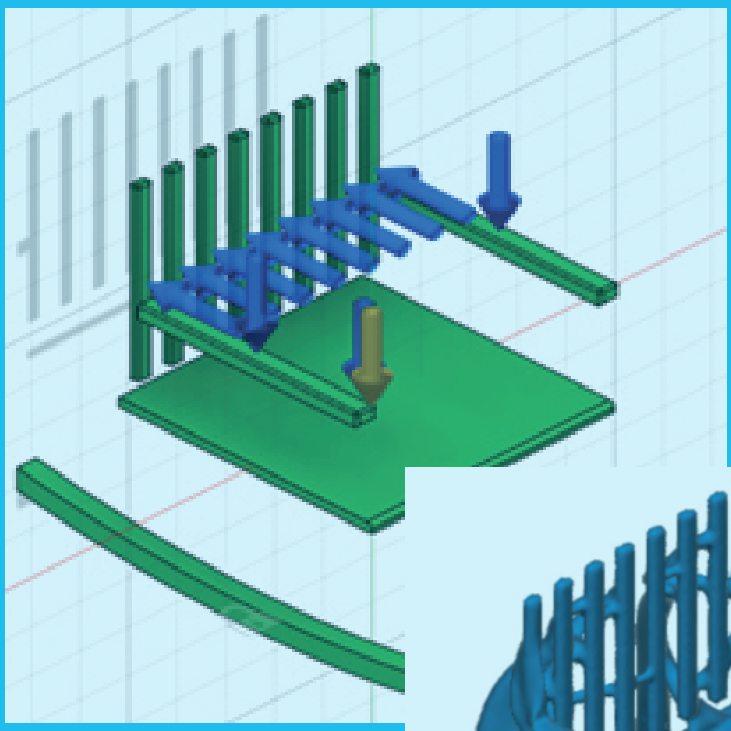
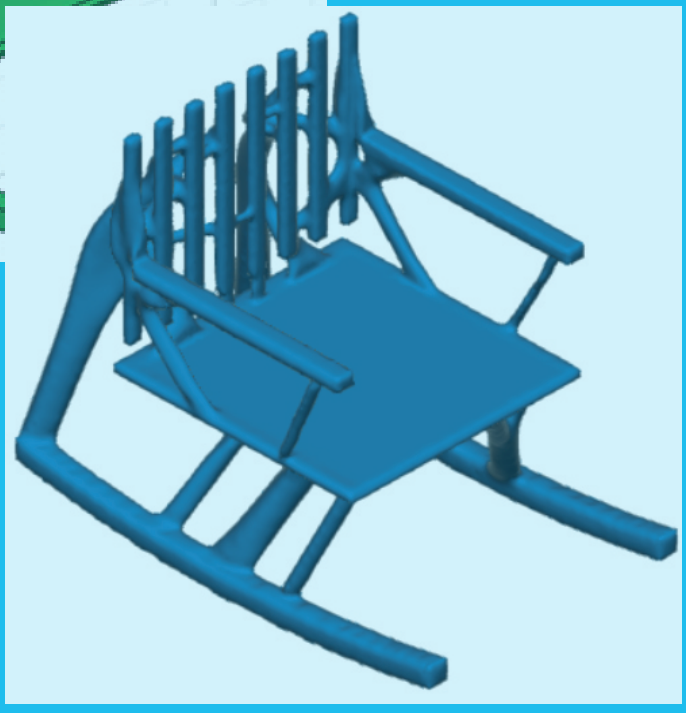
ARTIFICIAL INTELLIGENCE-AIDED PRODUCT DESIGN PRACTICES

Lecturer Hayrettin MERİÇ





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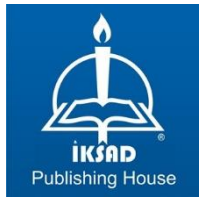

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1.INTRODUCTION

1.1. Artificial Intelligence

The concept of "artificial intelligence", which has gained a lot of attention in recent years, has been the subject of countless academic researches, tens of books and films for many years. With the effect of today's developing technologies, works in this field have gained a serious momentum and attracted more attention than ever before. Considering its social and cultural effects, it can be said that artificial intelligence stands out as a field that requires extensive and deep researches (1).

Artificial intelligence field, which at first glance seem to be related only to computer sciences, is an interactive science that exists in all areas related to humans, from cognitive sciences to philosophy discipline, from biology to electronics science, and today to art and design disciplines. Artificial intelligence applications have become more easily accessible to all industries thanks to the continuous development of technology; and it serves humanity in a wide range of fields such as medicine, banking, works of generating robots that think like a human, and game algorithms (1).

1.2. Generative Design

Generative design is the process of using algorithms to help explore variants of a design beyond what is currently possible using the traditional design process. Generative design, simulating the natural evolutionary approach, uses parameters and goals to find the best solution and quickly explore thousands of design variants (2).

Generative design uses machine learning to simulate nature's evolutionary approach to design. Designers or engineers enter design parameters (such as material, size, weight-mass, strength, manufacturing methods, and cost constraints) into generative design software, and the software explores all possible solution combinations,

quickly generating hundreds or even thousands of design options. Then, designers or engineers can filter and choose the results to best meet their needs (2).

Autodesk explains generative design as follows: "*Generative design is a design exploration process. Designers or engineers input design goals into the generative design software, along with parameters such as performance or spatial requirements, materials, manufacturing methods, and cost constraints. The software explores all the possible permutations of a solution, quickly generating design alternatives. It tests and learns from each iteration what works and what doesn't (3)*."

When the literature is analysed, it is seen that there are researches in various disciplines on generative design (4-44), however, the number of scientific researches, especially including practices, should increase. This book is a continuation of my scientific work called "GENERATIVE DESIGN FOR BOOKSHELF AND TV UNIT DESIGN"; and it contains plenty of practice, rather than providing lengthy literature information. The author hopes that the book will contribute to the generative design discipline thanks to its abundant and diverse practices.

2. METHOD

In this research, 6 different product design practices were carried out using the generative design module in Fusion 360 software. More detailed information about the method was specified in the previous scientific study (45).

In the previous book, 2 different materials were used for generative design practices (MDF and Polypropylene). However, since the material type does not make a difference in terms of form / construction, only MDF (medium density fiberboard) was preferred as the material in this work. Also, in all design practices, the gravity value is constant and this number is g = 9.807 m/s^2. At the end of each section, the numerical values calculated for the designed products are shown in the tables.

3. FINDINGS

3.1. Dining Table-1 Designs

In this model, it is aimed to design leg forms from the corner points of the dining table, and obstacle geometries are created accordingly. A force of 750 N was applied onto the dining table, 50 mm from the corners. The views of designs created by generative design for the dining table-1 are shown in figures 5-20.

Figure 1. Perspective Views of the Dining Table-1 and Load Applied to It

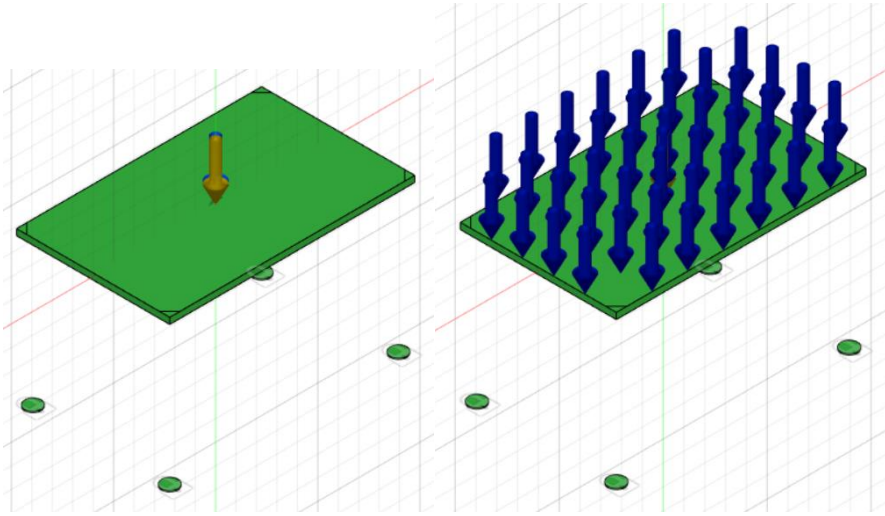


Figure 2. Perspective Views of The Dining Table-1 (Green represents preserve geometry, red represents obstacle geometry)

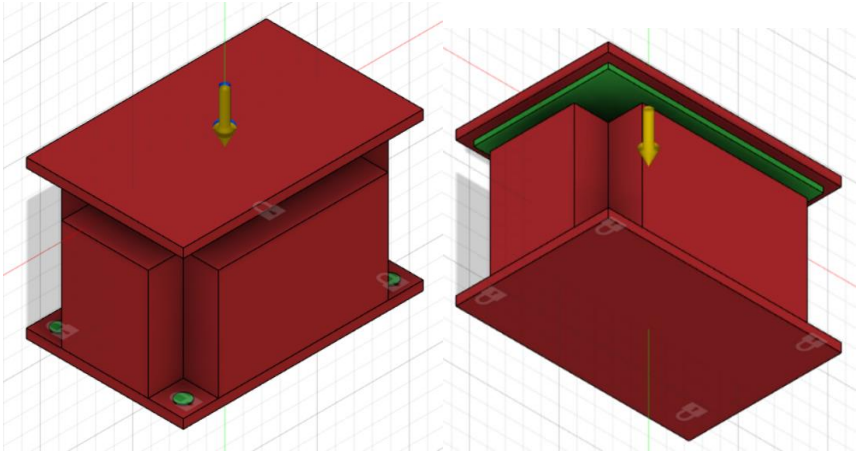
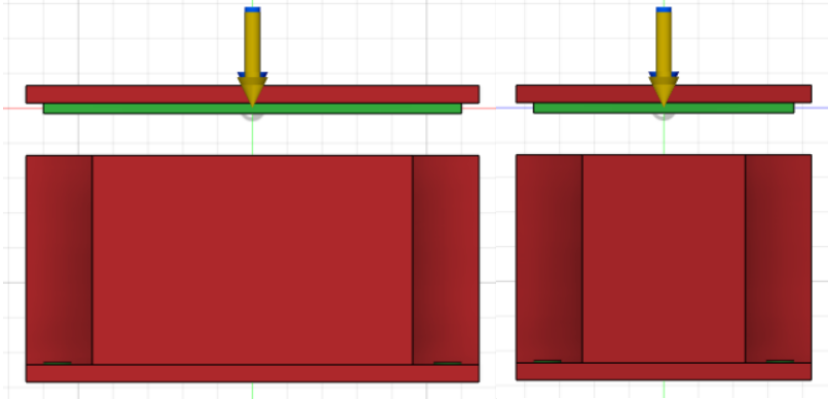


Figure 3. Front and Side Views of The Dining Table-1



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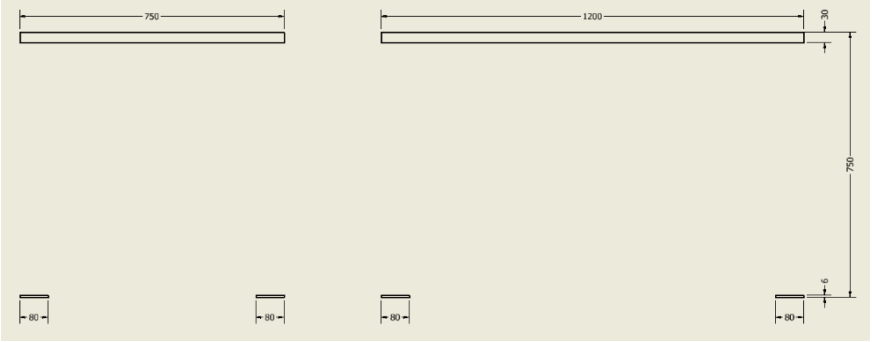

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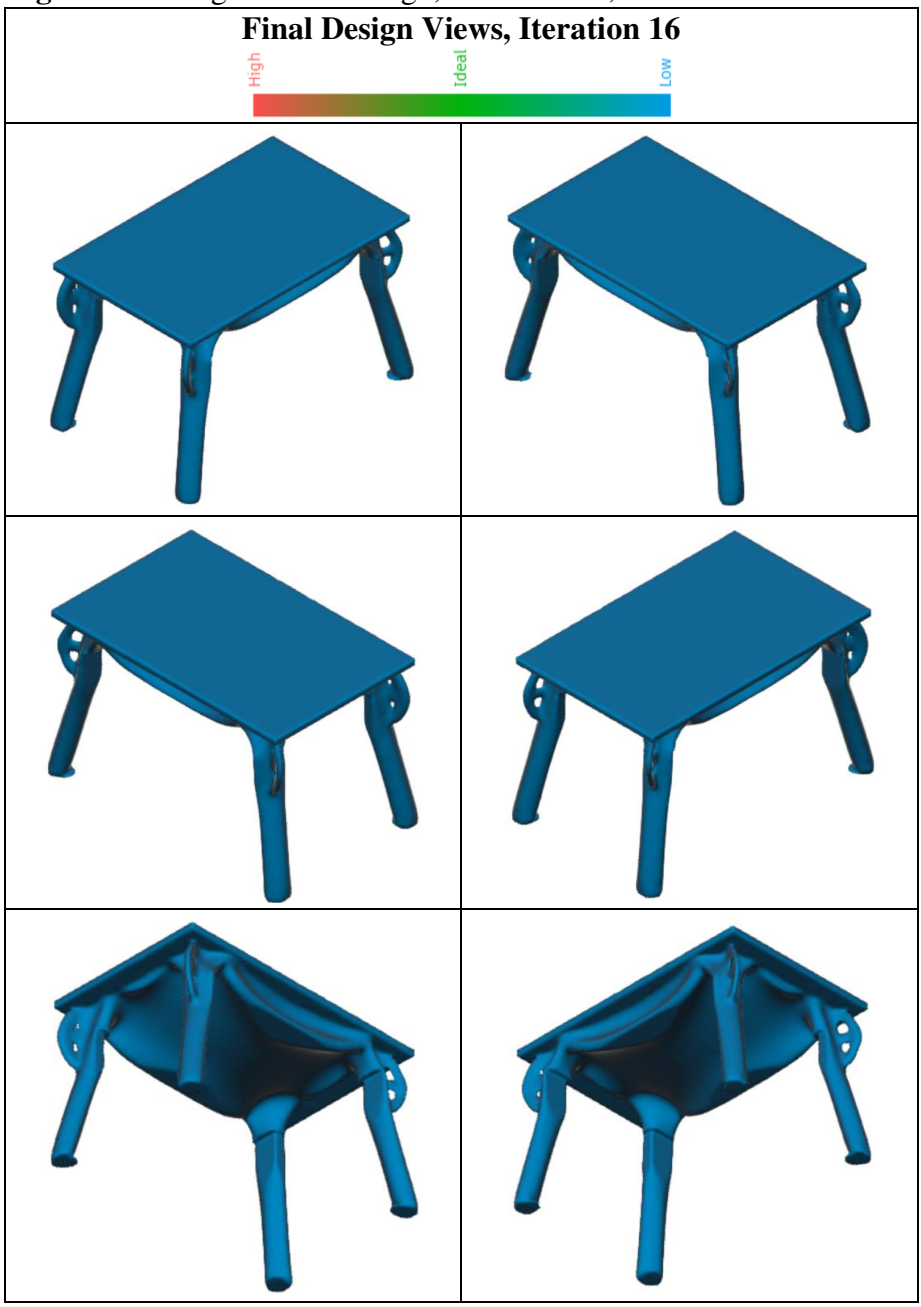

