TESTING THE STRUCTURAL ELEMENTS OF THE "SCA CHAIR" ASSEMBLY AT THE WEIGHT OF 120 KG. CASE STUDY

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RESEARCH ARTICLE

Abstract
The paper presents the structural elements of the SCA chair, which is tested at a weight of 120 kg payload. The SCA chair is a folding chair that is a product made structurally in 3D with the help of SolidWorks Professional 2010 design software. The chair has mechanical strength and this information can be seen from the reports of resistance to different forces or weights subjected to the testing process.

Keywords: chair resistance tests, SolidWorks, design software, case study.
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INTRODUCTION

The SCA chair is an engineering concept that is designed in such a way that the wooden material used to create it is very easy to process, and the parts that make up this chair are designed in such a way that they must resist to certain mechanical stresses.

If specific dimensions of various benchmarks are not respected, they can be reused at another benchmark also within this chair. The program design helped to test the seat components.

MATERIAL AND METHOD

First of all, it was aimed to test the assembly at a pressure force of 120 kg perpendicular to the seat and backrest and with a fixation from the lower end of the front and rear legs, which comes positioned on a flat surface.

Using SOLIDWORKS software, designers were able to quickly design, check, and revise assemblies, moving development forward at a rapid pace.

In any study done in SolidWorks Professional software we need fixing parts and constraints that we apply to the assembly - in this case the SCA chair.

The fixing parts in this case study were the four legs on which the chair rests in normal use.

The fixation was made on the rounded lower part of the legs on an invisible virtual surface, which allows the elements to move left-right front-back according to the resulting forces on the existing elements and constraints.

Table 1 show the method of fixing elements and the place where the forces were applied is presented in Table 2.

Table 1

Fixture

Restraint name	Selection set
Roller/Slider-1 < Rear assembly -1/Mirror Leg rear-2, Rear assembly -1/Rear leg-1, Front assembly -2/Leg front element 1-1, Front assembly -2/Mirror Leg front element 1-2>	on 4 Face(s)Roller/Sliding

Table 2

Load system – place of the applied forces

Load name	Selection set
Force-2 < Upper backrest -1, Upper backrest -2>	on 2 Face(s) apply normal force 120 kgf using uniform distribution
Force-3 <Seated assembly -1/ Seated sticks -1, Seated assembly -1/Seated sticks-2, Seated assembly -1/ Seated sticks -3, Seated assembly -1/ Seated sticks -4, Seated assembly-1/ Seated sticks-5>	on 5 Face(s) apply normal force 120 kgf using uniform distribution

RESULTS AND DISCUSSIONS

Each component that makes up this assembly was active in the resistance study and effectively participated. Throughout this study, all the physical and thermal properties of the seat components were taken into account.

The area of application of the dispersed forces was disposed perpendicularly to the following surfaces: upper backrest, lower backrest, the first four slats and the two struts, which are actually subjected to the pressure exerted by the weight of the human body.

The following table show us the connectors to which are part of this assembly.

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Table 3

The list of the assembly connectors

Connector name	Selection set
Pin Connector-1 < Head bolt -2, Plate-3, Plate-7, Mirror Leg front element 2-2>	Pin Connectors on 4 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-2 < Head bolt -13, Mirror Leg front element 2-2>	Pin Connectors on 2 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-3 < Head bolt -4, Leg front element 2-1>	Pin Connectors on 2 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-4 <Leg front element 2-1, Head bolt -3, Plate-6>	Pin Connectors on 3 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-7 < Head bolt -5, Safety-1, Plate-7, Safety-2, Plate-3>	Pin Connectors on 5 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-11 <Plate-9, Safety-4, Plate-6, Safety-3, Head bolt -10>	Pin Connectors on 5 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-13 <Plate-9, Plate-6, Head bolt -15, Front assembly -2/Mirror Leg front element 1-2>	Pin Connectors on 4 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-14 <Plate-7, Head bolt -14, Plate-3, Front assembly -2/Leg front element 1-1>	Pin Connectors on 4 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-15 <Plate-9, Rear assembly -1/Mirror Rear Leg -2, Head bolt -17, Plate-6>	Pin Connectors on 4 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad
Pin Connector-16 <Plate-7, Rear assembly -1/Rear leg-1, Placuta-3, Head bolt -16>	Pin Connectors on 4 Face(s); no pin translation; with rotational stiffness of 0.00000 N-m/rad

Observations:

Other forces or constraints than those mentioned in the work were not applied, such as wind, temperature changes, vibrations, etc.

