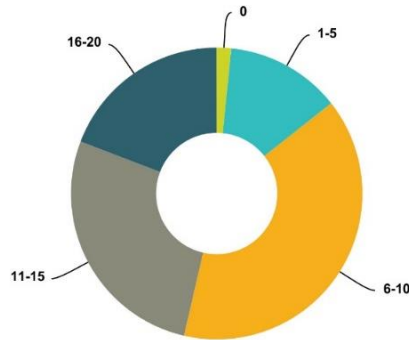


Answer Choices	Responses	
First Year	17.60%	22
Second Year	30.40%	38
Third Year	20.80%	26
Forth Year	27.20%	34
Graduate	4.00%	5
<b>Total</b>		<b>125</b>

**Figure 6.5.** *Survey participant's current academic year statistics.*

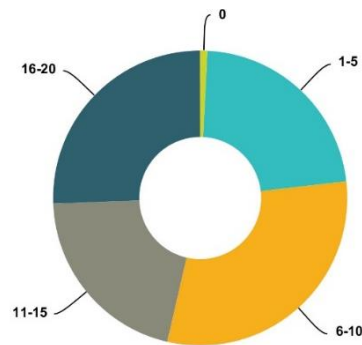
### 6.3 Survey; Statics, Results, and Analysis

The survey resulted 85.6% of the students spend between 6-20 hours weekly working inside the design studio classroom for their projects (see fig. 6.6.), while 46.8% of them spends between 6-20 hours weekly working on their design studio projects outside the deisgn studio course (see fig. 6.7.). As shown in fig. 6.8., significant number of those students of 82.40% are a constant users of the seats they have been provided in the design studio they learn and work in.



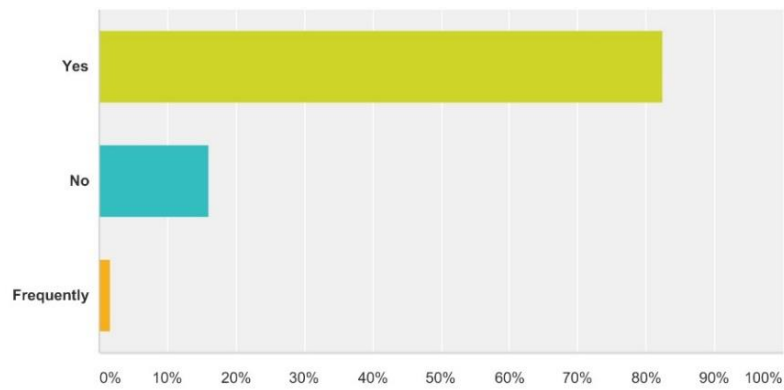
Answer Choices	Responses	
0	1.60%	2
1-5	12.80%	16
6-10	39.20%	49
11-15	27.20%	34
16-20	19.20%	24
Total		125

**Figure 6.6.** Average of working hours inside the design studio classroom by design student's statistics.



Answer Choices	Responses	
0	0.80%	1
1-5	22.40%	28
6-10	30.40%	38
11-15	20.80%	26
16-20	25.60%	32
Total		125

**Figure 6.7.** Average of working hours inside the design studio classroom by design student's statistics.



Answer Choices	Responses	Count
Yes	82.40%	103
No	16.00%	20
Frequently	1.60%	2
<b>Total</b>		<b>125</b>

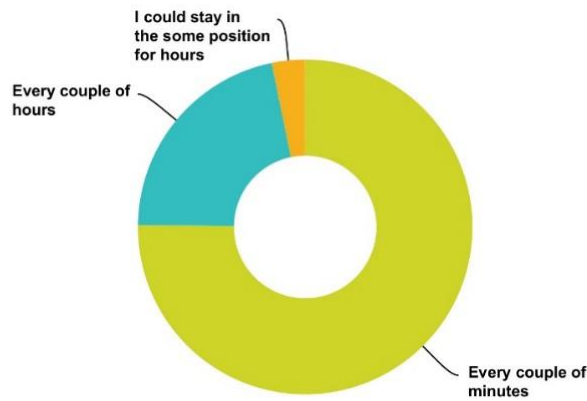
**Figure 6.8.** Average of using the seats inside the design studio classroom by design student's statistics.

While using the seats in the design studio, students showed a high concern level for their physical and mental health, while they considered the seat's aesthetics or quality as moderate concern and this obtained in fig .6.9.



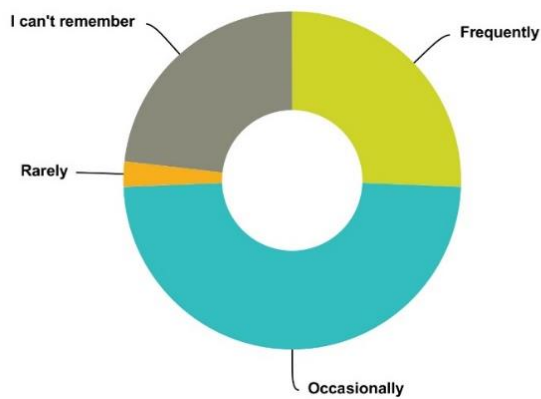
**Figure 6.9.** Average of using concerns in using seats by design student's statistics.

75.20% of the students change their sitting positions every couple of minutes (see fig. 6.10.), 48.80% of the students occasionally, and 25.60% of the students frequently have been ill, injured, or/and had pain caused by their awkward sitting posture on a drafting chair or stool while performing work in the design studio (see fig. 6.11.)



Answer Choices	Responses	
Every couple of minutes	75.20%	94
Every couple of hours	21.60%	27
I could stay in the some position for hours	3.20%	4
<b>Total</b>		<b>125</b>

**Figure 6.10.** Average in changing of student’s sitting positions in the design studio statistic.

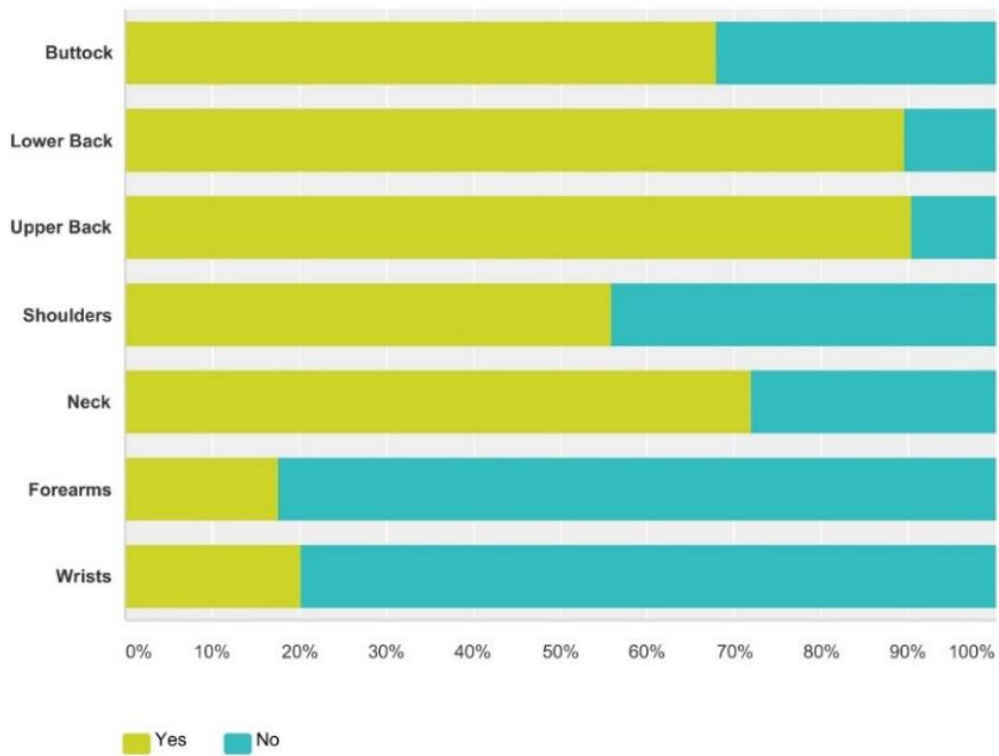


Answer Choices	Responses	
Frequently	25.60%	32
Occasionally	48.80%	61
Rarely	2.40%	3
I can't remember	23.20%	29
<b>Total</b>		<b>125</b>

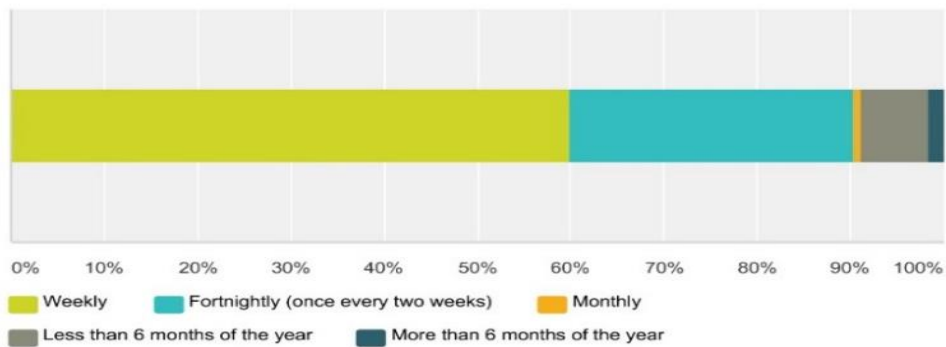
**Figure 6.11.** Average of illness, injuries, or pain caused by student’s awkward sitting posture on a drafting seat, while performing work in the design studio statistics.