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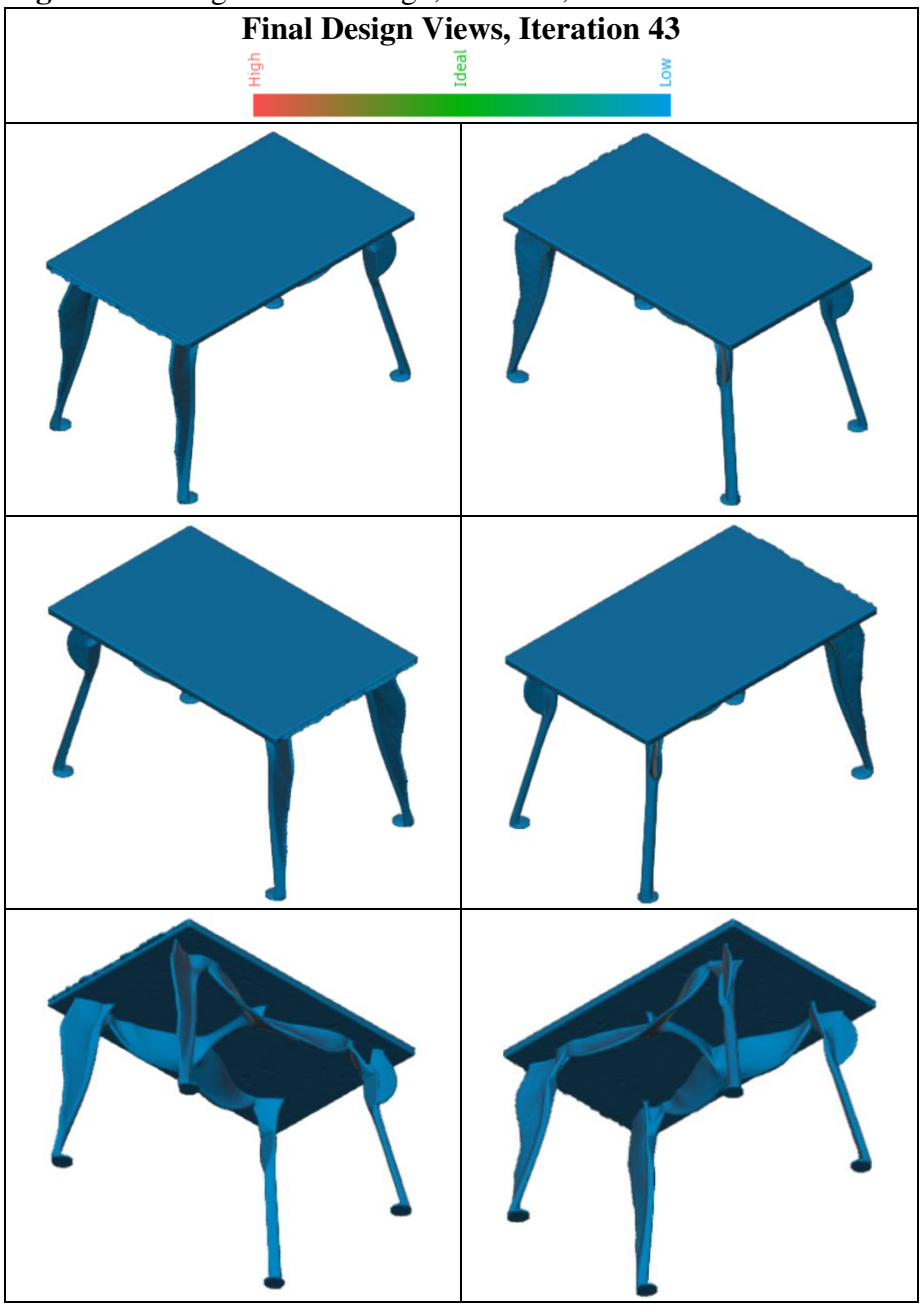
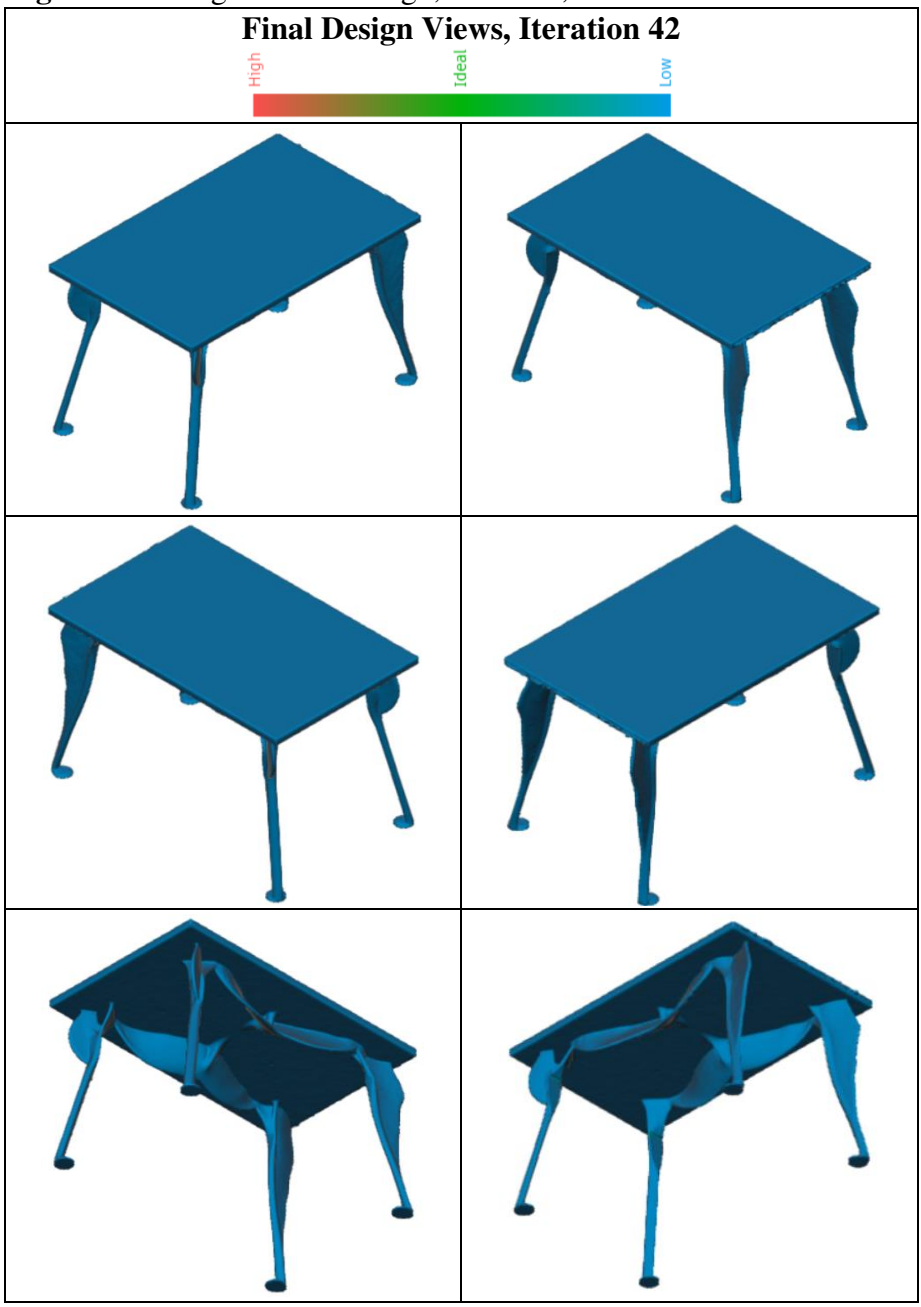


Figure 7. Dining Table-1 Design, Additive, X-



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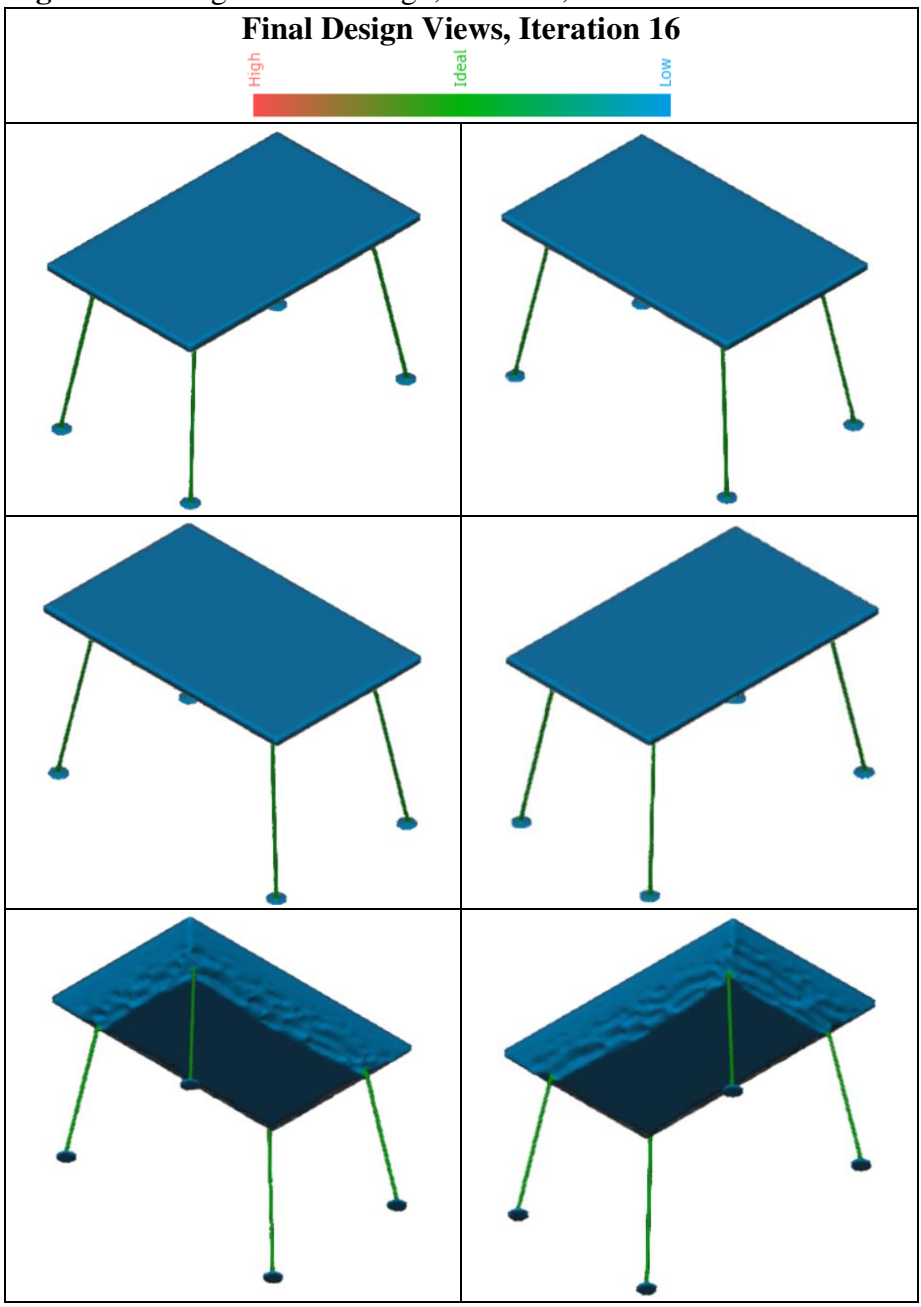

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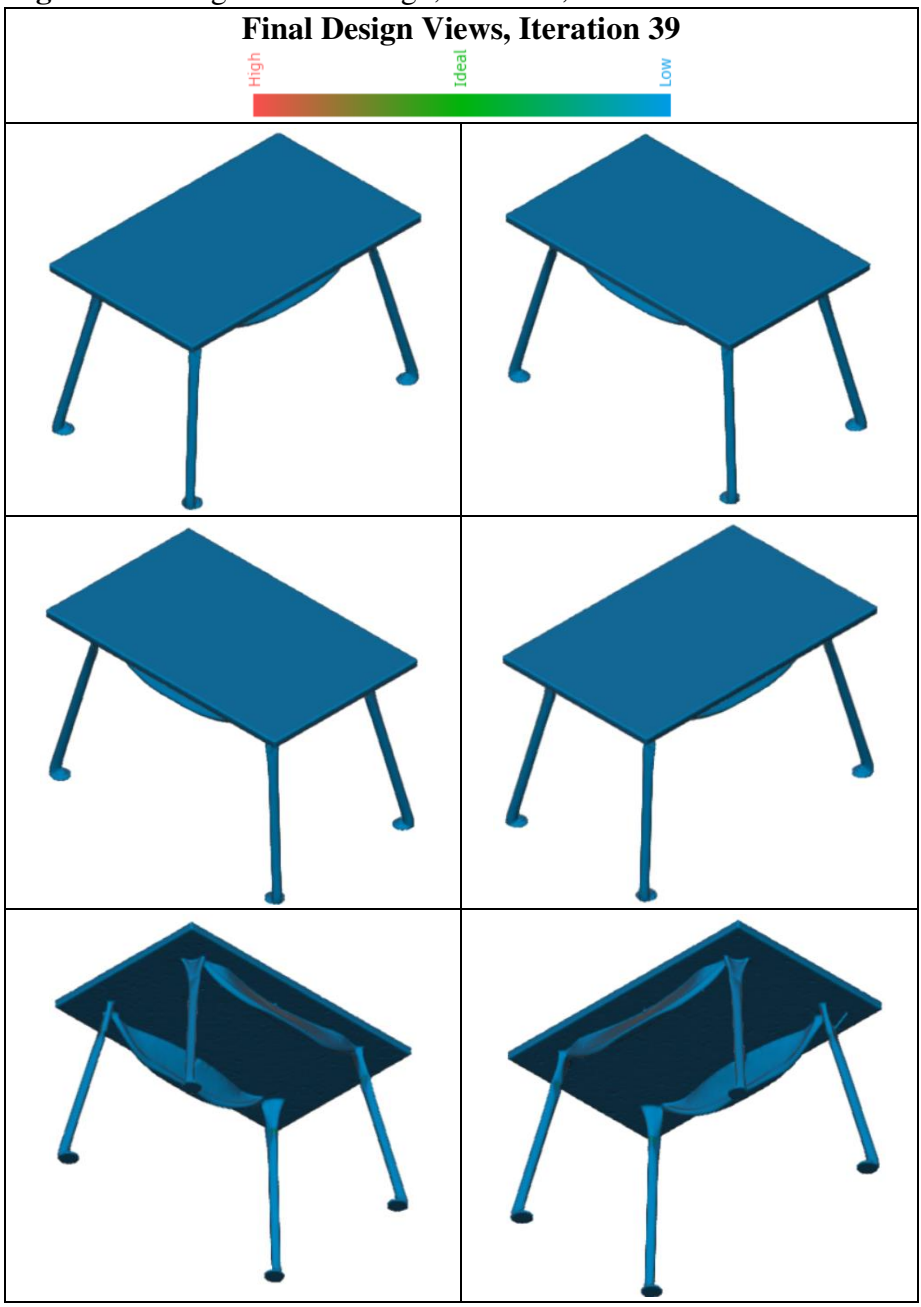