The report created by the Solidworks software showed us all the areas that have changed or moved, after or during the study, and are marked from red to blue (Red the biggest changes and blue the smallest or none).

The table below describes the contacts between hardware, assembly and landmarks.

Table 4

The contacts between hardware, assembly and landmarks

Contact Set-2	No Penetration contact pair: Between selected entities of the Back assembly -1/Link-2 and Seated assembly -1/MirrorLonjeron-3
Contact Set-3	No Penetration contact pair: Between selected entities of Bolt-1 and Back assembly -1/Back leg-1
Contact Set-4	No Penetration contact pair: Between selected entities of Bolt-2 and Back assembly -1/Mirror back leg-2
Contact Set-5	No Penetration contact pair: Between selected entities of Seated Assembly -1/Lonjeron-1 and Head bolt-18
Contact Set-6	No Penetration contact pair: Between selected entities of Bolt cu cap-18 and Front Assembly-2/Leg front element 1-1
Contact Set-7	No Penetration contact pair: Between selected entities of Head bolt-19 and Seated assembly -1/MirrorLonjeron-3
Contact Set-8	No Penetration contact pair: Between selected entities of Head bolt-19 and Front assembly -2/Mirror Leg front element 1-2
Global Contact	Contact component: on <Leg front element 2>-<Fillet1>@Mirror leg front element 2-2@Resistance study
Component Contact-1	Contact component: on Cut-Extrude2@Safety-1@ Resistance study
Component Contact-2	Contact component: on Safety-4
Component Contact-5	Contact component: on Front Assembly -2/Leg front element 1-1
Component Contact-6	Contact component: on Back Assembly -1/Mirror Back Leg -2
Component Contact-7	Contact component: Bonded on Seated Assembly -1/Lonjeron-1

The tolerances defined in this study were 0.5 mm XYZ, which is the maximum tolerance allowed for this product. This is done in order to better highlight critical areas to fix in series production.

The table below shows the sum of the reaction forces that resulted from the tests.

Table 5

Sum of the reaction forces that resulted from the tests.

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	0	0	147.891	147.891

Table 6

Free-Body Forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N	-0.0643309	-1629.52	-794.581	1812.93

Table 7

Free-body Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Body	N-m	0	0	0	1e-033

The following table summarizes the final result of the strain and stress study.

Table 8

Strain and stress elements

Name	Type	Min	Location	Max
Stress1	VON: von Mises Stress 87.0004 N/m^2 Node: 54988	(-210.586 mm, 559.292 mm, -77.4698 mm)	4.42131e+008 N/m^2 Node: 72507	(222 mm, 584.987 mm, -45.9431 mm)
Displacement1	URES: Resultant Displacement 1.16728 mm Node: 2573	(213.975 mm, 0.659153 mm, 305.304 mm)	7.28994 mm Node: 73499	(5.44161 mm, 805.03 mm, -234.572 mm)
Strain1	ESTRN: Equivalent Strain 5.83671e-010 Element: 21674	(178.61 mm, 357.856 mm, -130.668 mm)	0.00318211 Element: 5861	(-197.22 mm, 373.512 mm, 76.403 mm)

CONCLUSIONS

In conclusion, this chair project has successfully passed all the strength tests performed in the SolidWorks software at 120 kgf according to the above results.

The approximate deviation from reality is 8-10%, as the chair was tested with exact forces and at an exact weight applied to the selected landmarks.

The ratio may have small deviations that fall within the tolerated limits due to the quality of the wood and its drying method.

The images represent the final result of the deformation (Figure 1) and tension (Figure 2) study. A survey of displacement and also a study of strain.