When design students prolong sitting on a drafting chair or stool after or/and while working in the design studio, a significant number of them suffer from buttock, lower-back, upper-back, shoulders, neck, and some of them mentioned in their answers thighs pain, fig. 6.12. shows the results. 60.00% of the students are being weekly affected by pain caused by working seated on available seats in the design studio classroom, while 30.40% of them are affected fortnightly (once every two weeks) see fig. 6.13.



**Figure 6.12.** Selected pain points in the student's body when prolong sitting on the provided drafting seat in the design studio statistics.



**Figure 6.13.** Student's pain effects with time caused by working seated in the design studio statistics.

125 subjects rated their level of agreement with the following statements as a drafting chair/stool user (fig. 6.14.). Significantly, design students agreed that the drafting seat height is appropriate for the drafting table height they are using, 43.20% of them declared their ability to support a foot up when sitting in the design studio. Nevertheless, 48.80% of the design students stated that their seats sitting tops don't have padding to reduce their body pressure, and a high agreement level that the drafting items are within easy reach when they are sitting.

From a level of agreement of 5.00, while 1.00 is strongly disagree and 5.00 is considered as strongly agree (liquored scale), the student's level of agreement stated 2.02/5.00 that the available seat in the design studio they are using supports their lower-back, and 1.89/5.00 that the provided seats at the design studio supports their upper-back while sitting. 88.62 of the students declared that the seats don't have armrests, while they had a moderate level of agreement of 2.55/5.00 that their wrists and forearms are in a neutral straight position when drafting seated in the design studio.

As a fact, students rated their level of agreement of 2.76/5.00, agreeing that their seats height can be adjusted to accommodate their height. 2.77/5.00 of the students stated that frequent breaks are provided by the design studio Instructors; nevertheless, on a scale of agreement of 5.00, 2.90/5.00 of the students stretch their bodies hourly when working in the design studio.

3.62/5.00 of the students think that sitting for a long time causes poor mental health, although they are prolong sitting while working, just 2.18/5.00 are being able to maintain proper/comfortable sitting posture while drafting in the design studio classroom, even though 4.04/5.00 stated that they find themselves sitting awkwardly at the design studio classroom.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total	Weighted Average
The drafting seat height I am using is appropriate for the drafting table height	13.60% 17	19.20% 24	26.40% 33	35.20% 44	5.60% 7	125	3.00
I am able to support a foot up when sitting	16.00% 20	27.20% 34	28.00% 35	24.80% 31	4.00% 5	125	2.74
Sharp edges along the seat top have padding to reduce the contact pressure	21.60% 27	27.20% 34	12.80% 16	32.00% 40	6.40% 8	125	2.74
While I am sitting on a drafting chair or a drafting stool, the drafting items within easy reach	8.00% 10	30.40% 38	18.40% 23	32.80% 41	10.40% 13	125	3.07
During drafting, the chair/stool I sit on supports my lower back (lumbar support)	42.40% 53	32.80% 41	9.60% 12	11.20% 14	4.00% 5	125	2.02
During drafting, the chair/stool I sit on supports my upper-back	44.80% 56	33.60% 42	11.20% 14	8.80% 11	1.60% 2	125	1.89
The drafting chair/stool I use have an armrest	53.66% 66	34.96% 43	7.32% 9	2.44% 3	1.63% 2	123	1.63
When drafting and sitting on a chair/stool, my wrist and forearm are in a neutral or straight position	20.00% 25	28.80% 36	28.80% 36	20.80% 26	1.60% 2	125	2.55
The chair/stool I am using in the design studio can be adjusted to accommodate my height	23.20% 29	27.20% 34	15.20% 19	19.20% 24	15.20% 19	125	2.76
Frequent breaks are provided by the design studio Instructors	12.00% 15	29.60% 37	32.80% 41	20.80% 26	4.80% 6	125	2.77
When I am working in the design studio classroom, hourly I stretch my body	12.80% 16	29.60% 37	21.60% 27	26.40% 33	9.60% 12	125	2.90
I think that sitting for a long time causes poor mental health	8.00% 10	8.80% 11	23.20% 29	33.60% 42	26.40% 33	125	3.62
I am able to maintain proper/comfortable sitting posture while drafting in the design studio classroom	23.20% 29	44.00% 55	24.80% 31	8.00% 10	0.00% 0	125	2.18
I find myself sitting awkwardly at the design studio classroom	5.60% 7	1.60% 2	11.20% 14	46.40% 58	35.20% 44	125	4.04

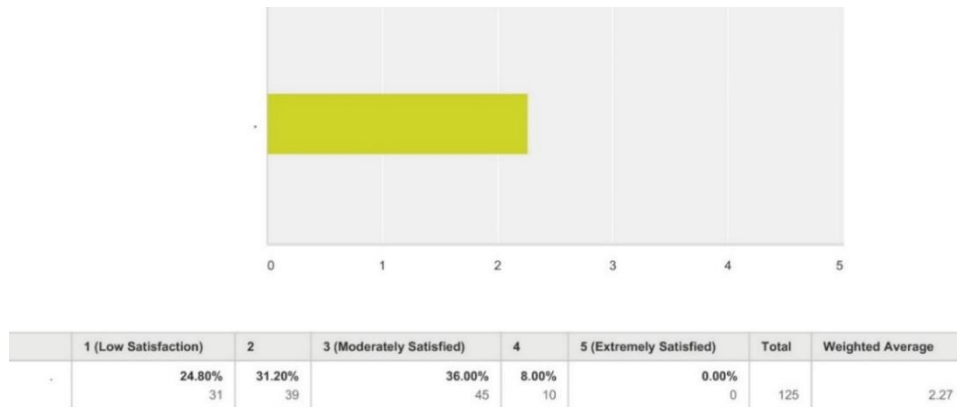
**Figure 6.14.** Rating of Student's level of agreement with the following statements as a drafting seat users in the design studio statistical results.

On a scale of 5.00, 125 design students rated their level of satisfaction with the healthcare aspects of the drafting seat that they are provided and using in the educational institution they are attending, they rated it by 1.98/5.00 (dissatisfaction level), and moderately rated the seats Functionality, design, aesthetics, quality, materials, safety, height, sitting surface size, and durability between 2.42 - 3.18/5.00. See fig. 6.15.

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied	Total	Weighted Average
Health care	0.81% 1	7.32% 9	17.89% 22	36.59% 45	37.40% 46	123	1.98
Function	0.80% 1	17.60% 22	27.20% 34	32.00% 40	22.40% 28	125	2.42
Design	0.80% 1	12.80% 16	36.80% 46	29.60% 37	20.00% 25	125	2.45
Aesthetics	1.60% 2	12.80% 16	40.80% 51	26.40% 33	18.40% 23	125	2.53
Quality	0.81% 1	18.55% 23	45.16% 56	24.19% 30	11.29% 14	124	2.73
Materials	1.60% 2	32.00% 40	32.80% 41	20.80% 26	12.80% 16	125	2.89
Safety	4.00% 5	27.20% 34	35.20% 44	22.40% 28	11.20% 14	125	2.90
Height	3.20% 4	36.80% 46	31.20% 39	17.60% 22	11.20% 14	125	3.03
Sitting Surface size	5.60% 7	40.80% 51	23.20% 29	19.20% 24	11.20% 14	125	3.10
Durability	4.00% 5	40.00% 50	32.80% 41	16.00% 20	7.20% 9	125	3.18