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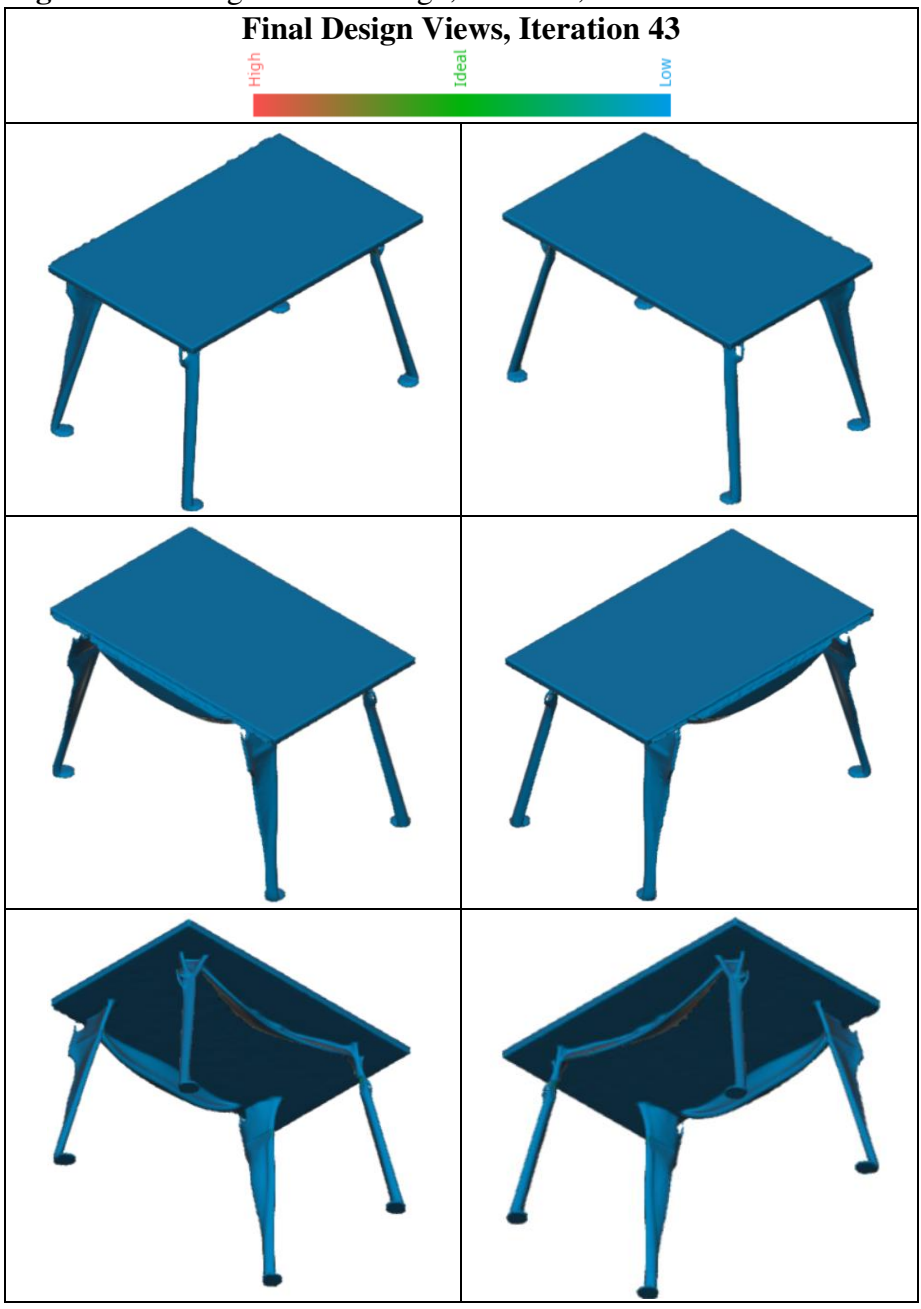
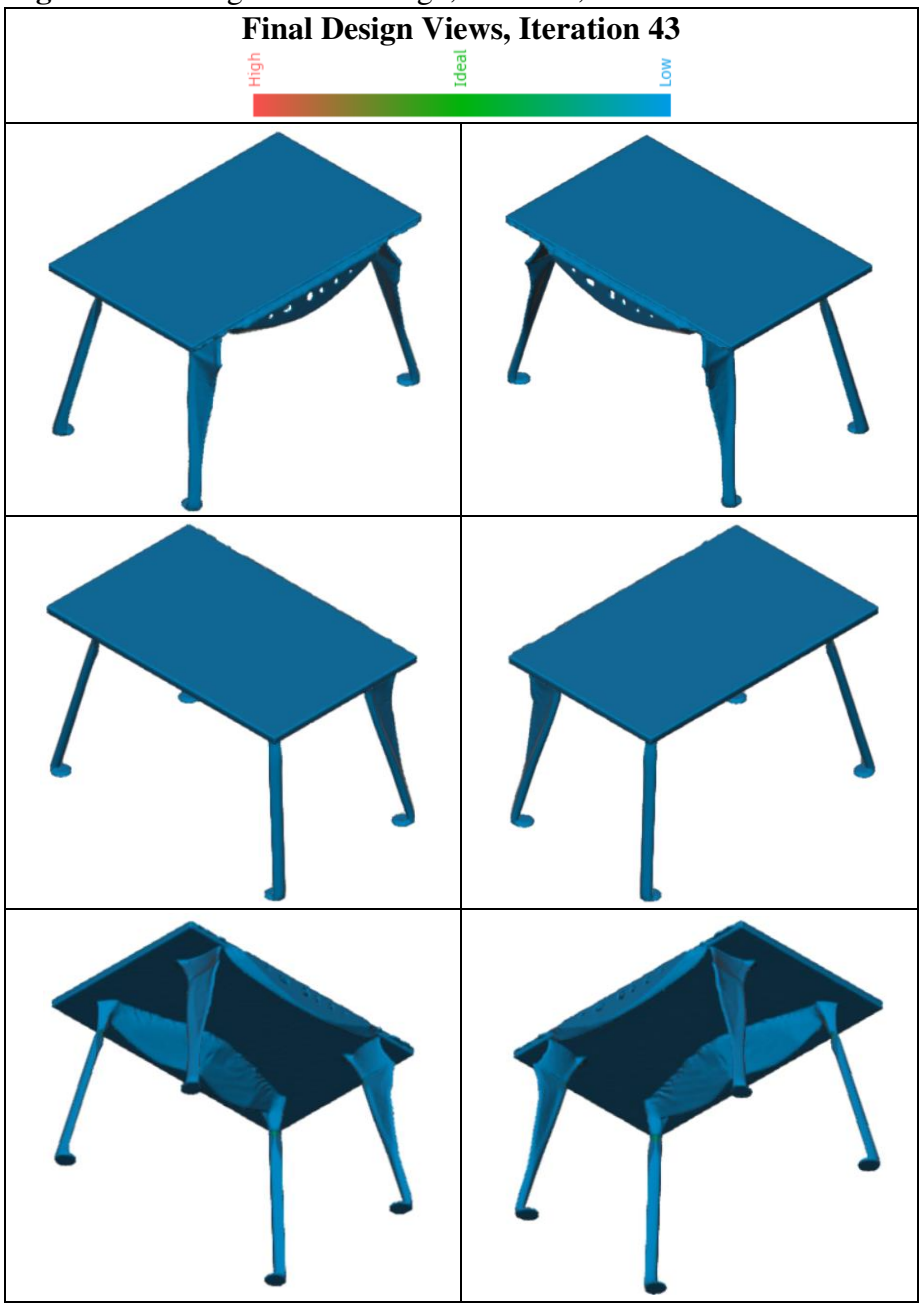


Figure 11. Dining Table-1 Design, Additive, Z-



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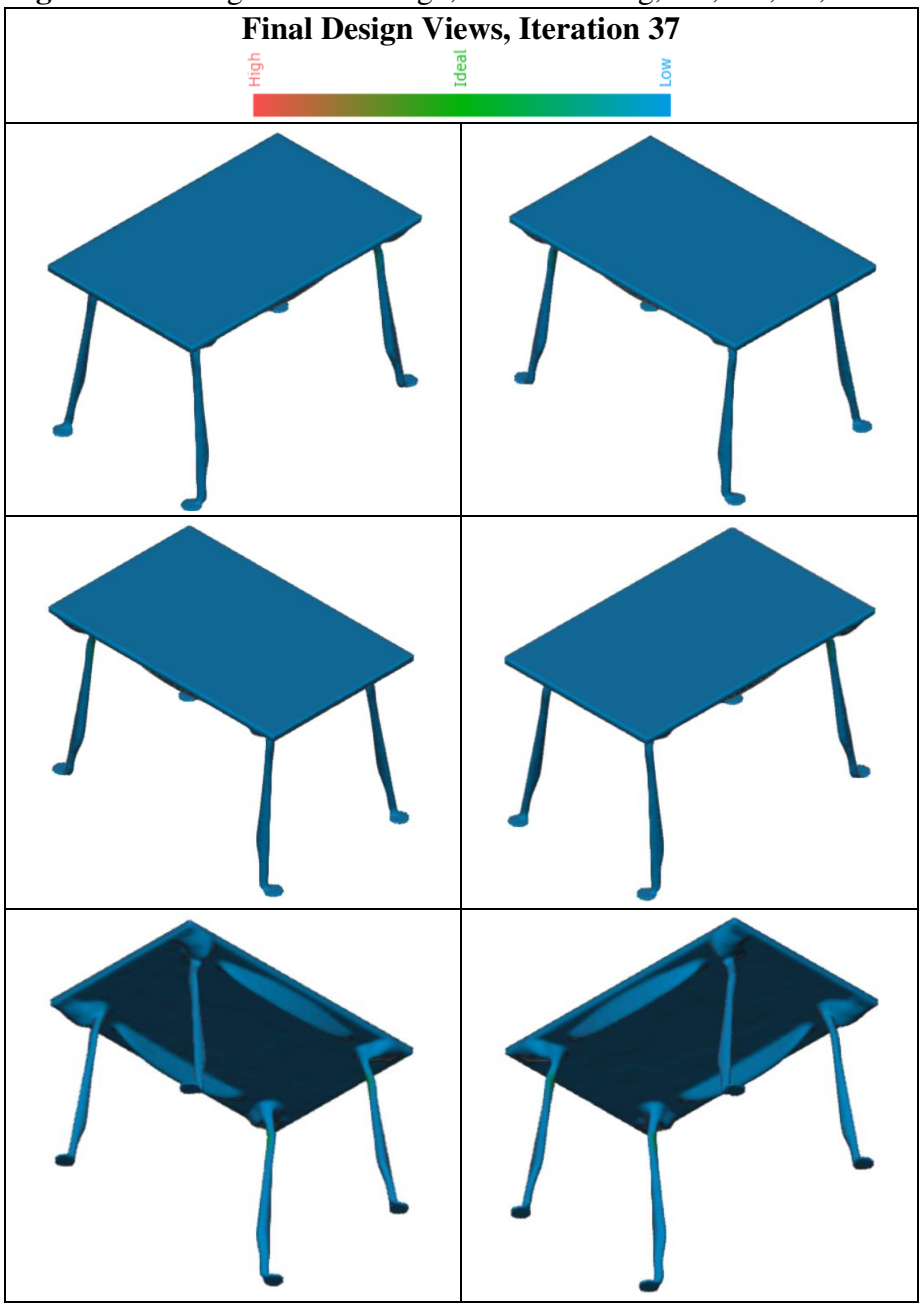

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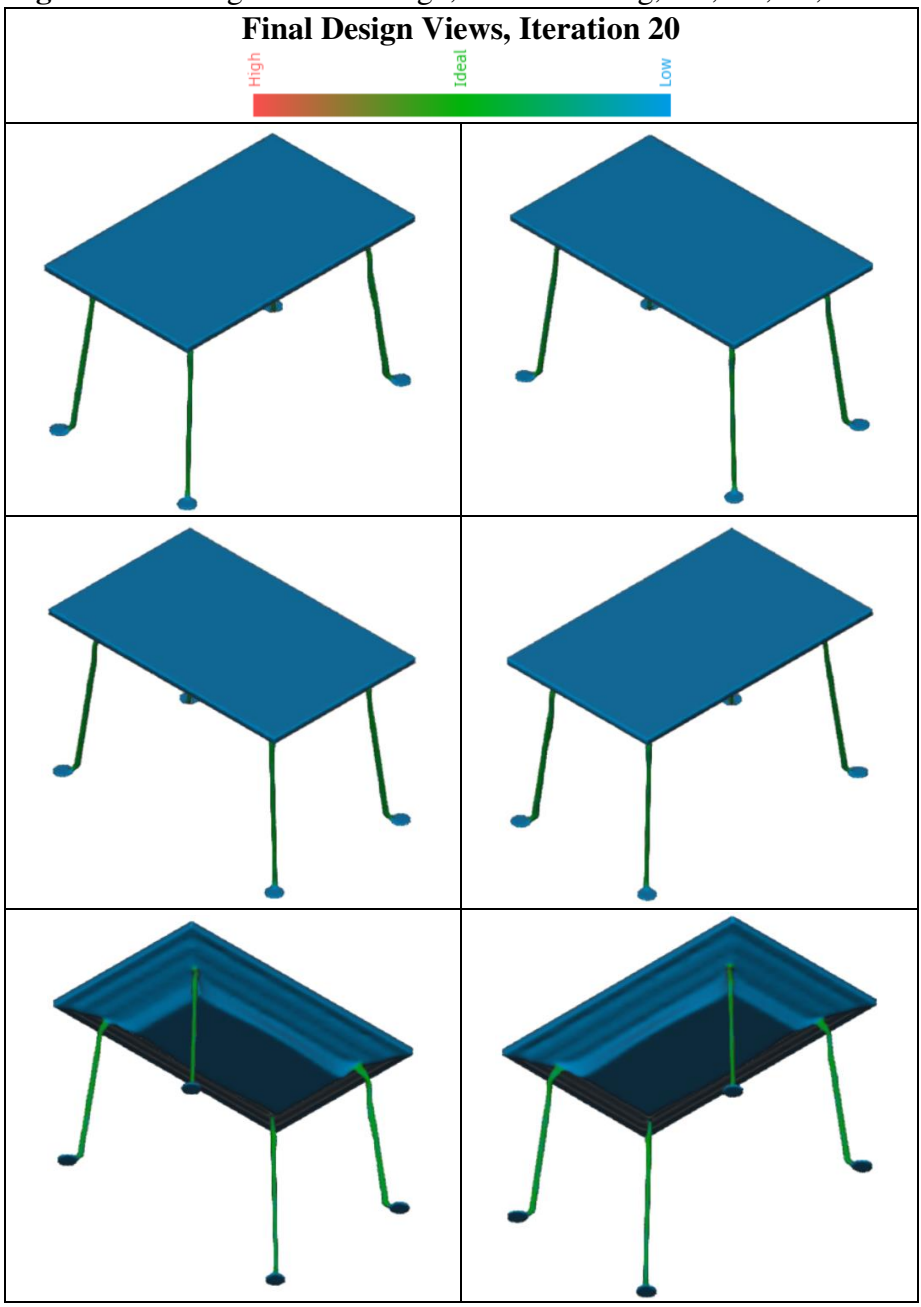