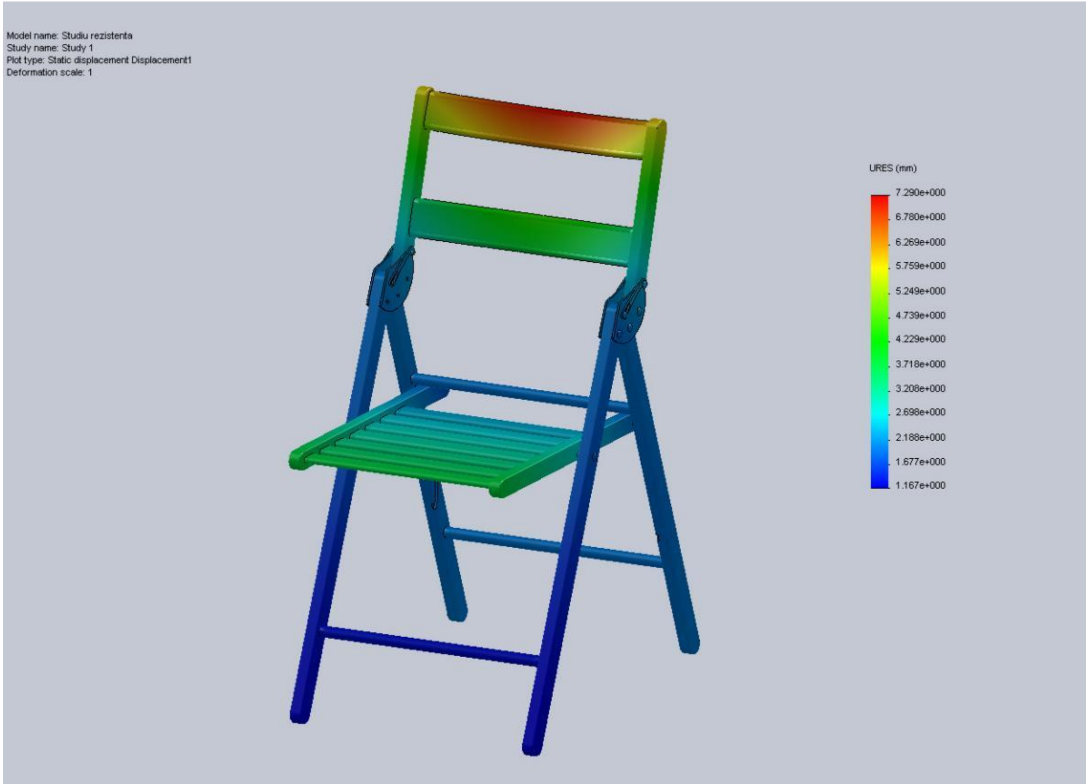

Figure 1. **The SCA chair. Component displacement study**

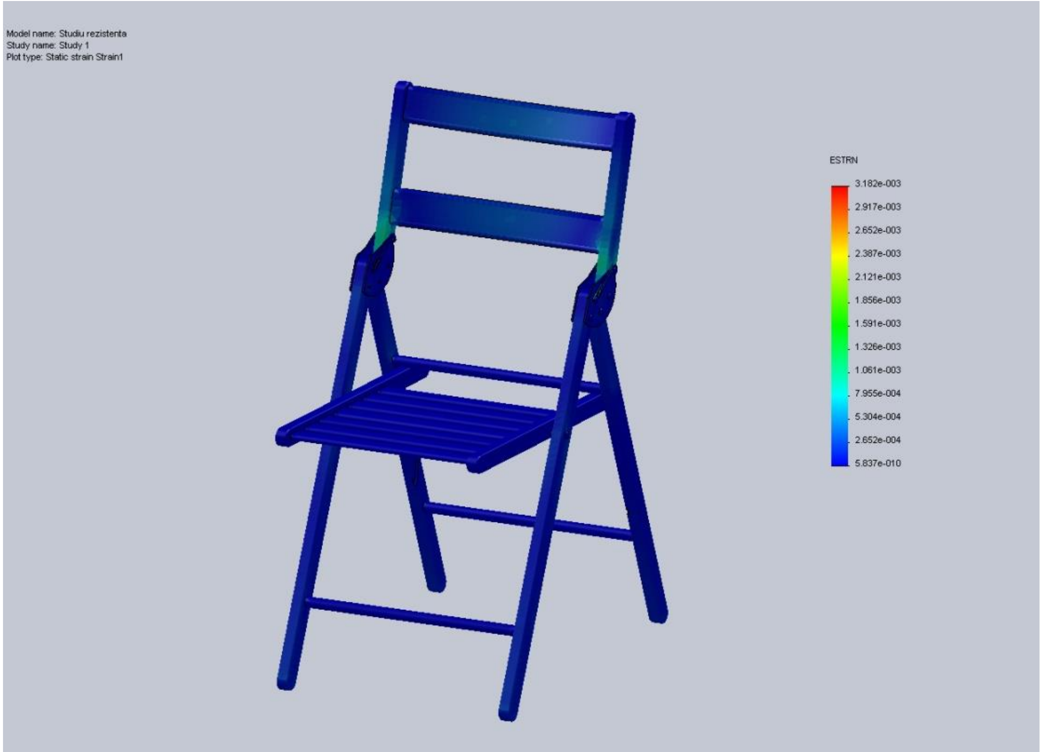

Figure 2. **Stress study of SCA chair components**

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