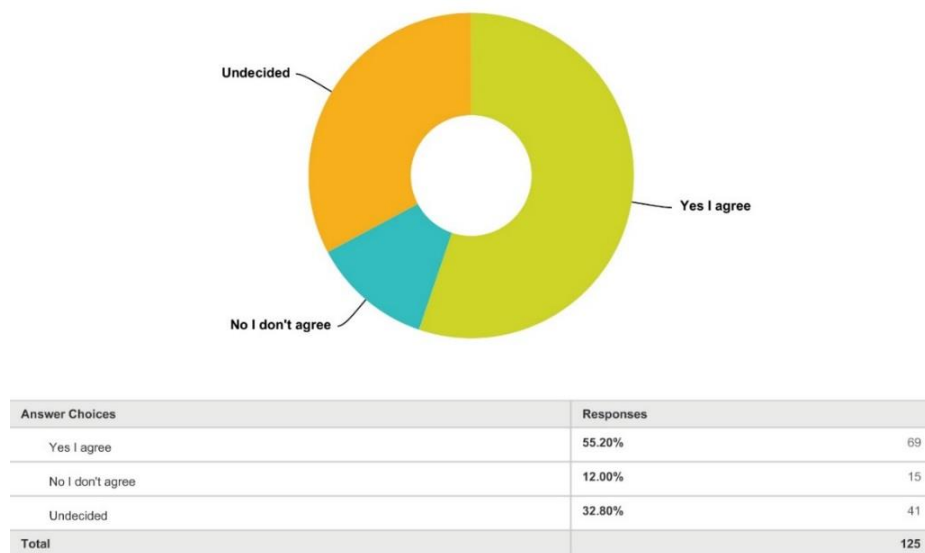
**Figure 6.15.** rating of student's level of satisfaction with some aspects of the drafting seats they are using in the educational institution they are attending statistical results.

Those 125 subjects, rated their satisfaction with the drafting stool that the university provided to them to sit on and use in the design studio by 2.27/5.00, which is considered as a dissatisfactory level and a decline of using the seat from the student's as a user experience. See fig. 6.16.



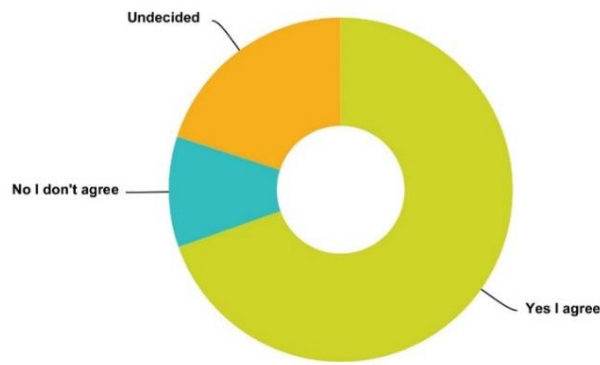
**Figure 6.16.** Student's satisfaction rating with the drafting seat that the University provided them with to sit on and use in the design studio statistics.

55.20% of the design students agreed that using the provided drafting chair or drafting stool by their university risks their mental health, and effects their focus creative performance at the design studio, some students also mentioned that sitting uncomfortably on the provided and available seats decreases their level of focus and Disperses their creative thinking. See fig. 6.17.



**Figure 6.17.** Question: Do you agree that using the provided drafting chair or drafting stool by your university risks your mental health, and effects your creative performance at the design studio statistical result.

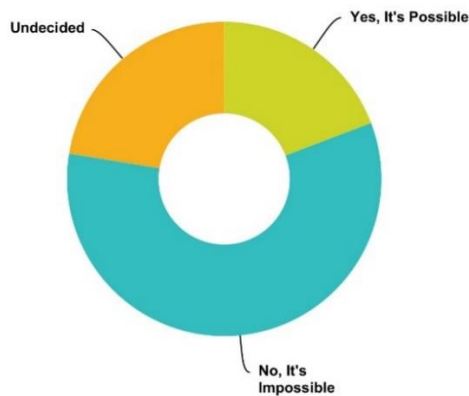
While 69.60% of the students agreed that using the provided drafting seats by their university risks their physical health, and effects their work productivity at the design studio, stating that good physical health is a must to enrich the mental health to result a creative and healthy designing process. See fig. 6.18.



Answer Choices	Responses	
Yes I agree	69.60%	87
No I don't agree	10.40%	13
Undecided	20.00%	25
<b>Total</b>		<b>125</b>

**Figure 6.18.** *Question: Do you agree that using the provided drafting chair or drafting stool by your university risks your physical health, and effects your work productivity at the design studio? statistical result.*

58.40% of the students thinks that it is impossible to perform creatively or productively using the seats that are available in the design studio they learn and work at their design departments. (figure. 6.19.).



Answer Choices	Responses	
Yes, It's Possible	19.20%	24
No, It's Impossible	58.40%	73
Undecided	22.40%	28
<b>Total</b>		<b>125</b>

**Figure 6.19.** *Question: As a design student expected to perform creatively and productively at the design studio, do you think you'll be able to accomplish that while sitting on a drafting chair/stool that have been provided by the educational institute you are attending and you are compelled to use it and may not fit your needs?*

#### 6.4 Design Studio Seats in Some Universities in Turkey; Observations and Analysis (Research).

In order to evaluate the status of some examples of the design studio seating elements, the author had ethical and approved visits, to obtain, photograph and take the dimensions of the existing seats provided by five different official and private universities, from three big cities in Turkey. In this part of the study dimensional measuring criterion was prepared to be implemented to measure the anthropometrical aspects of the seats, this criterion is shown in Table. 6.1.

**Table 6.1.** *Anthropometric measuring criterion for the design studio seat's evolutionary study.*

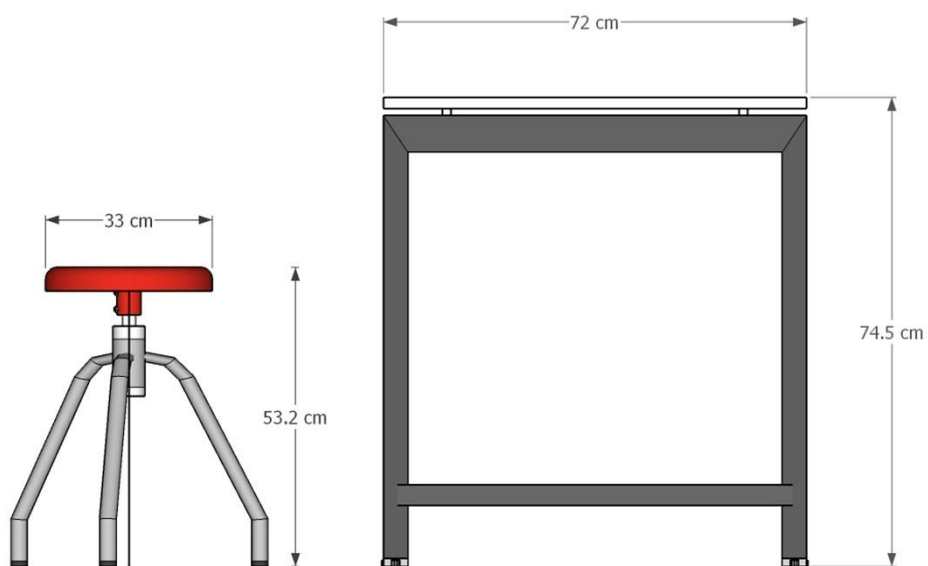
<b>School Name</b>	
Seat Type - Chair	
<b>A</b>	Seat Height
<b>B</b>	Seat Depth
<b>C</b>	Seat Width
<b>D</b>	Adjustable Seat Height
<b>E</b>	Seat's Backrest
<b>F</b>	Adjustable Backrest Angle
<b>G</b>	Seat's Armrest
<b>H</b>	Cushioning Thickness
<b>I</b>	Footrest Height

- **Anadolu University, Eskişehir**

At Anadolu University, at the department of interior architecture, in the design studio we obtained stool seats (see fig. 6.20.) with three metal feet, a thin cushioned seat surface, adjustable seat height, but with a complete absence of armrest, footrest and backrest-support. These seats are new, and were provided by the school in 2015-2016 educational year. The seat's sitting surface is not accurate with the drafting table working surface (see fig. 6.21.) height. Table 6.2. shows the dimensions of the found seat at the design studio.