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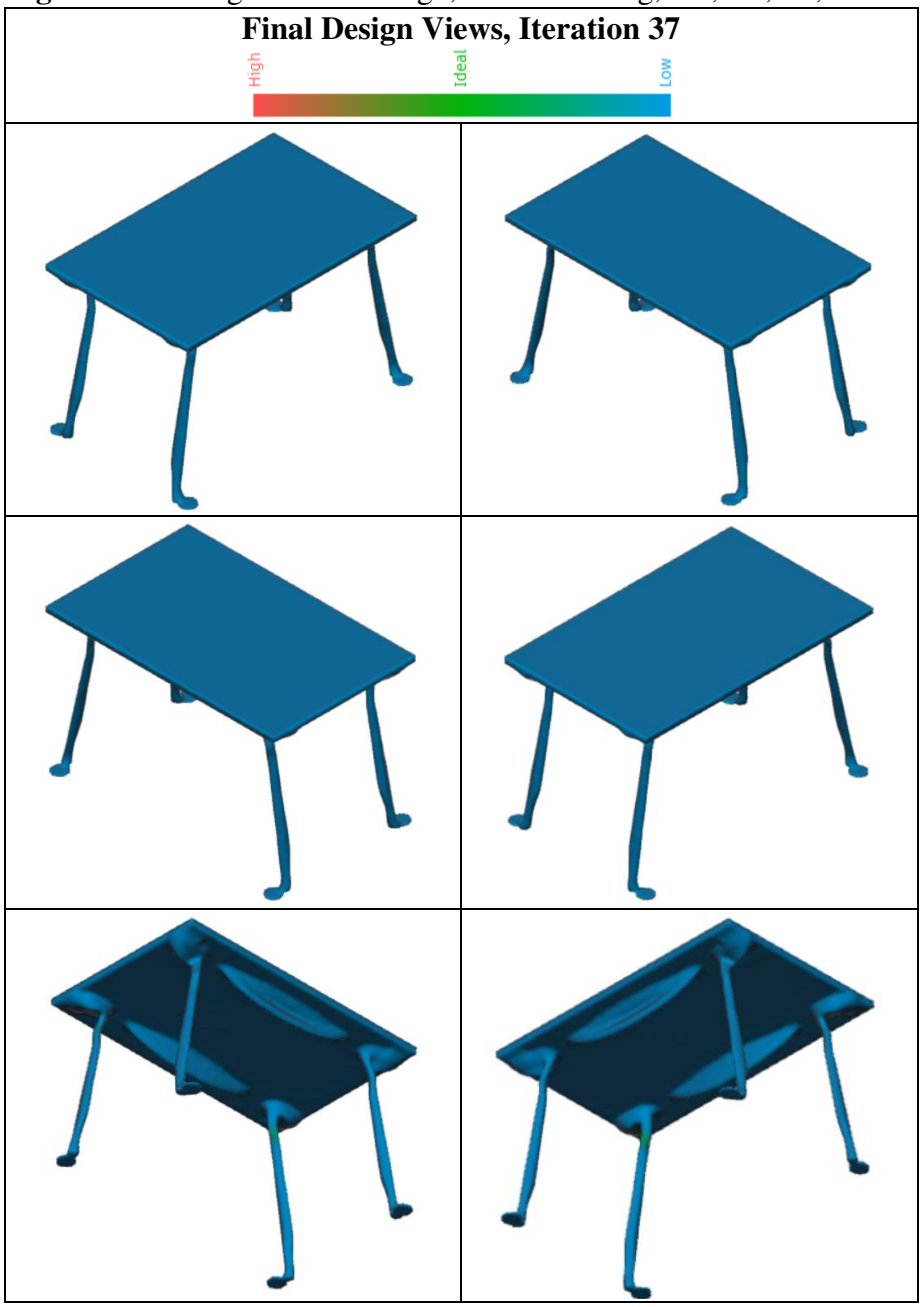

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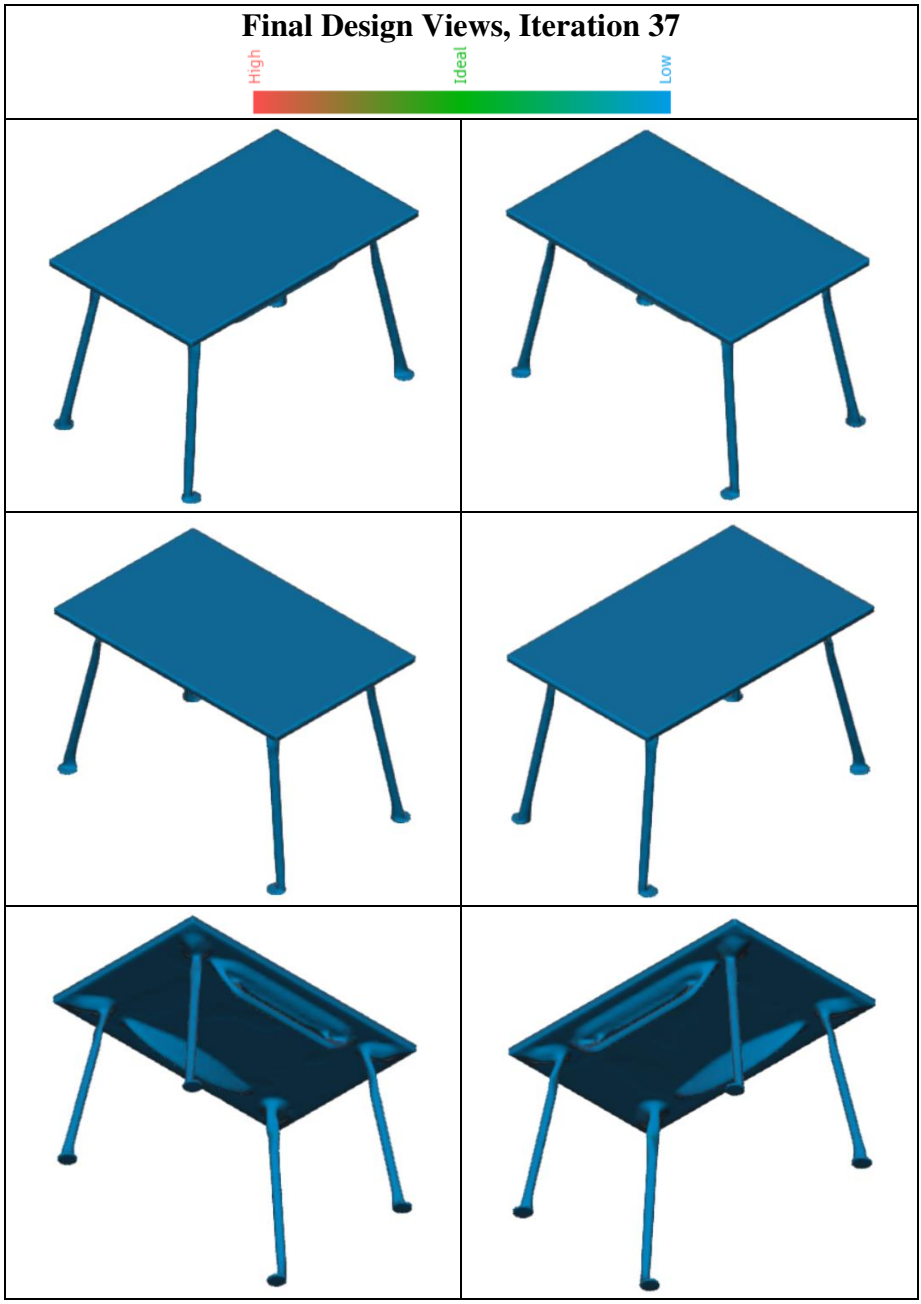

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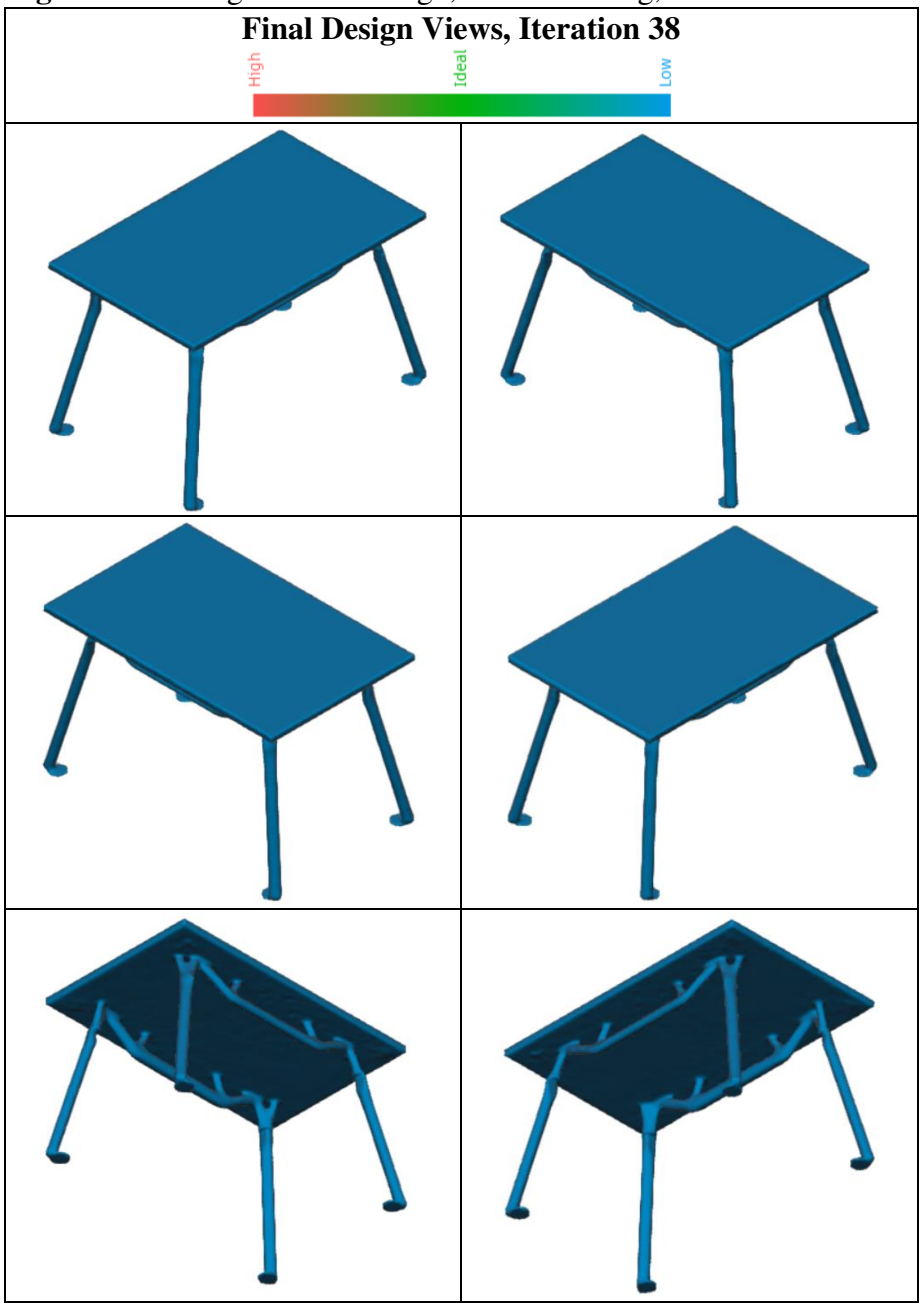


Figure 17. Dining Table-1 Design, 2 Axis Cutting, Z

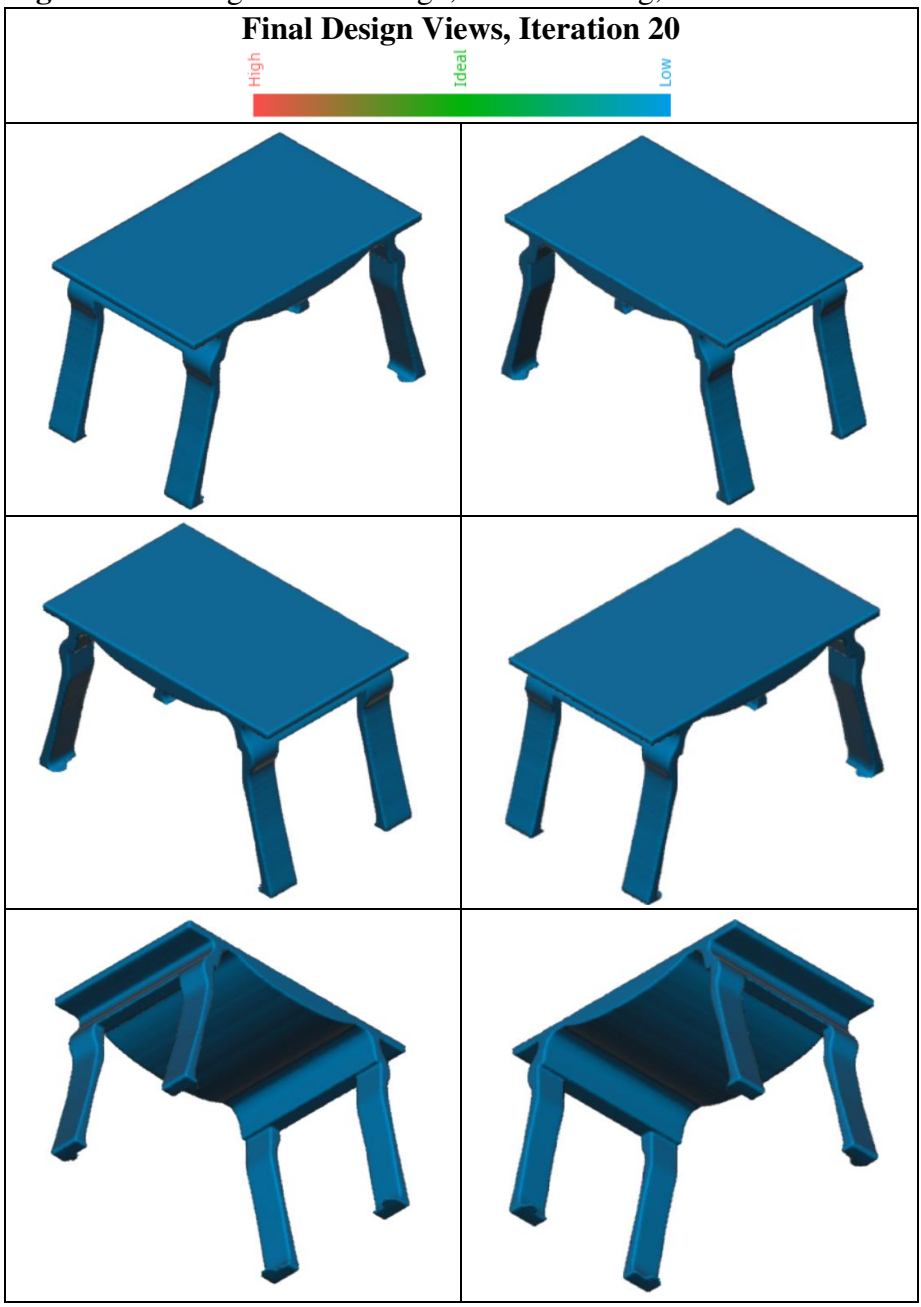


Figure 18. Dining Table-1 Design, Die Casting, X+, X-

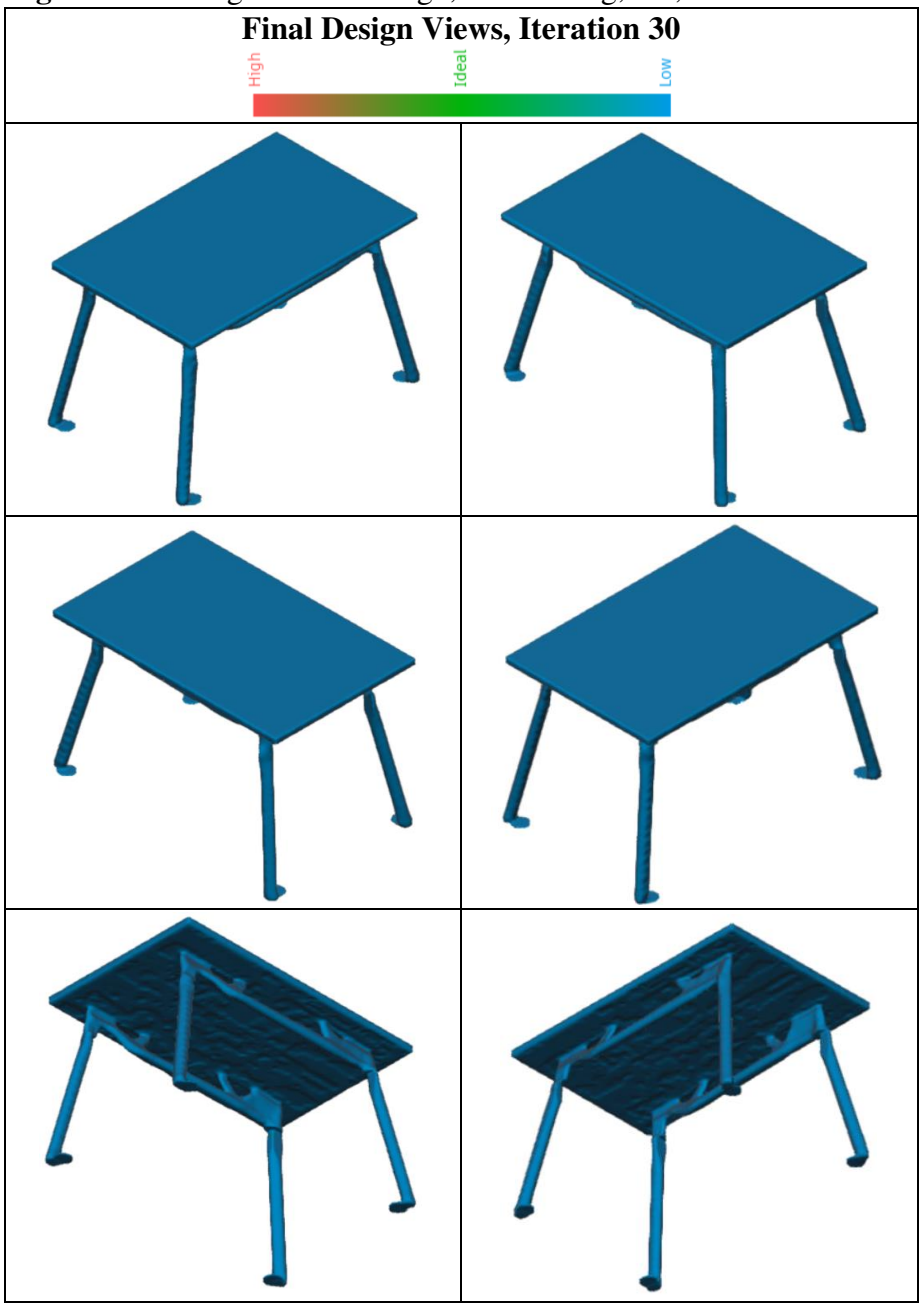
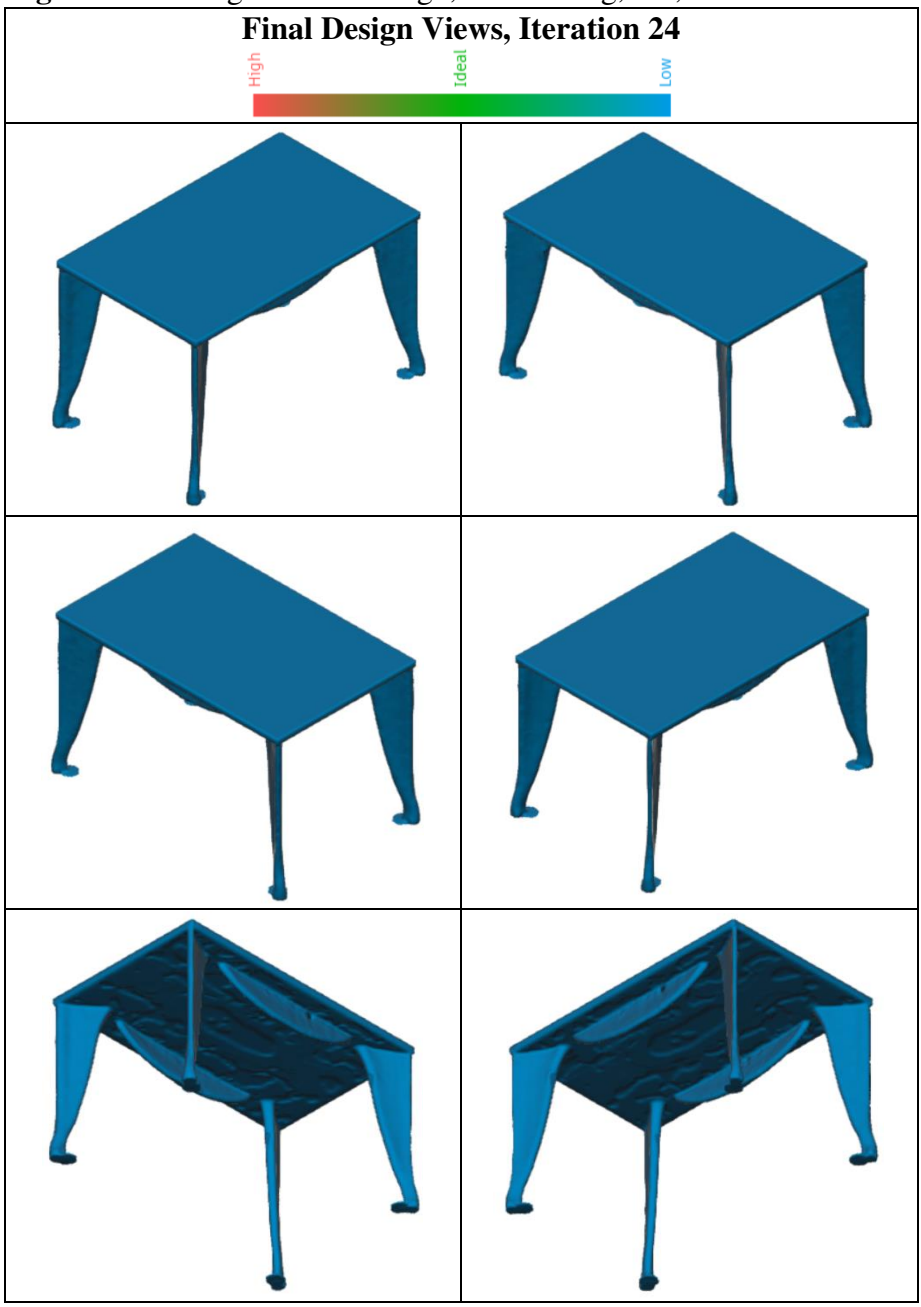


Figure 19. Dining Table-1 Design, Die Casting, Y+, Y-



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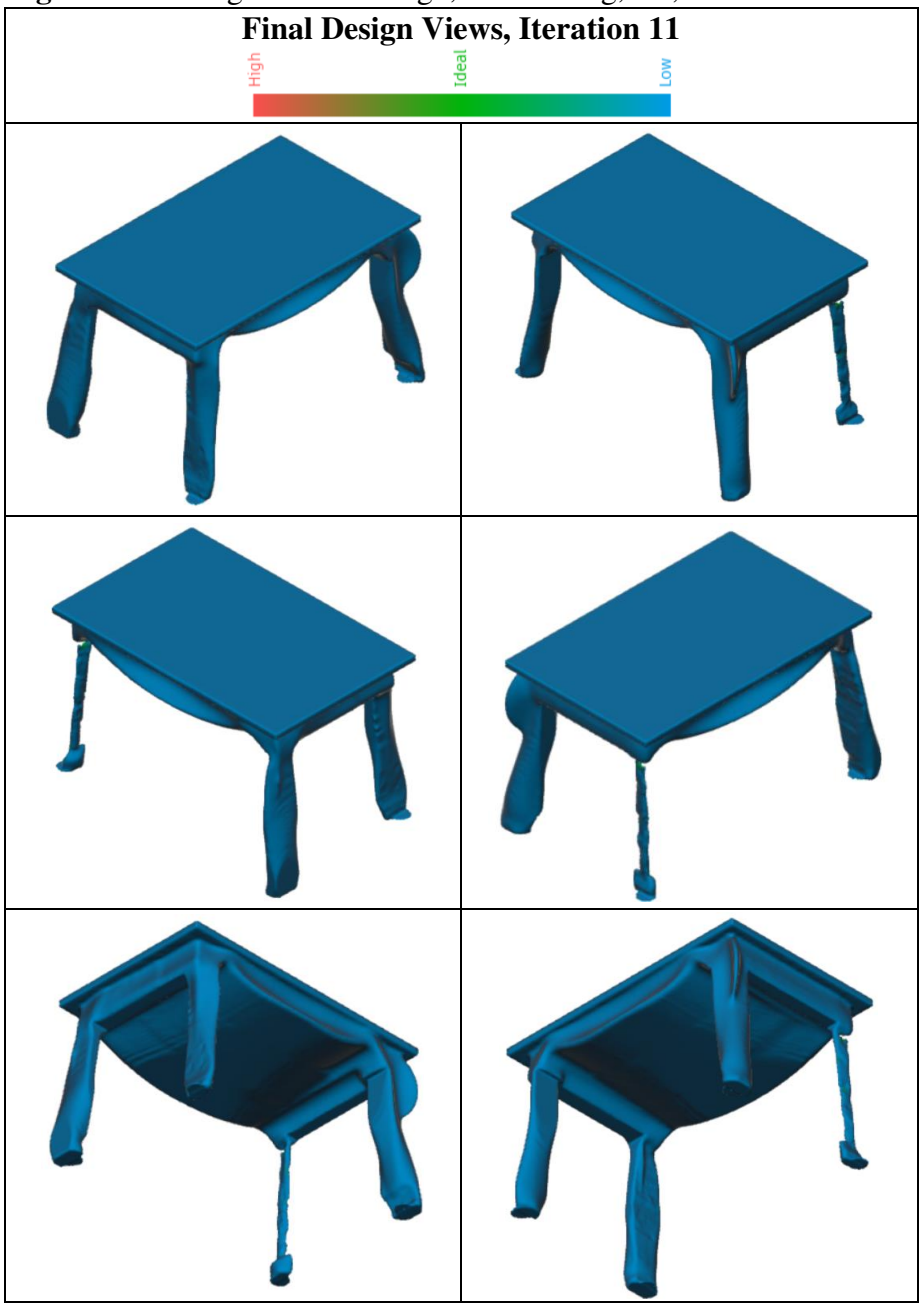

Table 1: The Values Calculated for The Dining Table-1 Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	8.972e+7	71.776	0.3	0.06
Additive	X+	3.711e+7	29.685	1.3	0.24
	X-	3.644e+7	29.153	1.3	0.3
	Y+	1.069e+8	85.491	3.9	0.8
	Y-	3.61e+7	28.879	1.4	0.22
	Z+	3.662e+7	29.299	3	0.31
	Z-	3.67e+7	29.364	2.3	0.26
3 axis milling	X+, Y+, X-, Y-	3.681e+7	29.447	1.5	0.46
	X+, Z+, X-, Z-	8.386e+7	67.089	3.8	0.57
	Y+, Z+, Y-, Z-	3.628e+7	29.028	1.5	0.14
	X+, Y+, Z+, X-, Y-, Z-	3.702e+7	29.614	1	0.31
5 axis milling	Unrestricted	3.621e+7	28.968	0.7	0.19
2 axis cutting	Z	7.48e+7	59.837	0.4	0.11
Die casting	X+, X-	3.816e+7	30.524	1	0.2
	Y+, Y-	4.125e+7	33.004	0.4	0.21
	Z+, Z-	1.215e+8	97.178	1.2	0.14

3.2. Dining Table-2 Designs

In this model, it is aimed to design leg forms from the middle area of the dining table, and obstacle geometries are created accordingly. A force of 750 N was applied onto the dining table, 50 mm from the corners. The dimensions used for the dining table-2 are the same as those used for the dining table-1. The views of designs created by generative design for the dining table-2 are shown in figures 24-39.

Figure 21. Views of Load Applied to The Dining Table-2

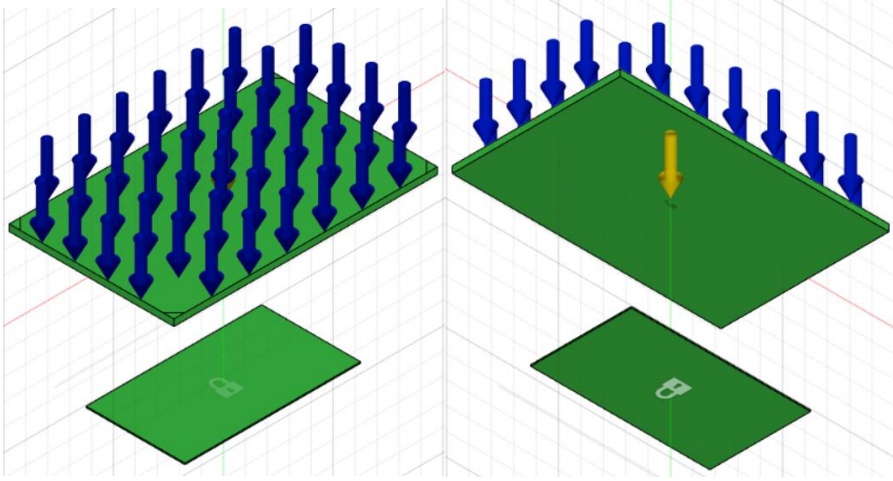

Figure 22. Front and Side Views of Preserve and Obstacle Geometries of The Dining Table-2