**Figure 6.20.** *Interior Architecture design studio at Anadolu University, Turkey. 28 December 2016.*

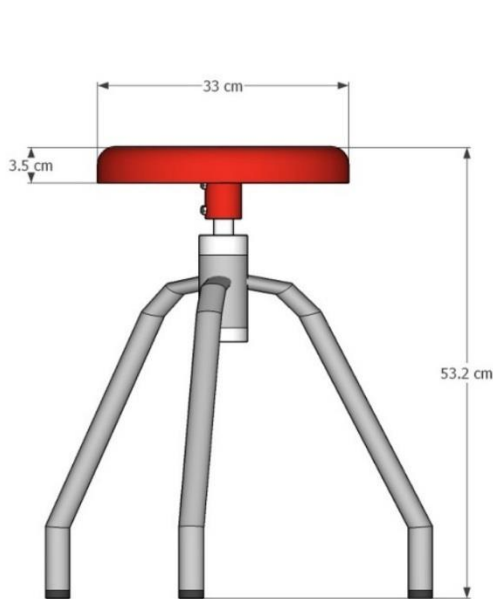


**Figure 6.21.** *Anadolu University, Interior Architecture design studio drafting table and stool's technical drawing with dimensions.*

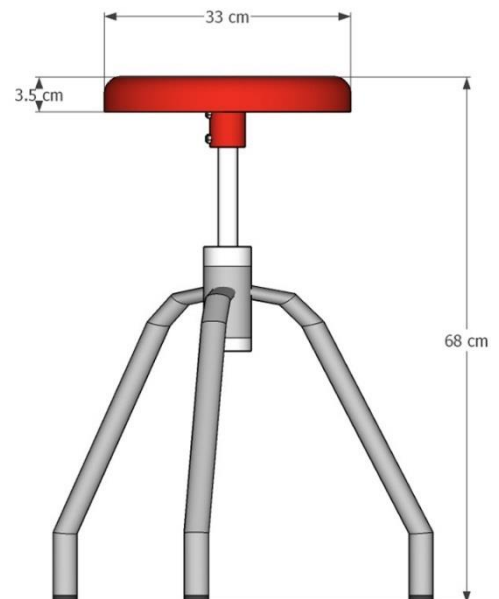


**Table 6.2.** *Anadolu University, Interior Architecture design studio's stool dimensions (Dimensions are in CM)*

<b>Anadolu University</b> Seat Type – Stool seat	
<b>A</b>	53
<b>B</b>	33
<b>C</b>	33
<b>D</b>	68
<b>E</b>	--
<b>F</b>	--
<b>G</b>	--
<b>H</b>	3.5
<b>I</b>	--



**Figure 6.22.** *Anadolu University, Interior Architecture design studio's stool dimensions with minimum adjusted seat height*



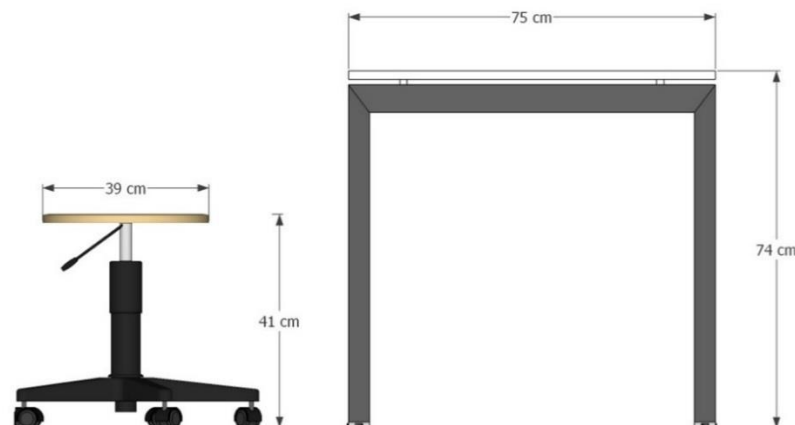
**Figure 6.23.** *Anadolu University, Interior Architecture design studio's stool dimensions with maximum adjusted seat height.*

- **Middle East Technical University, Ankara**

From the author's visit to Middle East Technical University in Ankara, which is known as one of the bests educational institutions of architecture and design in Turkey, the author obtained at the architecture design studio classroom (see fig. 6.24. / 6.25.) a modern designed and wheeled stool seat with the opportunity to adjust its height. The obtained stool's sitting surface was found to be wooden, lightly concaved, and thin; the stool's width is considered to be satisfying. The seat height as we can obtain in fig.6.25. is considered to be not engaged to the drafting surface height. The provided stool seat by METU design entirely ignores the features of any back support, neck support, or and a footrest. Thus, Table 6.3. and fig. 6.26/ 6.27. shows the stool's dimensions at METU.



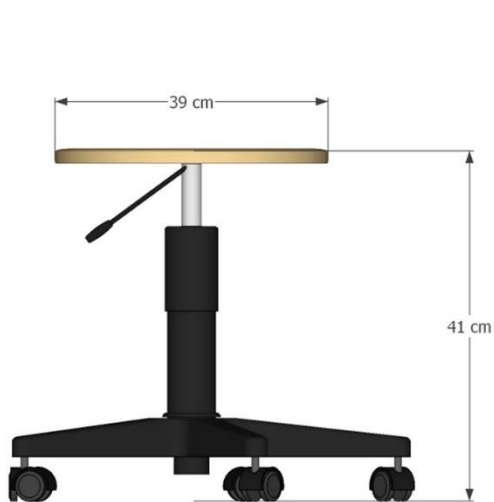
**Figure 6.24.** *students drafting at the architecture design studio at METU, Turkey. 27 December 2016*



**Figure 6.25.** *Middle East Technical University, Architecture design studio drafting table and stool's technical drawing with dimensions.*

**Table 6.3.** METU, Architecture design studio's stool dimensions. (Dimensions are in CM)

Middle East Technical University Seat Type – Stool seat	
<b>A</b>	41
<b>B</b>	39
<b>C</b>	39
<b>D</b>	54
<b>E</b>	--
<b>F</b>	--
<b>G</b>	--
<b>H</b>	--
<b>I</b>	--



**Figure 6.26.** METU, Architecture design studio's stool dimensions with minimum adjusted seat height.



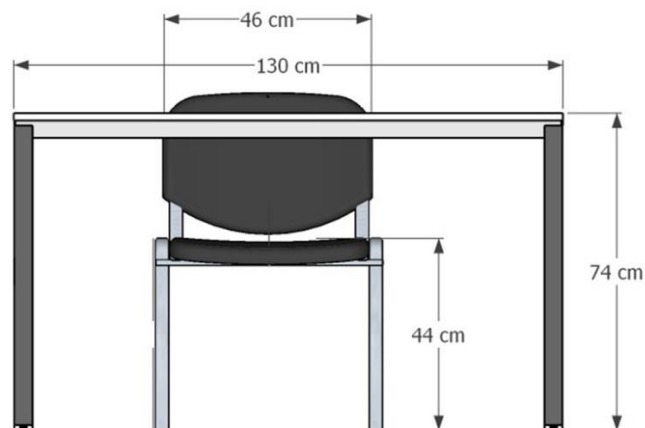
**Figure 6.27.** METU, Architecture design studio's stool dimensions with maximum adjusted seat height.

- **Atilim University, Ankara**

The industrial design department at Atilim University, provided the design studio and the design students with a basic school chair fig. 6.28., the chair is constructed from a metal base with a regular curved seat surface and a back-rest. The provided chair is obtained to be not engaged enough with the drafting table height fig.6.29, while the sitting surface depth is obtained to be wide and may result a disability for easy reach of the drafting tools on the drafting/working surface (see fig. 6.30.). The chair's backrest and the sitting surface are both cushioned to decrease the pressure of the users while sitting. The chair had a complete absence of any armrest, footrest, and or neck support for the users. Table 6.4. shows the chair dimensions of the industrial design studio provided by Atilim University.