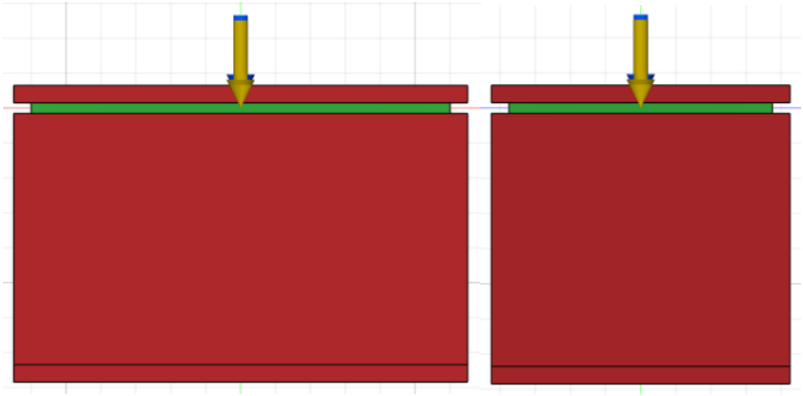

Figure 23. Perspective View of Obstacle Geometry of The Dining Table-2

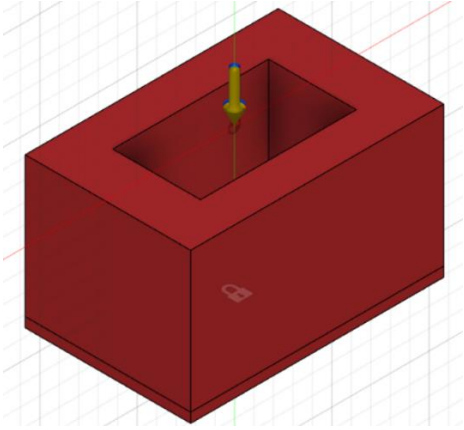

Figure 24. Dining Table-2 Design, Unrestricted, -

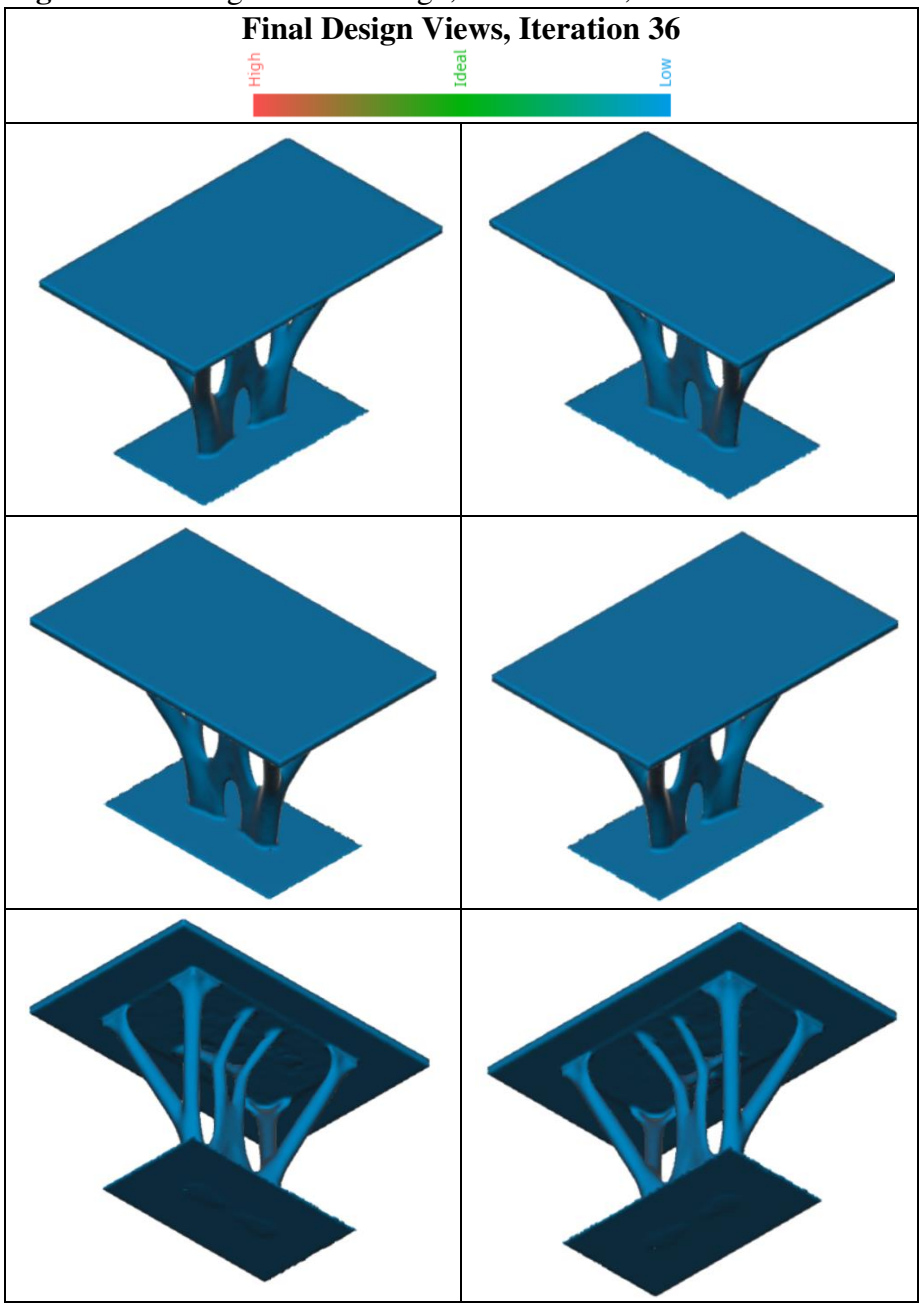

Figure 25. Dining Table-2 Design, Additive, X+

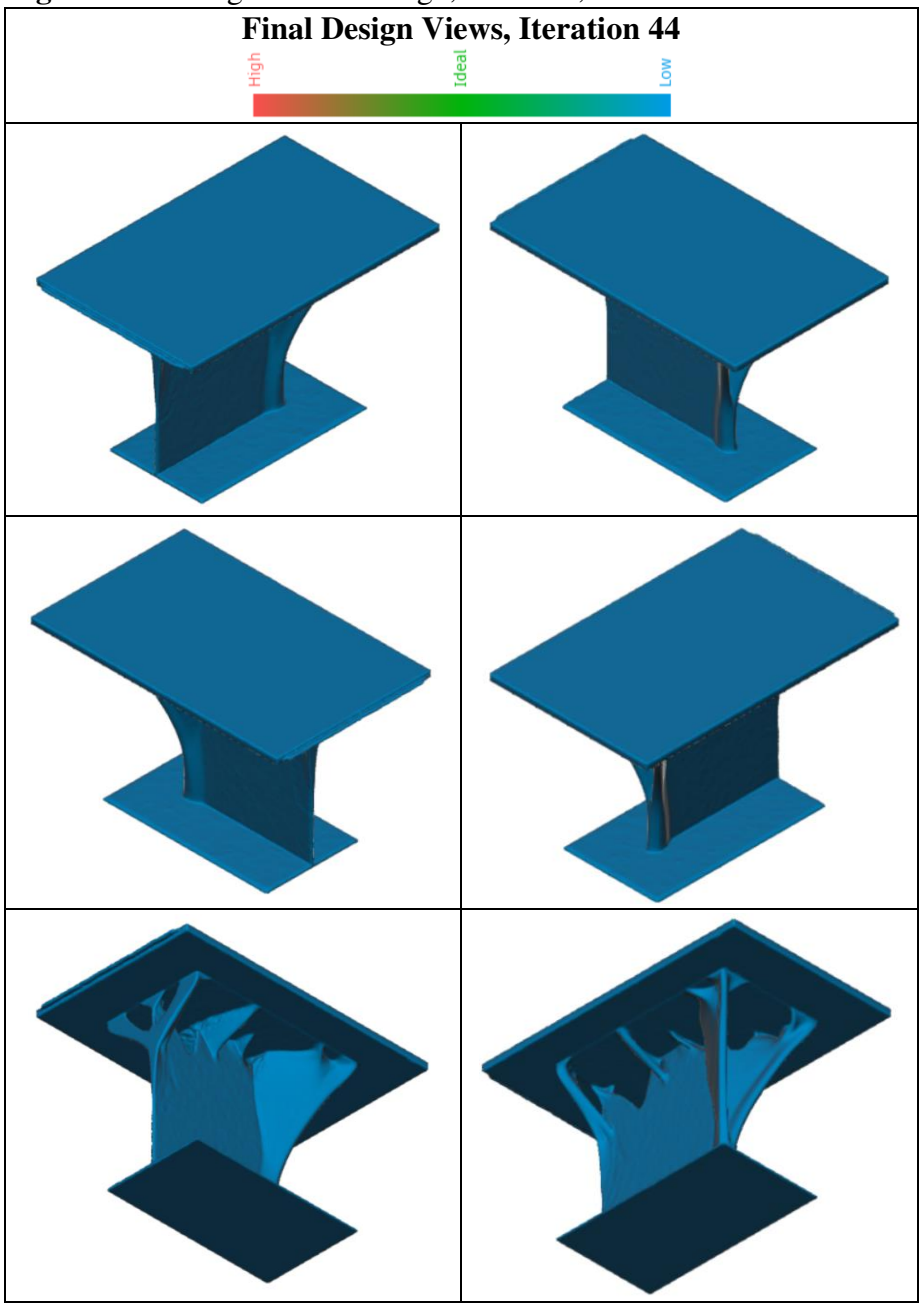

Figure 26. Dining Table-2 Design, Additive, X-

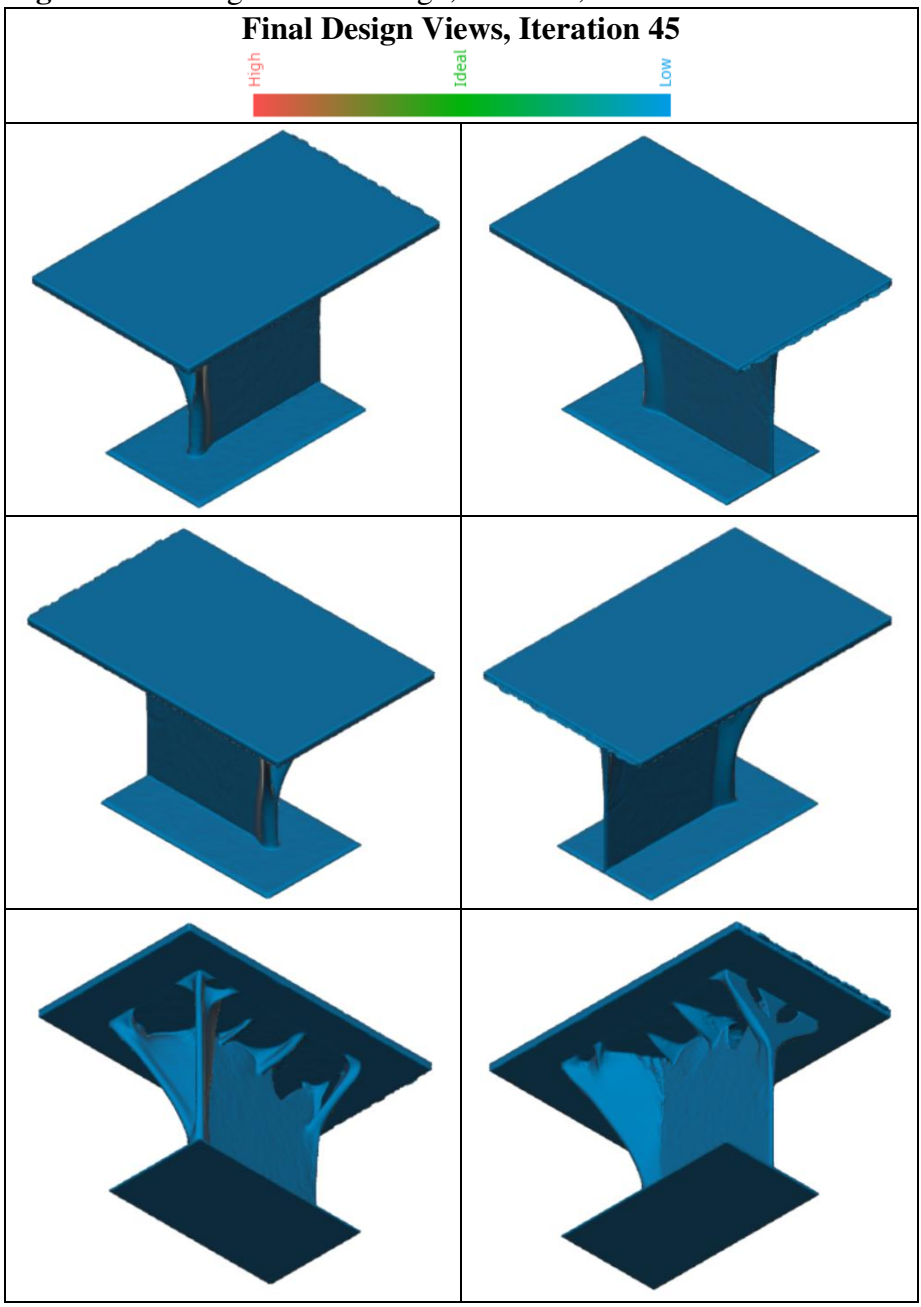

Figure 27. Dining Table-2 Design, Additive, Y+