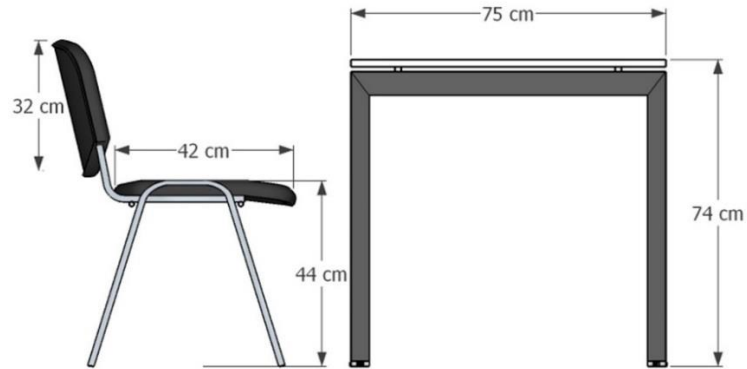


**Figure 6.28.** *The provided drafting table and seat at the industrial design studio at Atilim University, Turkey.*



**Figure 6.29.** *Atilim University, industrial design studio drafting table and chair's*

*drawing with dimensions, 26 December 2016.*



**Figure 6.30.** *Atilim University, industrial design studio drafting table and chair's drawing with dimensions.*

**Table 6.4.** *Atilim University, Interior Architecture design studio's chair dimensions. (Dimensions are in CM)*

**Atilim University**  
Seat Type – Chair seat

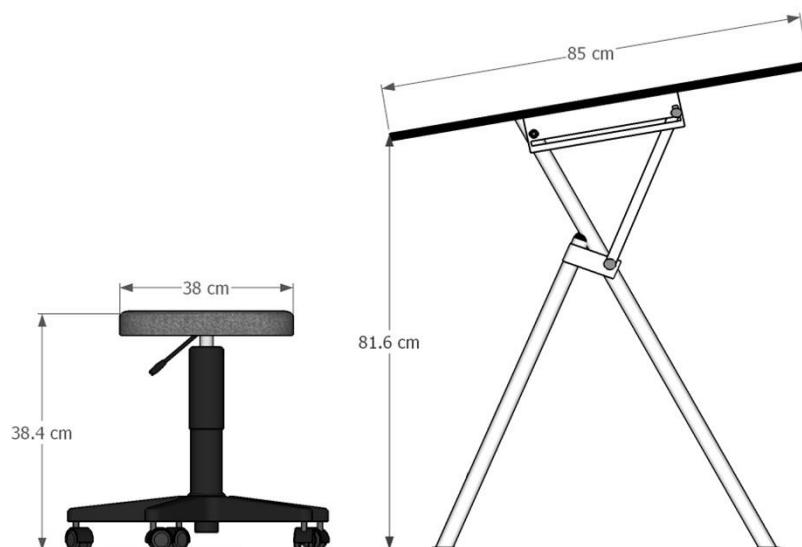
<b>A</b>	44
<b>B</b>	42
<b>C</b>	46
<b>D</b>	--
<b>E</b>	32 × 46
<b>F</b>	--
<b>G</b>	--
<b>H</b>	3
<b>I</b>	--

- **Gazi University, Ankara**

From the author's visit to the department of industrial design at Gazi University, in Ankara, the obtained seat designed provided by the school is a stool seat (see fig. 6.31.). The stool seat height is to be adjusted. The seat's sitting surface basic height is obtained to be low concerning the provided drafting table height in the design studio (see fig.6.32.). the sitting surface is cushioned, and the seats provided have to backrest, or foot rest. Table 6.5. and fig. 6.33. /6.34. shows the chair dimensions of the industrial design studio provided by Gazi University.



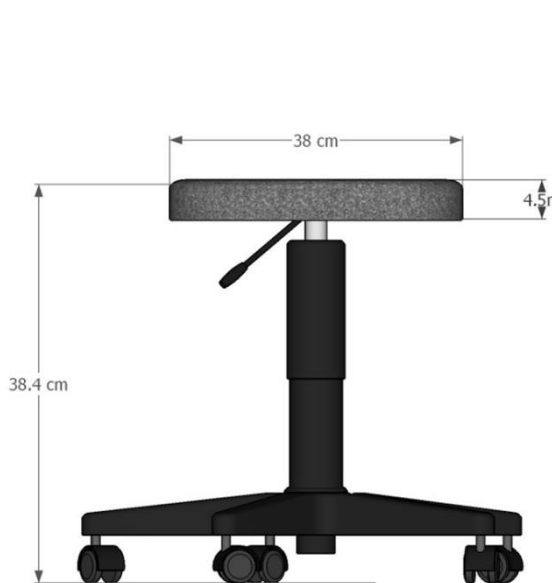
**Figure 6.31.** *The provided drafting table and stool at the industrial design studio at Gazi University, Turkey. 27 December 2016.*



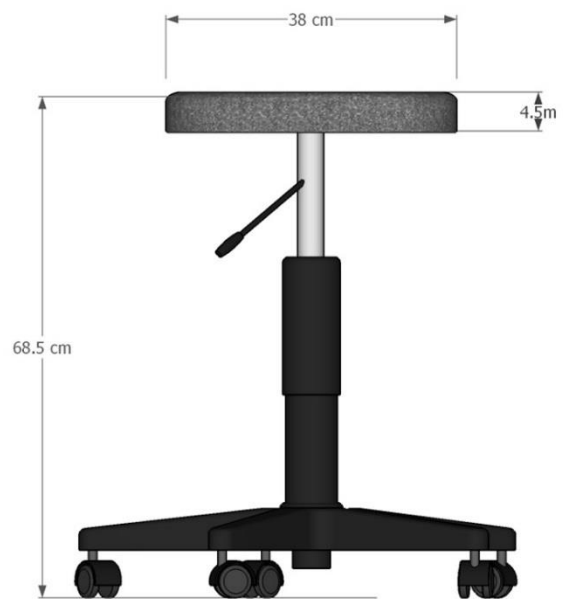
**Figure 6.32.** Gazi University, industrial design studio drafting table and stool's technical drawing with dimensions.

**Table 6.5.** Gazi University, industrial design studio's chair dimensions (Dimensions are in CM)

Gazi University Seat Type – Stool seat	
A	42
B	38
C	38
D	54.5
E	--
F	--
G	--
H	4.5
I	--



**Figure 6.33.** Gazi University, industrial design studio's stool dimensions with minimum adjusted seat height.



**Figure 6.34.** Gazi University, industrial design studio's stool dimensions with maximum adjusted seat height.

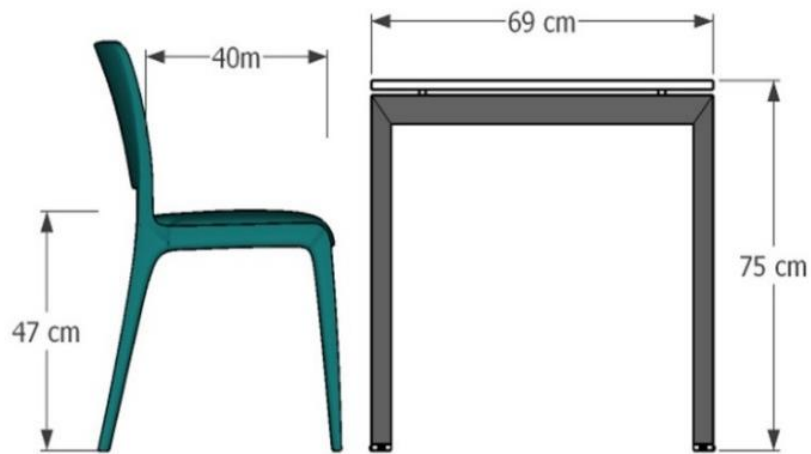
- **Istanbul Technical University, Istanbul**

At The Faculty of Architecture in Istanbul Technical University, there were two types of seats obtained in the design classrooms. Chairs were provided at the architecture and industrial design studios (see fig. 6.35.), the chairs are molded plastic seats and were set in the classrooms three years ago as one of the students mentioned; we can always find this type of chairs inside the commercial coffee shops and/or snack houses. The provided chair seats by the Istanbul Technical University were very far away from the school furniture standards and considered to be a misconduct in the classroom physical environment and furnishing requirements. The provided solid chair design height is not relevant with the working table surface height, which can prevent the design students from performing their work with an easy reach for the drafting or designing tools and materials (see fig. 6.37.). The chair as shown in fig. 6.38. comes with a curved sitting surface and backrest with a total absence of an armrest or footrests. Table 6.6. shows the chair dimensions at Istanbul Technical University Design Studio.



**Figure 6.35.** *The provided drafting table and chair at the architecture and industrial design studio at Istanbul Technical University, Turkey. 29 December 2016.*



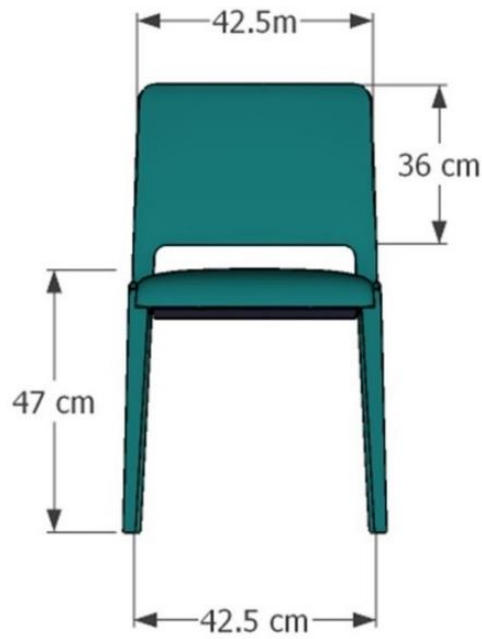


**Figure 6.37.** *Istanbul Technical University, architecture and industrial design studio drafting table and chair's technical drawing with dimensions.*

**Table 6.6.** *Istanbul Technical University, architecture and industrial design studio's chair dimensions. (Dimensions are in CM)*

**Istanbul Technical University**  
Seat Type – Chair seat

<b>A</b>	47
<b>B</b>	41
<b>C</b>	40
<b>D</b>	--
<b>E</b>	42.5×36
<b>F</b>	--
<b>G</b>	--
<b>H</b>	4
<b>I</b>	--