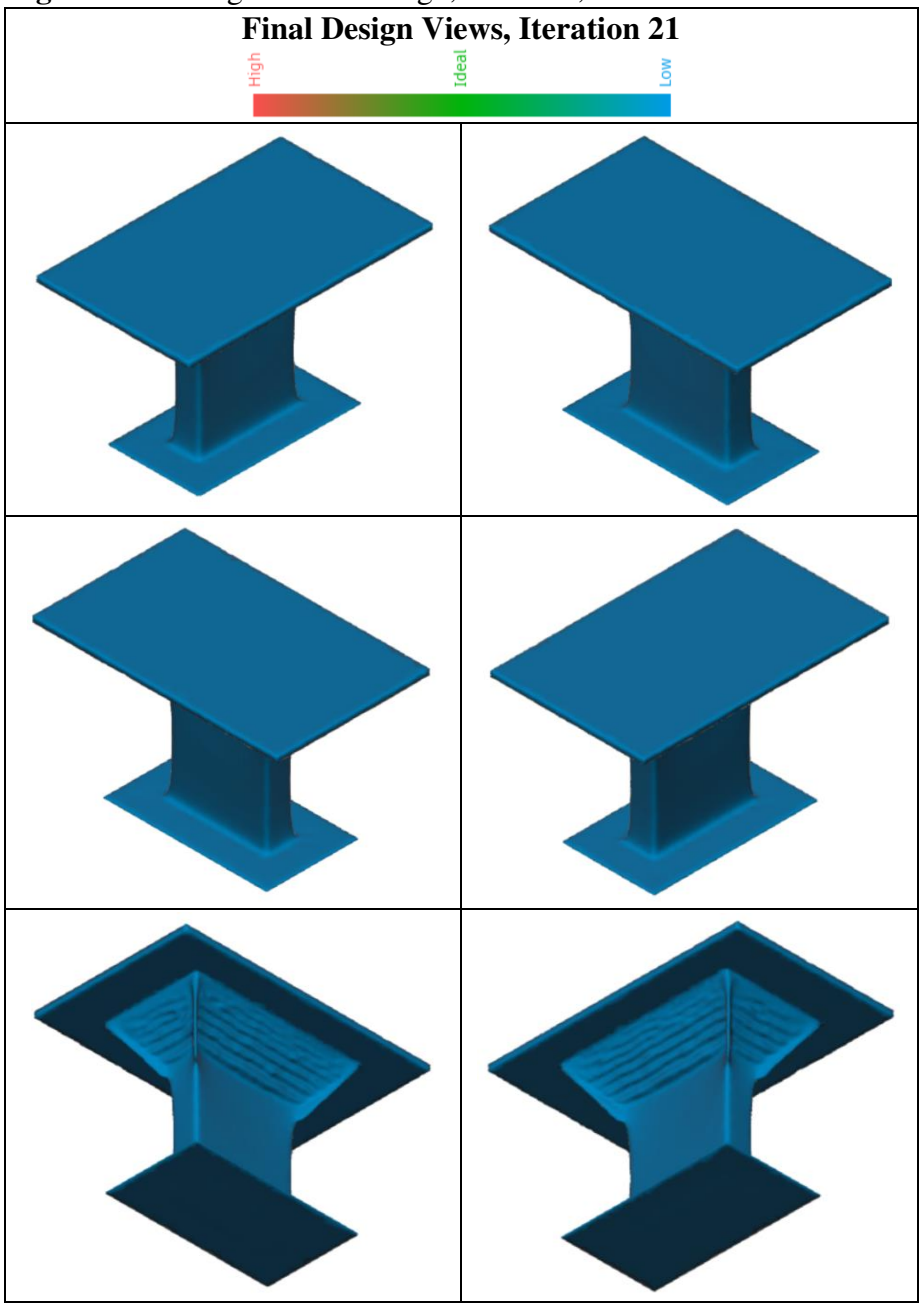

Figure 28. Dining Table-2 Design, Additive, Y-

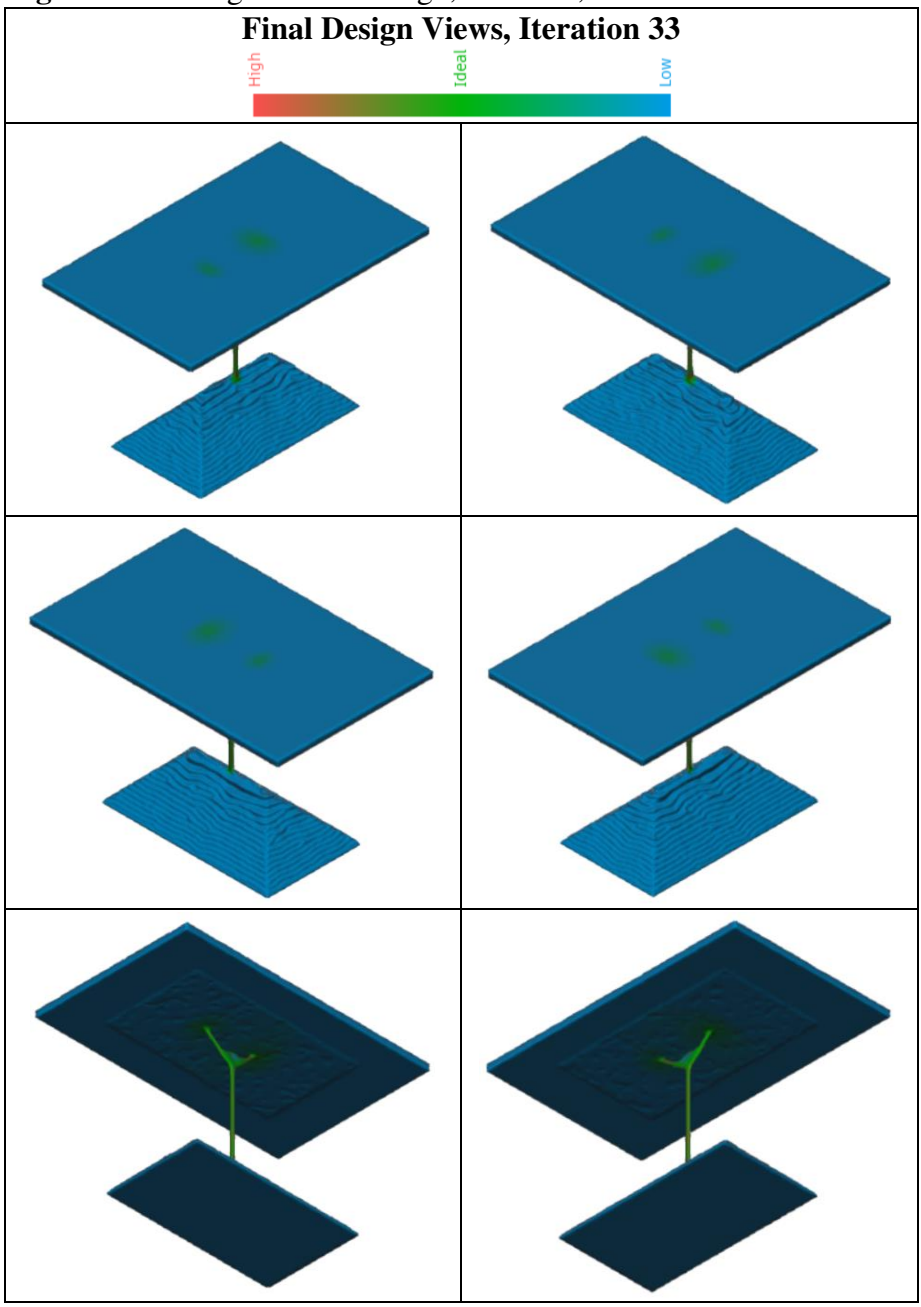

Figure 29. Dining Table-2 Design, Additive, Z+

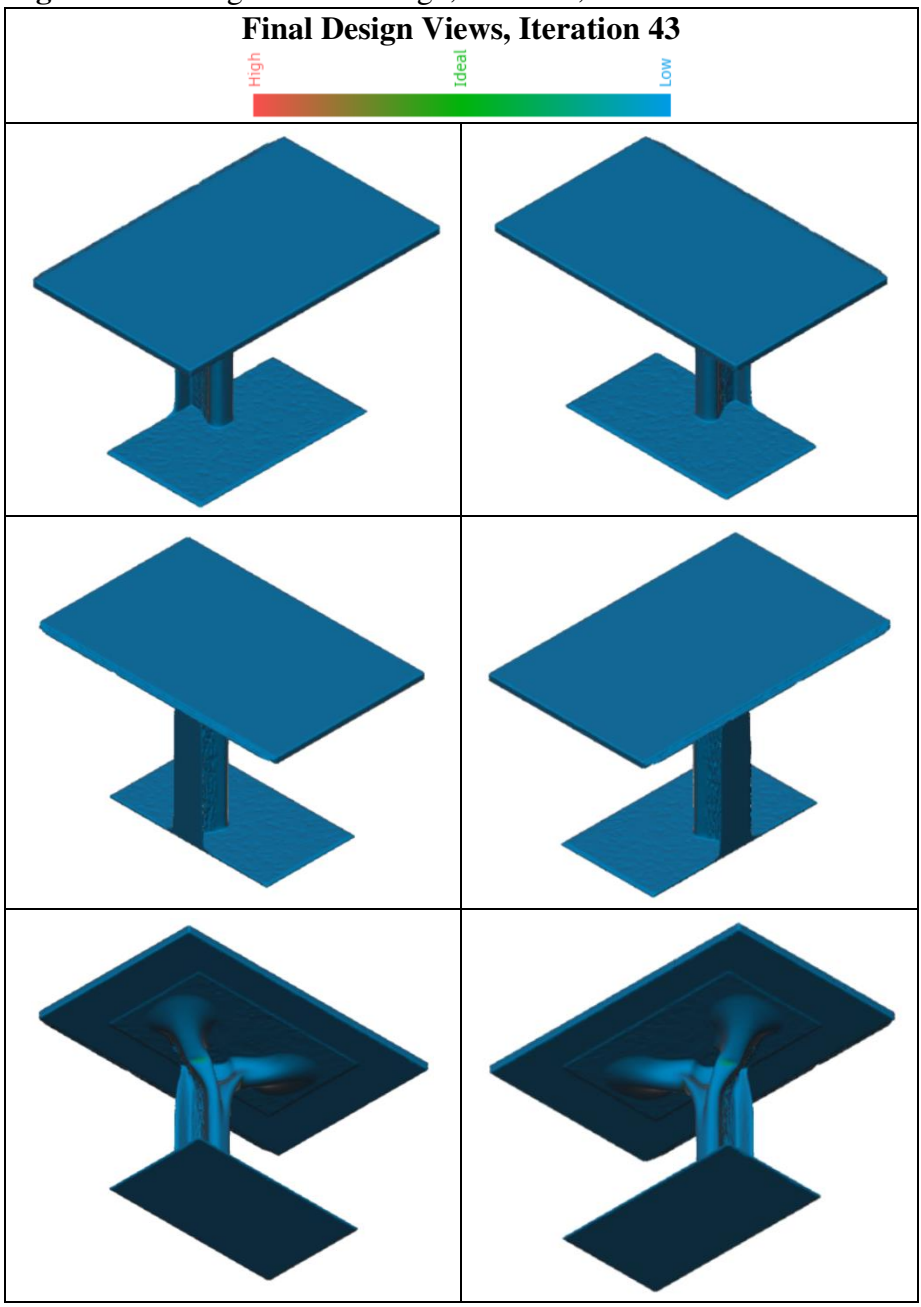

Figure 30. Dining Table-2 Design, Additive, Z-

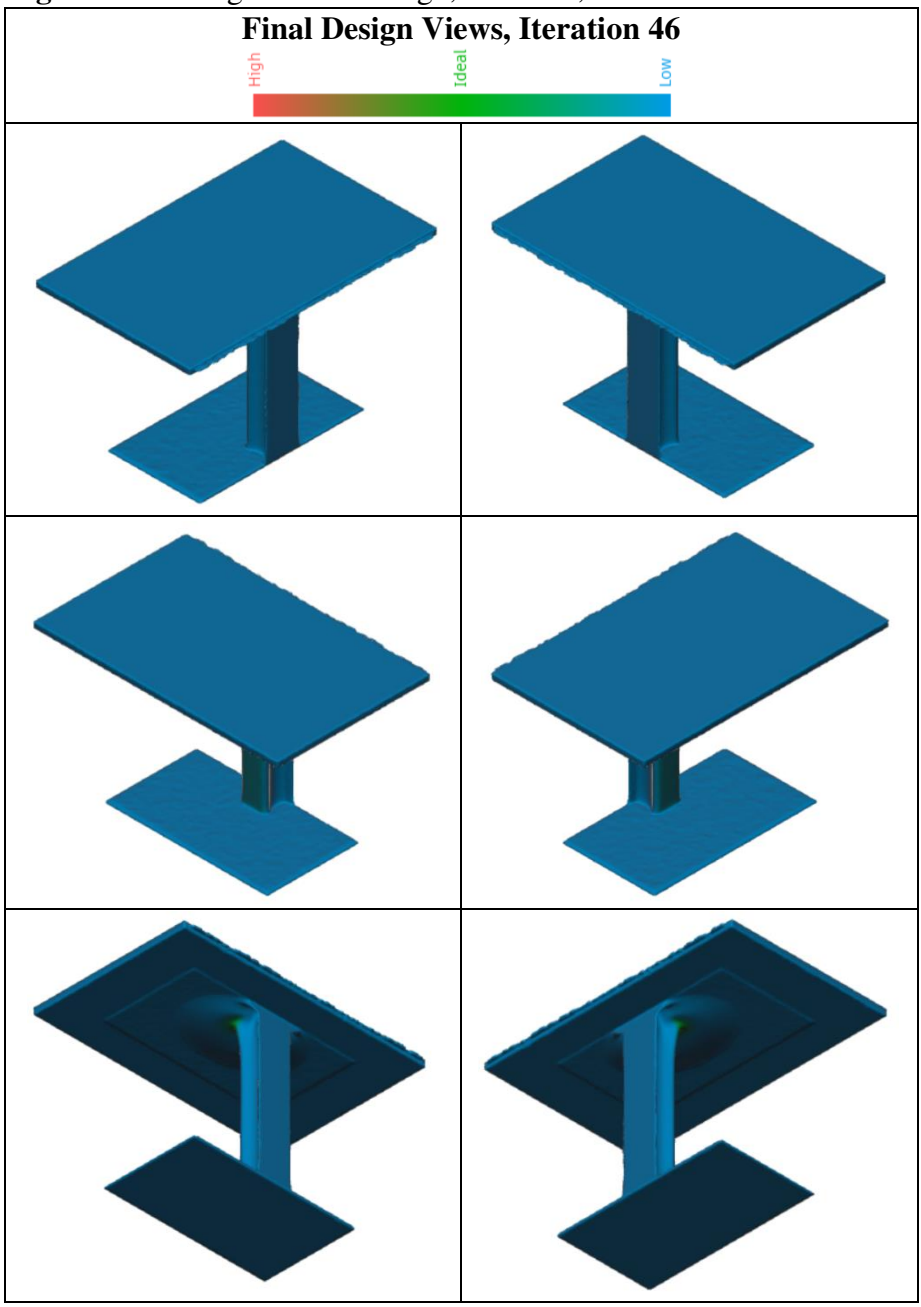

Figure 31. Dining Table-2 Design, 3 Axis Milling, X+, Y+, X-, Y-

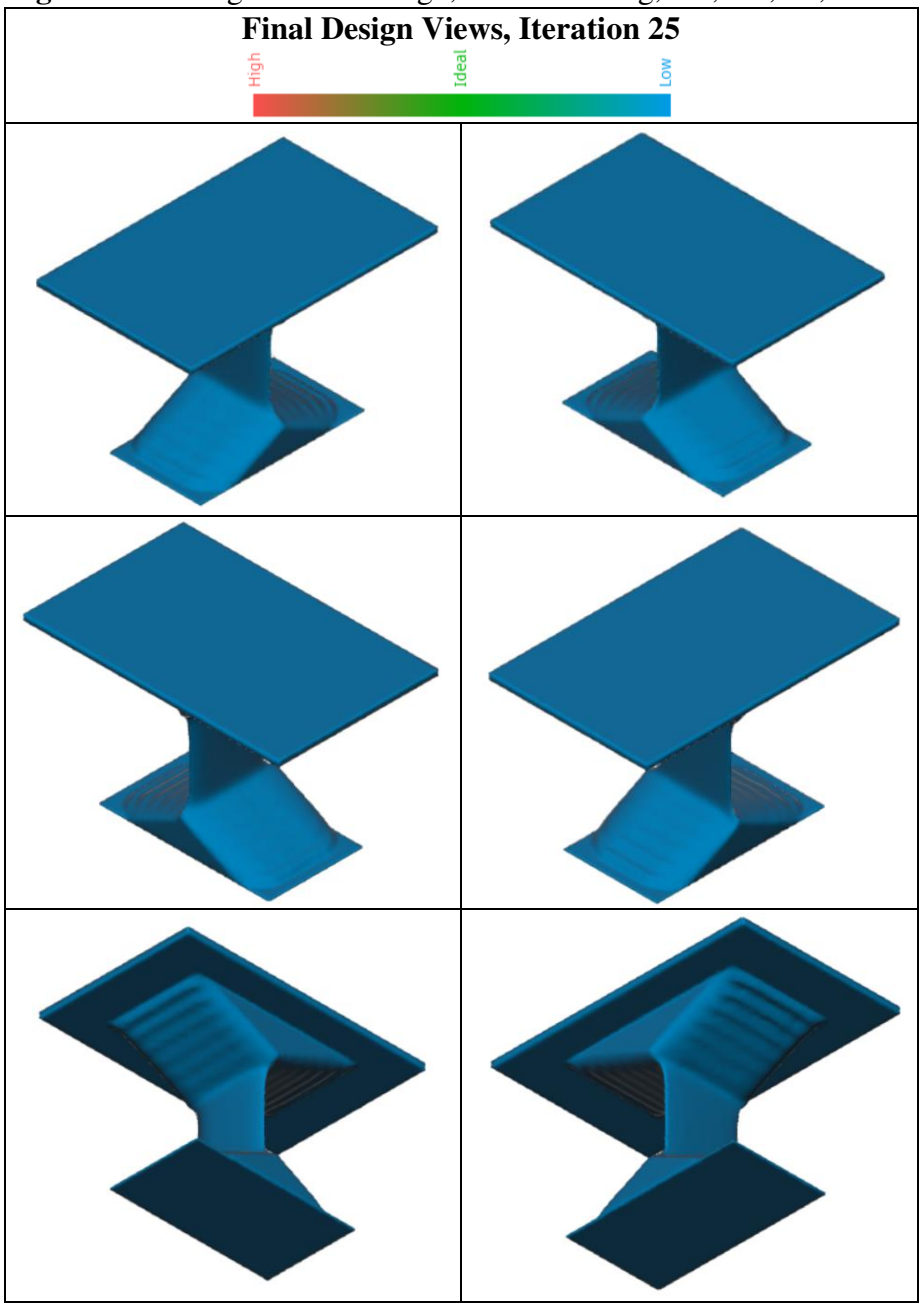