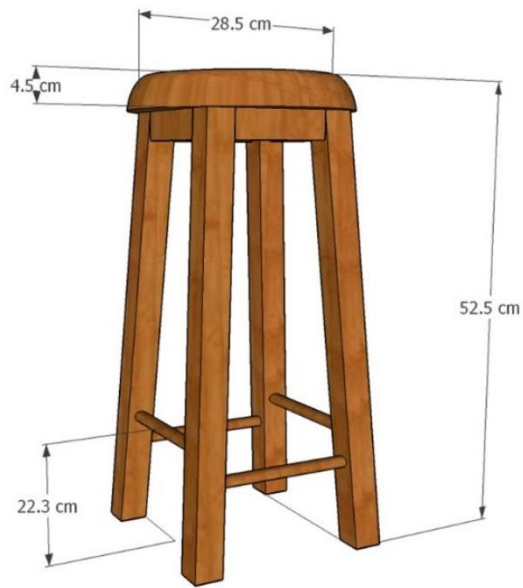


**Figure 6.38.** *Istanbul Technical University, architecture and industrial design studio drafting chair's drawing with dimensions.*

On the other hand, and during the author's visit to Istanbul technical University, basic wooden stool seat were found in design workshops (see fig. 6.39.). these stools are considered as the very classical stool design and structure from very long period of time. The stool's sitting surface diameter was curved and not acceptable to hold all the human body types, their height was too high and not be adjustable to meet the user's needs, also was vey high for the found working table surface. Table 6.7. and fig.6.40. shows the stool's dimensions found in Istanbul Technical University.



**Figure 6.39.** *The provided drafting table and stool at the faculty architecture design studio at Istanbul Technical University, Turkey. 29 December 2016.*



**Figure 6.40.** *Istanbul Technical University, Faculty of Architecture design studio drafting stool's drawing with dimensions.*

**Table 6.7.** *Istanbul Technical University, Faculty of Architecture design studio's stool dimensions. (Dimensions are in CM)*

**Istanbul Technical University**  
Seat Type – Stool seat

<b>A</b>	52.5
<b>B</b>	28.5
<b>C</b>	28.5
<b>D</b>	--
<b>E</b>	--
<b>F</b>	--
<b>G</b>	--
<b>H</b>	--
<b>I</b>	22.3

## 6.5 Measured Seats Dimensional Evaluation; Results, Standards and Analysis

Because of the research's aim which is to state and locate the design studio seats' problems, this part of the research is to evaluate the studied seats in the five universities, and to measure their dimensions then compare them with the standards of seats anthropometrical aspects and ergonomics in-order to determine if the sitting on the provided design studio seats (chairs and drafting stools) may be associated with a decline in the student's healthcare risking their creative performance and productivity when performing design-work tasks in the design studio classroom. See table 6.8.

In furniture design every millimeter or angle degree is important, the previous table showed the studied seat's dimensional analysis and compared it with standard dimensions from three different standard references. The found differences in the total dimensional average showed just one anthropometrical aspect dimensions which meets the authorized worldwide standard dimensions, only the

- **A:** seat heights met the standard criteria.
- The found seats showed an average dimensional difference of:
- **B:** -1.8cm from the standards of the seat depth standards;
- **C:** -0.83cm in the seat's width;
- **D:** -9.6cm for the seat's height adjustability feature;
- **E:** added/extra (+12.8cm) × (+12.7cm) on the seat's backrests;
- and a complete absence and a zero cm of
- **F:** Adjustable backrest angle and; **G:** seat armrest;
- and a non-presence or missing -1.33cm in **H:** seat footrest aspect.

**Table 6.8.** Dimensional analysis of the measured seats with standard dimensions where: A: Seat Height; B: Seat Depth; C Seat Width; D: Adjustable Seat Height; E: Seat Backrest; F: Adjustable Backrest Angle; G: Seat Armrest; H: Cushioning Thickness; I: Footrest Height. (All dimensions are in CM)

	Anadolu University	Middle East Technical University	Atilim University	Gazi University	Istanbul Technical University	Universities Total Average	SD (Standard Dimensions)				Average Differences between the measured seats at the obtained universities and the stated standard dimensions
							According to "Human dimension & interior space" book by: Julius Panero, Martin Zelnik	According to "Ergonomic Chair" by: Canadian Centre for Occupational Health and Safety	According to(Ertan Yesari HASTÜRK, 2013) PhD thesis from "Turkish Standards Institute" TS 3585 ENV 1729-1	Obtained Standard Dimensions Average	
<b>A</b>	53	41	44	42	47	52.5	53.3 – 69.9	35-51	45	44.4 - 55.3	
<b>B</b>	33	39	42	38	41	28.5	39.4 – 40.6	38-43	--	38.7 – 40.3	1.78 – 3.38
<b>C</b>	33	39	46	38	40	28.5	39.4 – 40.6	30-40	45	38.13 – 41.9	-0.71 – 3.18
<b>D</b>	68	54	--	54.5	--	--	76.2	--	--	76.2	-17.37
<b>E</b>	--	--	32 × 46	--	42.5 × 36	--	35.6 × 22.9	15-30	32	27.5 × 28.3	4.5 × 5.4
<b>F</b>	--	--	--	--	--	--	--	Up to 30° (vertical)	6°	18°	--
<b>G</b>	--	--	--	--	--	--	--	Up to 25	--	Up to 25	--
<b>H</b>	3.5	--	3	4.5	4	--	5.08 minimum	--	--	5.08 minimum	-1.33

## 7 CONCLUSION AND DISCUSSION

### 7.1 Conclusion

Many scholars have debated about the importance of design studio's educational theories, while others kept on questioning the importance of empowering the design studio's pedagogical models, but there was no conducted data spotting the design studio's furnishing elements and their standards as a part of the studio's physical environment and the student's healthcare in the in an educational working space such as the design studio. In the meantime, design studio classroom physical environment and furnishing standards were way far from being discussed and studied in higher education researches, therefore this study intends and discusses the design studio's seats and their impact on the design students inside the design studio they learn in. The aim of this study is to evaluate the impact of design studio's seating elements on the creative performance and the productivity of design students, referring it to the students' physical and mental health and their interaction with the seats while working in the studio. Two studying types were implemented in this research. In these studies, 125 students (subjects) majoring in three different fields, from five different private and public governmental universities, with 6 available different seats design were discussed.

The First type of the study included in the research is evaluating the students as a user experience with the available seats their educational schools provide them by. This study was implemented by undertaking a digital prepared survey. Nevertheless, as the factors of comfort and discomfort can be classified into several sub-groups: impression, relief/energy, well-being, relaxation, and fatigue, restlessness, pain/biomechanics, strain and circulation (Vlaović, Domljan, Župčić, & Grbac, 2016), thus questions evaluating the design student's physical interaction, mental impacts, level of satisfaction with the design studio seats they are using, and the student's emotional behavior in the studio, were asked and answered by the 125 subjects.

The survey results indicated that a high number of the participated male and female subjects works while being seated for at least 5-7 hours daily inside the design studio classroom, with a high percentage (75.2%) who change their sitting positions every couple of minutes. The participants stated their physical health problems and located their pain points in their bodies caused by using the seats in the design studio they currently learn in, locating the pain points in their bodies rooted from using the seats in the design studio like buttock, lower and upper back, neck, shoulders, and sometimes thighs. The survey obtained that significant number of students were effected physically and felt pain from sitting prolonged in the design on the provided seats either once a week or once every two weeks; the survey also indicated that a high percentage of students of (25.60%) frequently and (48.80%) occasionally are being ill or injured due to their unsuitable sitting posture on the provided drafting seat, while performing work in the design studio.

The studied seats were given an average rate of satisfaction of 2.27/5.00, which is considered as a seat design fail and decline from the student's as a user experience. The available found seats in the design studios considered as a root of the design student's discomfort. The student's level of satisfaction with some aspects of the drafting seats that they are using in the educational institution they are attending were rated, and gave a weighted average of 1.98/5.00 with seats healthcare aspect, 2.42/5.00 for the seat's functionality, 2.45/5.00 for the seat's design, and moderate levels for the seat's resulting: aesthetics (2.53/5.00), quality (2.73/5.00), materials (2.89/5.00), safety (2.90/5.00), safety (2.90/5.00), height (3.03/5.00), sitting surface size (3.10/5.00), and the seat's durability (3.18/5.00).

The second implemented study type is an anthropometrical-dimensional study on 6 different seats that were found in the design studios; anthropometrically, the obtained results showed significant differences in the dimensions of the measured seats from the standard ones. Also, there was either partial or total absence of some anthropometrical essentials that are important to include in a seat design (see table.8). The study's obtained dimensional differences indicated variables from the seat's standards dimensions by a total of 6.7-23.3cm in the seat's height; 2.48-3.68cm in the seat depth; 1.98-3.18cm in seat's width; absence and 8.37cm differences in adjustable seat's height; 3.6×-23.1cm or absence of the seats backrests dimensions; a complete absence of adjustable backrests and armrests; 1.33cm variance or absence of the measured cushioning thickness in the seats; 8.2cm difference and a nonappearance of footrests in 5 of the measured seats.

Nevertheless, the study showed that there is a significant connection between the design student's mental and physical health, with their creative performance and productivity in the design studio work place. In this study, the participated design students linked their mental health comfort to their physical health comfort, stating that their poor creative performance in the design studio is rooted from mental distractions caused by physical fatigue and/or physical pain in some of their body parts like, buttock, lower back, upper back, neck, shoulders, and sometimes thighs.

## 7.2 Discussion

Design institutions and educators' main job is seeking new ways to improve and empower the design studio educational system, and enrich the student's design knowledge and disciplines. They provide the students with classrooms, workstations, technical workshops, printers, and books or digital access to authorized educational libraries. They focus on enlightening their design education models for better teaching-learning quality, and they work hard to teach their students how to design everything using knowledge.

Design schools, instructors, and scholars, work hard to teach students how to design a project or a product properly. The focus of their work is well centered on teaching design students how to solve design problems and/or create new design concepts through, ergonomics, anthropometry, human factors, users' needs, safety, etc. These aspects require the students to perform creatively and productively when starting design job at the design studio classroom/course.

The implemented research on 125 students from five universities in Turkey, and with the study of the provided 6 different seat types in the design studios results, not only obtained fails anthropometrically and dimensionally in the design studio seats, but also resulted in a significant product decline (design studio seats as a product) from a user experience (design students).

These fails and declines were rooted at the usage of a provided standard seat by the students in the design studio educative-working spaces, where those seats seem to be non-designed or about zero ergonomically-anthropometrically designed, that, later, were proven to affect student's level of creative performance and productivity. These six seats were found to be more commercially designed and not proper for furnishing design studios, the providers or the producers of those seats, notably focused on the seat's durability and cost, and never thought of the seat's design standards and essentials.

In addition, the designers of these seats almost forgot about the time design students spends sitting on those seats in the design studio, without body support that leads to the student's physical discomfort that roots mental distractions. Thus, the need of the right seat design is to be provided and used in the design studio remains. Design students who are learning how to perform creatively and productively in the design studio, are to be using the best, but the perfect designed seats in order to motivate them to accomplish a correct and/or ethical design discipline in the future, that helps them to solve any design problem/s, and find or create the best innovations that improves the world and human's life.

The questions discussing the design studio seating elements, including the design of these seats, their production, their selection and providing the students with, continues. Nonetheless, seats testing, the experience told by the design students, seems always to be the small key (finding problem/s) that opens big door (solving problem/s).



## **8 LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH**

Progress has been made in discussing the design studio's seating elements impact on student's healthcare linking it to their creative performance and productivity level, but additional detailed research and critical scientific support needs remain.

Although this research was wisely prepared and implemented, the author still aware of its limitations.

This thesis/research was just conducted on a small size of population in 5 universities between 125 students, in one country which is Turkey, and with the presence and the study of 6 different design studio seat types, which may be not enough for the author/researcher to observe and analyze all the impact of design studio seats on the design student's creative performance and productivity in the world. The studies were implemented in a short time which can be not enough to discuss such an issue, thus it would be improved if it would be done in a longer time with the scope of different design schools and students participating from all around the world. Likewise, and since the evaluation of the research was conducted by the author himself, it is obvious that this research has a certain level of subjectivity. In-fact, objectivity was to be accurate with if this research had more surveyors and scholars. Nevertheless, there is very few and indirect data that discusses and states design studio physical environment and furnishing requirements, thus this research intended and aimed to discuss it.

The author's recommendations are to enhance studies that indicate and solve the problem/s of the design studio seating elements, and the design studio educational working space physical environment, thus, the design student's needs in such places. This thesis's research is not to be stopped here, and it is to be discussed in future studies by furniture/industrial designers, ergonomists, anthropometrics and all researchers and scholars who are at least slightly interested in such an essential topic.

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## APPENDIX: Questionnaire for participants of the Survey

### Survey Quesstionarie

- **Survey Design; English Version**



**Anadolu Üniversitesi**  
Fen Bilimleri Enstitüsü

The Impact of Designing Studio's Seating Elements on the Creative Performance and the Productivity of Students

**Welcome to Our Survey**

**Thank you for participating in our survey. Your feedback is important.**

This Survey titled "The Impact of Designing Studio's Seating Elements on the Creative Performance and the Productivity of Students" has been prepared by Ahmad AFARA, under the supervision of Ass. Prof. Füsün CURAOĞLU in partial fulfillment of Ahmad AFARA's Degree of Master of Science in Industrial Design requirements at Anadolu University, Eskişehir, Turkey.

This survey is intended to discuss and obtain "The Impact of Designing Studio's Seating Elements on the Creative performance and the Productivity of Students."

### 1. Student Contact Information

Name

Email Address

### 2. What is your Gender

- Male  
 Female

### 3. What is your age?

- 18-20  
 21-23  
 24-26  
 27 +

### 4. The university you're currently attending

- Anadolu University  
 Middle East Technical University (METU)  
 Atilim University  
 Gazi University  
 Istanbul Technical University

### 5. Your field of studies

- Industrial Design  
 Interior Architecture  
 Architecture

### 6. Your current academic year

- First Year  
 Second Year  
 Third Year  
 Forth Year  
 Graduate

Questionnaire & Rating

7. On average, how many hours a week do you spend working on design studio projects, other than that of lectures and studio sessions?

- 0
- 1-5
- 6-10
- 11-15
- 16-20

8. On average, how many hours a week on average do you spend working on your projects at the design studio?

- 0
- 1-5
- 6-10
- 11-15
- 16-20

9. Do you often use the drafting chair or stool in the design studio classroom?

- Yes
- No
- Frequently

10. While using a chair or stool seat, what concerns you more??

	Low	Medium	High
Physical Health	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mental Helath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aesthetic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Based on the drafting chair or the drafting stool you often sit on; how frequently do you change your sitting positions

- Every couple of minutes
- Every couple of hours
- I could stay in the some position for hours

12. During your studying years, have you been ill, injured, or had pain caused by your awkward sitting posture on a drafting chair or stool, while performing work in the design studio?

- Frequently
- Occasionally
- Rarely
- I can't remember

13. Do you suffer from any pain when you prolong sit on a drafting chair or stool at the given following body parts? (Please select all that apply.)

	Yes	No
Buttock	<input type="radio"/>	<input type="radio"/>
Lower Back	<input type="radio"/>	<input type="radio"/>
Upper Back	<input type="radio"/>	<input type="radio"/>
Shoulders	<input type="radio"/>	<input type="radio"/>
Neck	<input type="radio"/>	<input type="radio"/>
Forearms	<input type="radio"/>	<input type="radio"/>
Wrists	<input type="radio"/>	<input type="radio"/>

14. How often are you affected by pain caused by working seated on a drafting chair or drafting stool in the design studio?

- Weekly
- Fortnightly (once every two weeks)
- Monthly
- Less than 6 months of the year
- More than 6 months of the year

Questionnaire & Rating

15. Please rate your level of agreement with the following statements drafting chair/stool user

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The drafting seat height I am using is appropriate for the drafting table height	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to support a foot up when sitting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sharp edges along the seat top have padding to reduce the contact pressure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
While I am sitting on a drafting chair or a drafting stool, the drafting items within easy reach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
During drafting, the chair/stool I sit on supports my lower back (lumbar support)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
During drafting, the chair/stool I sit on supports my upper-back	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The drafting chair/stool I use have an armrest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When drafting and sitting on a chair/stool, my wrist and forearm are in a neutral or straight position	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
The chair/stool I am using in the design studio can be adjusted to accommodate my height	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frequent breaks are provided by the design studio Instructors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I am working in the design studio classroom, hourly I stretch my body	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that sitting for a long time causes poor mental health	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am able to maintain proper/comfortable sitting posture while drafting in the design studio classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find myself sitting awkwardly at the design studio classroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Please rate your level of satisfaction with the following aspects of the drafting chair or the drafting stool that you are using in the educational institution you're attending

	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied
Function	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Durability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Height	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sitting Surface size	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safety	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aesthetics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Using any number from 1 to 5, what number would you choose to rate how your satisfaction with the drafting stool that your University provided to you to sit on and use?

1 (Low Satisfaction)	2	3 (Moderately Satisfied)	4	5 (Extremely Satisfied)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



18. Do you agree that using the provided drafting chair or drafting stool by your university risks your mental health, and effects your creative performance at the design studio?

- Yes I agree
- No I don't agree
- Undecided

Why? (please specify)

19. Do you agree that using the provided drafting chair or drafting stool by your university risks your physical health, and effects your work productivity at the design studio?

- Yes I agree
- No I don't agree
- Undecided


why? (please specify)

20. As a design student expected to perform creatively and productively at the design studio, do you think you'll be able to accomplish that while sitting on a drafting chair/stool that have been provided by the educational institute you are attending and you are compelled to use it and may not fit your needs?

- Yes, It's Possible
- No, It's Impossible
- Undecided

Why? (please specify)

- **Survey Design; Turkish Version**



**Anadolu Üniversitesi**  
Fen Bilimleri Enstitüsü

Tasarım Stüdyosundaki Oturma Elemanlarının Öğrencilerin  
Yaratıcılık Performansı ve Verimlilik Üzerindeki Etkileri

**Anketimize Hoş Geldiniz**

Anketimize katıldığınız için teşekkür ederiz. Görüşleriniz önemlidir.

**Bu anket, Ahmad AFARA tarafından, Endüstriyel Tasarım Programında Yüksek lisans tezini tamamlamak üzere, Anadolu Üniversitesi, Fen Bilimleri Enstitüsünde Yardımcı Doçent Füsun CURAOĞLU'nun gözetiminde hazırlanmıştır.**

**Bu anket, "Tasarım Stüdyosundaki Oturma Elemanlarının Öğrencilerin Yaratıcılık Performansı ve Verimlilik Üzerindeki Etkileri" ni tartışmak ve elde etmek için hazırlanmıştır.**

1. Öğrenci İletişim Bilgileri

Adı

E-posta Adresi

2. Cinsiyetiniz?

Erkek

Kadın

3. Yaşınız?

18-20

21-23

24-26

27 +

4. Okuduđunuz Üniversitenin Adı

- Anadolu Üniversitesi
- Orta Dođu Teknik Üniversitesi (ODTÜ)
- Atılım Üniversitesi
- Gazi Üniversitesi
- İstanbul Teknik Üniversitesi

5. Okuduđunuz Bölüm

- Endüstriyel Tasarım
- İç Mimarlık
- Mimarlık

6. Kaçınıcı sınıftasınız?

- Birinci Sınıf
- İkinci Sınıf
- Üçüncü Sınıf
- Dördüncü Sınıf
- Lisans üstü

7. Tasarım stüdyosundaki projeleriniz üzerinde, sınıfta haftada ortalama kaç saat çalışıyorsunuz?

- 0
- 1-5
- 6-10
- 11-15
- 16-20

8. Tasarım stüdyosu dışında, tasarım stüdyosundaki projeleriniz için, haftada ortalama kaç saat çalışıyorsunuz?

- 0
- 1-5
- 6-10
- 11-15
- 16-20

9. Sınıfta, sandalye veya taburenin düzenli kullanıcısı mısınız?

- Evet
- Hayır

10. Sandalye veya tabureyi kullanırken, sizin için önemli olan nedir? Aşağıdaki önemleri değerlendiriniz

	Düşük	Orta	Yüksek
Fiziksel sağlık	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zihinsel sağlık	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Estetik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kalite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Oturduğunuz sandalye veya tabure'ye göre, oturma pozisyonlarınızı ne sıklıkta değiştiriyorsun?

- birkaç dakikada bir
- birkaç saatte bir
- Saatlerce aynı pozisyonda kalabilirim

12. Eğitim yıllarınızda, Tasarım Stüdyosunda çalışırken, kullandığınız sandalye veya taburedeki oturma pozisyonunuzdan dolayı, acı çekme, hastalanma, veya Yaralanma gibi bir durumla karşılaştınız mı?

- Sık Sık
- Bazen
- Nadiren
- Hatırlamıyorum

13. Sandalye veya tabureye oturduğunuzda, aşağıda verilen vücut bölgelerinde, herhangi bir acı çekiyor musunuz?

	Evet	Hayır
Kalça	<input type="radio"/>	<input type="radio"/>
Bel	<input type="radio"/>	<input type="radio"/>
Sırt	<input type="radio"/>	<input type="radio"/>
Omuzlar	<input type="radio"/>	<input type="radio"/>
Boyun	<input type="radio"/>	<input type="radio"/>
Kol	<input type="radio"/>	<input type="radio"/>
Bilek	<input type="radio"/>	<input type="radio"/>

Diğer (lütfen belirtin)

14. Tasarım stüdyosunda oturarak çalışırken yaşadığınız ağrıdan ne sıklıkta etkileniyorsunuz?

- Haftada bir  
 İki haftada bir  
 Altı aydan az  
 Altı aydan fazla

15. Lütfen tasarım studiosunda bir sandalye veya tabure kullanıcısı olduğunuz için, Her bir seçeneği okuduktan sonra katılma derecenizi seçiniz

	Kesinlikle Katılmıyorum	Katılmıyorum	Ne Katılıyorum ne Katılmıyorum	Katılıyorum	Kesinlikle Katılıyorum
Kullandığım sandalye veya tabure yüksekliği, kullandığım masa yüksekliği ile uygundur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sandalyede veya taburede otururken bir ayak yukarı desteklemek mümkündür	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sandalye veya tabure üstündeki keskin kenarlarla, temas basıncını azaltmak için tabure üzeri sungerlidir	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sandalye veya taburede otururken, çizim malzemelerime kolayca ulaşabiliyorum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Otururken, sandalye veya tabure belimi destekliyor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Otururken, sandalye veya tabure sırtımı destekliyor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oturduğum sandalye veya taburede kolçak vardır	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sandalye veya taburede otururken, çizim yaparken bileğim ve önkolüm nötral veya düz pozisyonudadır	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Kesinlikle Katılmıyorum	Katılmıyorum	Ne Katılıyorum ne Katılmıyorum	Katılıyorum	Kesinlikle Katılıyorum
Tasarım stüdyosunda kullandığım sandalye veya tabure, yüksekliğime uyacak şekilde ayarlanabilir	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tasarım stüdyosunda çalışırken, eğitmenler tarafından sık sık mola veriliyor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tasarım stüdyosu dersinde çalışırken saat başı esneme hareketleri yapıyorum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uzun süre oturmanın kötü zihinsel sağlığa neden olduğunu düşünüyorum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tasarım stüdyosu dersinde çizim yaparken, uygun ve rahat oturuş duruşunu sürdürebiliyorum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tasarım stüdyosu dersinde sandalye veya taburede otururken, kendimi yanlış oturma pozisyonunda buluyorum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Lütfen, bir sandalye veya tabure kullanıcısı olduğunuz için, aşağıdaki yönlerinden memnuniyet seviyenizi değerlendiriniz

	Hiç memnun değilim	Memnun değilim	Ne memnunum ne memnun değilim	memnunum	Çok memnunum
Fonksiyon	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dayanıklılık	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yükseklik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oturma yüzey boyutu	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Malzemesi	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Güvenli	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sağlık Etkileri	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kalite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Estetik	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tasarımı	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. 1'den 5'e kadar herhangi bir rakamı kullanarak, Üniversitenizin kullanmanızı sağladığı sandalye veya tabureden memnuniyetinizi Belirtiniz?

	1 (Düşük Memnuniyet)	2	3 (Orta Derecede Memnuniyet)	4	5 (Yüksek Memnuniyet)
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. Üniversiteniz tarafından verilen sandalye veya taburenin kullanılması tasarım stüdyosundaki Yaratıcı Performansınızı etkilediğini ve zihinsel sağlığınıza riske attığına Katılıyor musunuz?

- Evet, katılıyorum
- Hayır, katılmıyorum
- Kararsızım

Neden (lütfen belirtin)

19. Üniversiteniz tarafından verilen sandalye veya taburenin kullanılması tasarım stüdyosundaki verimliliğinizi etkiliyor ve fiziksel sağlığınıza riske atıyor buna Katılıyor musunuz?

- Evet, katılıyorum
- Hayır, katılmıyorum
- Kararsızım
- Neden? (lütfen belirtin)

20. Bir tasarım öğrencisi olarak, kendinizin kullanmak zorunda olduğu ve sizin ihtiyaçlarınıza uymayacak bir sandalye veya tabure üzerinde otururken, yaratıcı performans sergilemek ve verimli olabilmek mümkün müdür?

- Evet, Mümkün
- Hayır, Mümkün değil
- Kararsızım

Neden? (lütfen belirtin)