Figure 32. Dining Table-2 Design, 3 Axis Milling, X+, Z+, X-, Z-

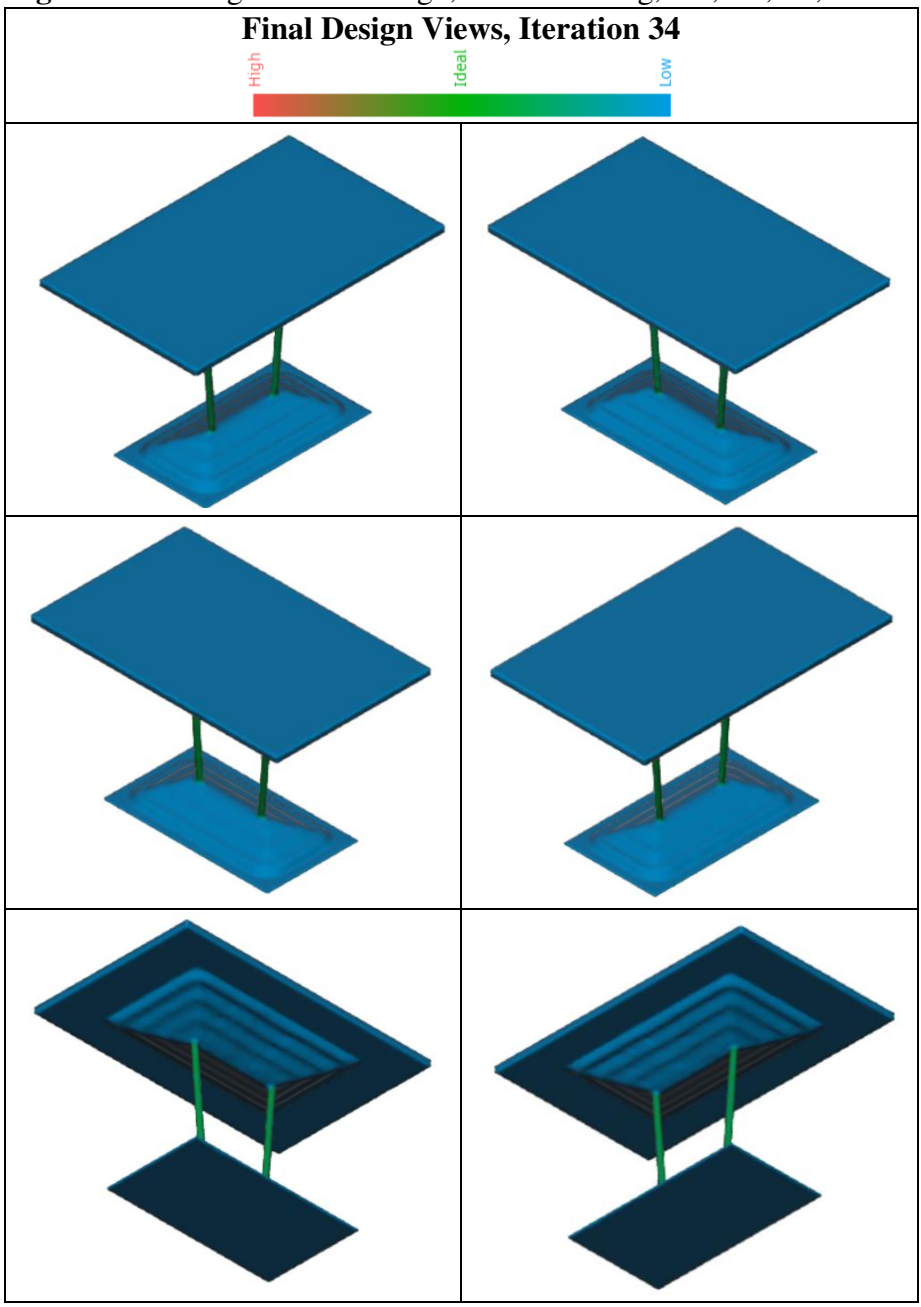

Figure 33. Dining Table-2 Design, 3 Axis Milling, Y+, Z+, Y-, Z-

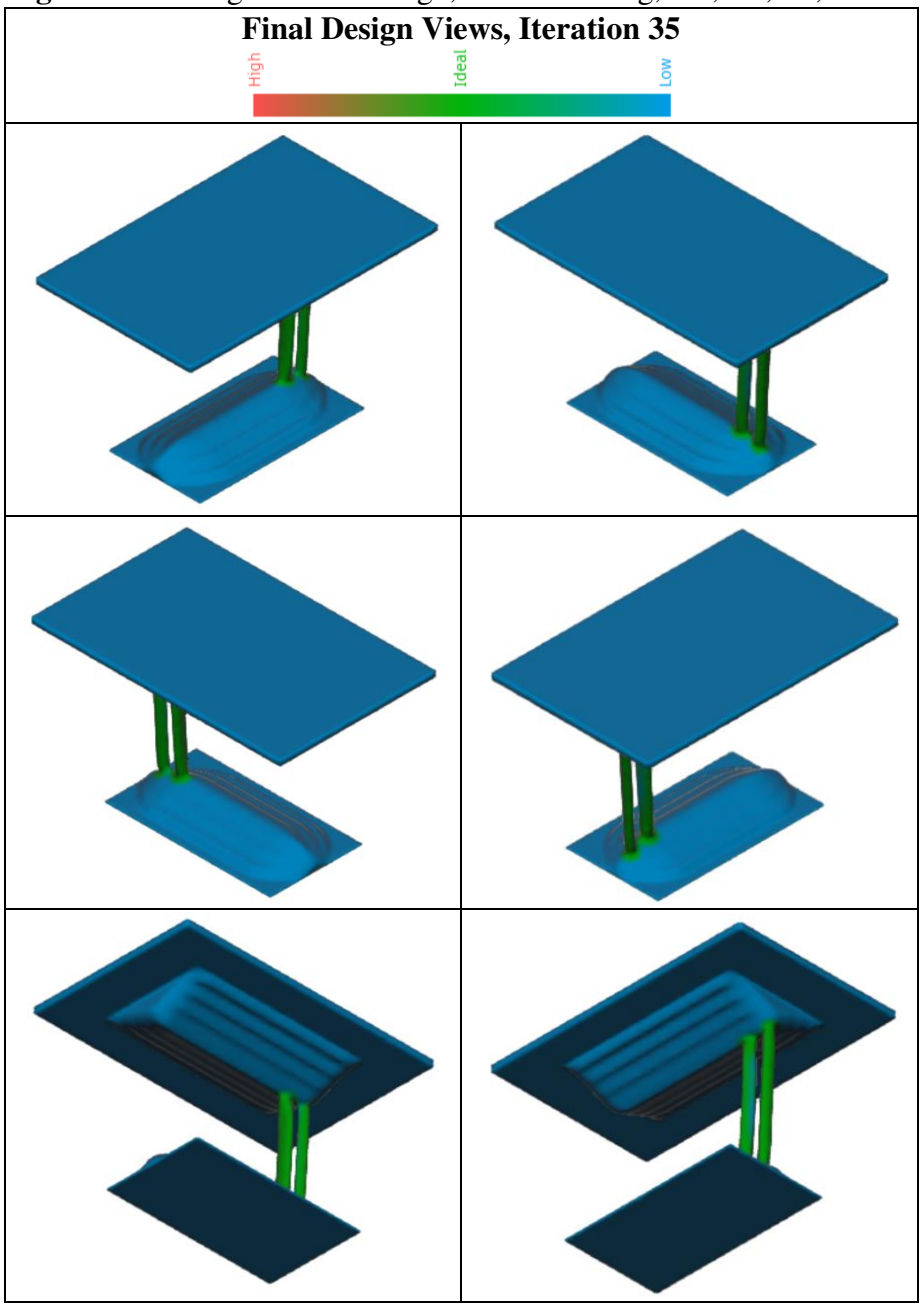

Figure 34. Dining Table-2 Design, 3 Axis Milling, X+, Y+, Z+, X-, Y-, Z-

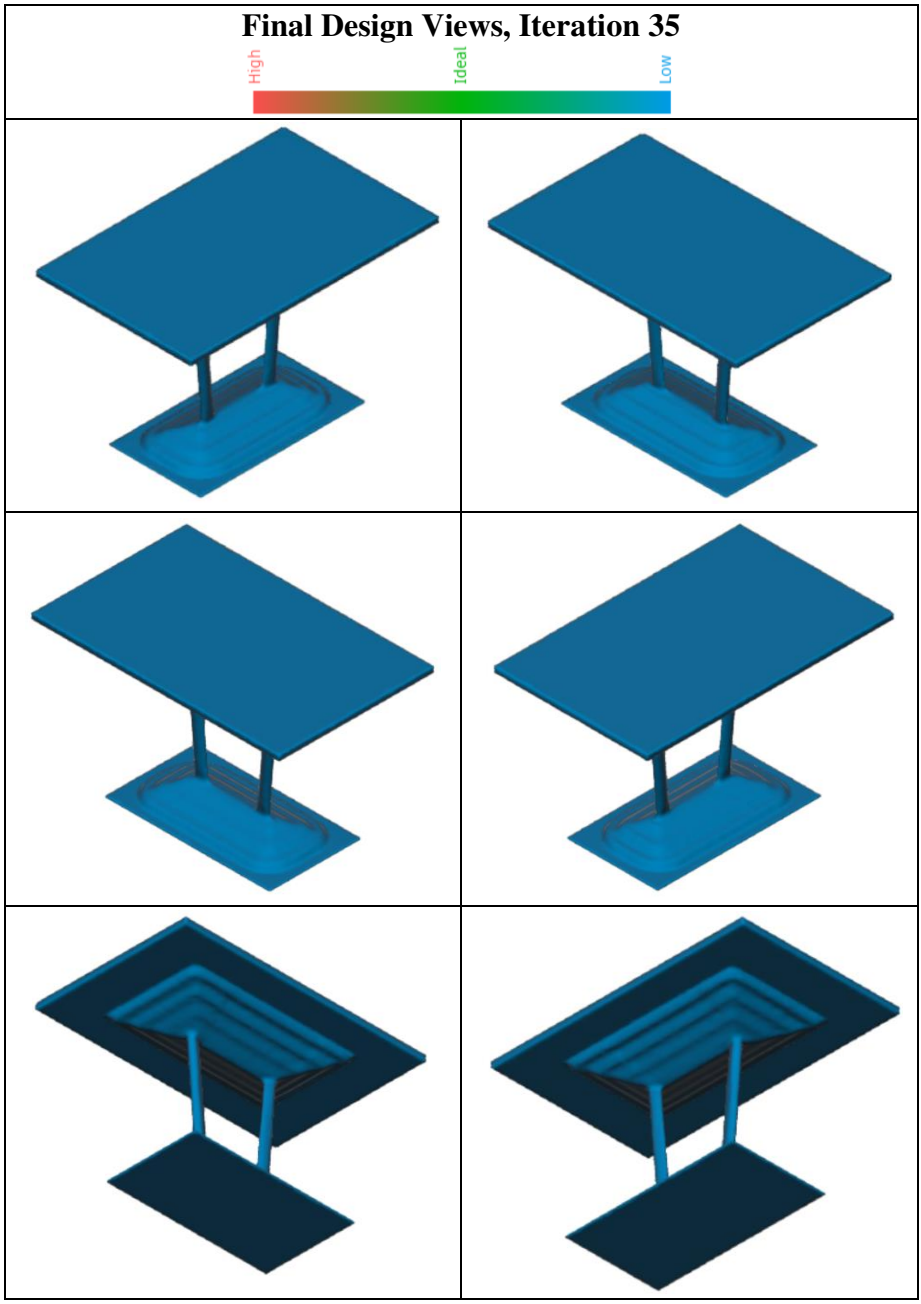

Figure 35. Dining Table-2 Design, 5 Axis Milling, Unrestricted

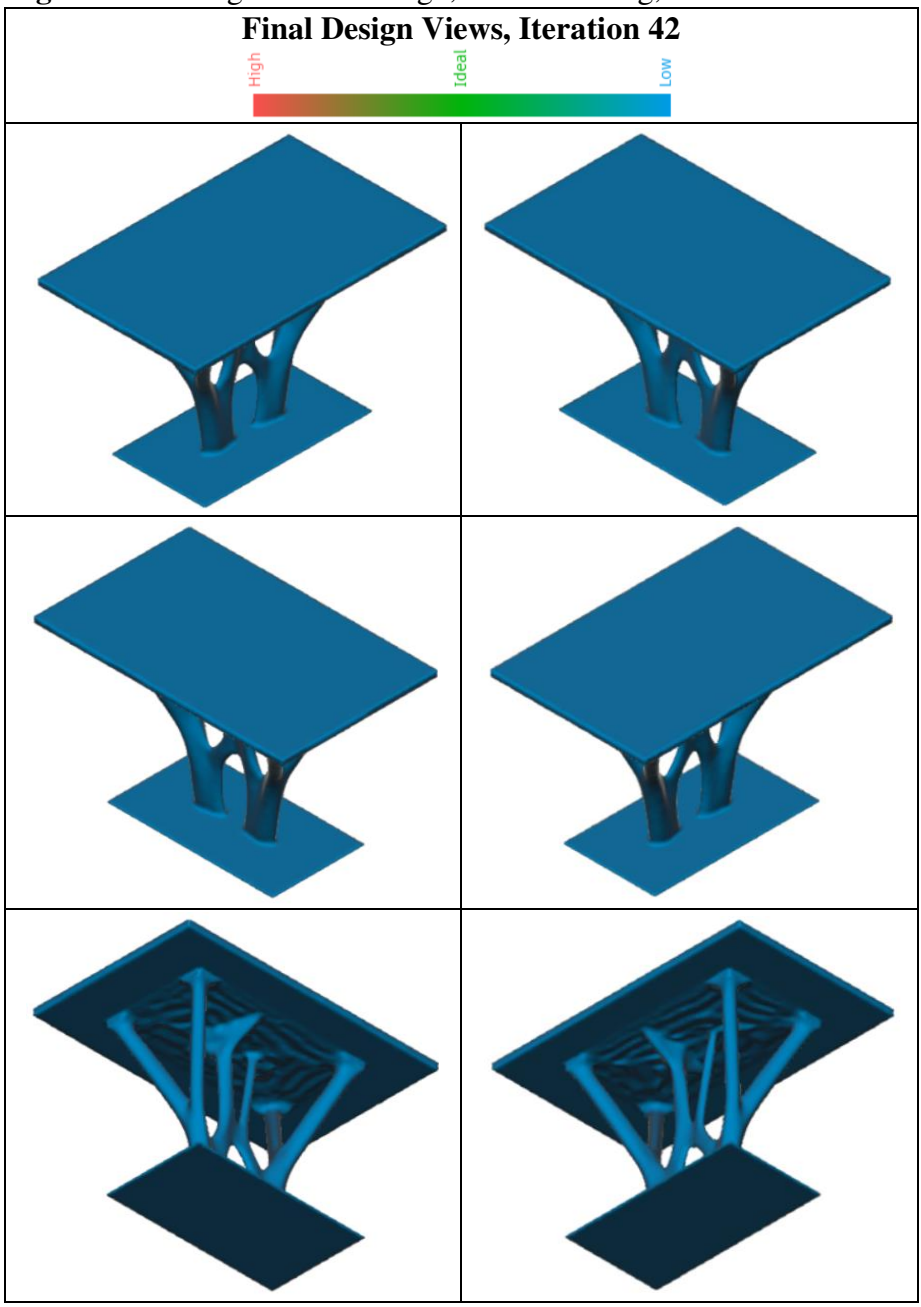

Figure 36. Dining Table-2 Design, 2 Axis Cutting, Z

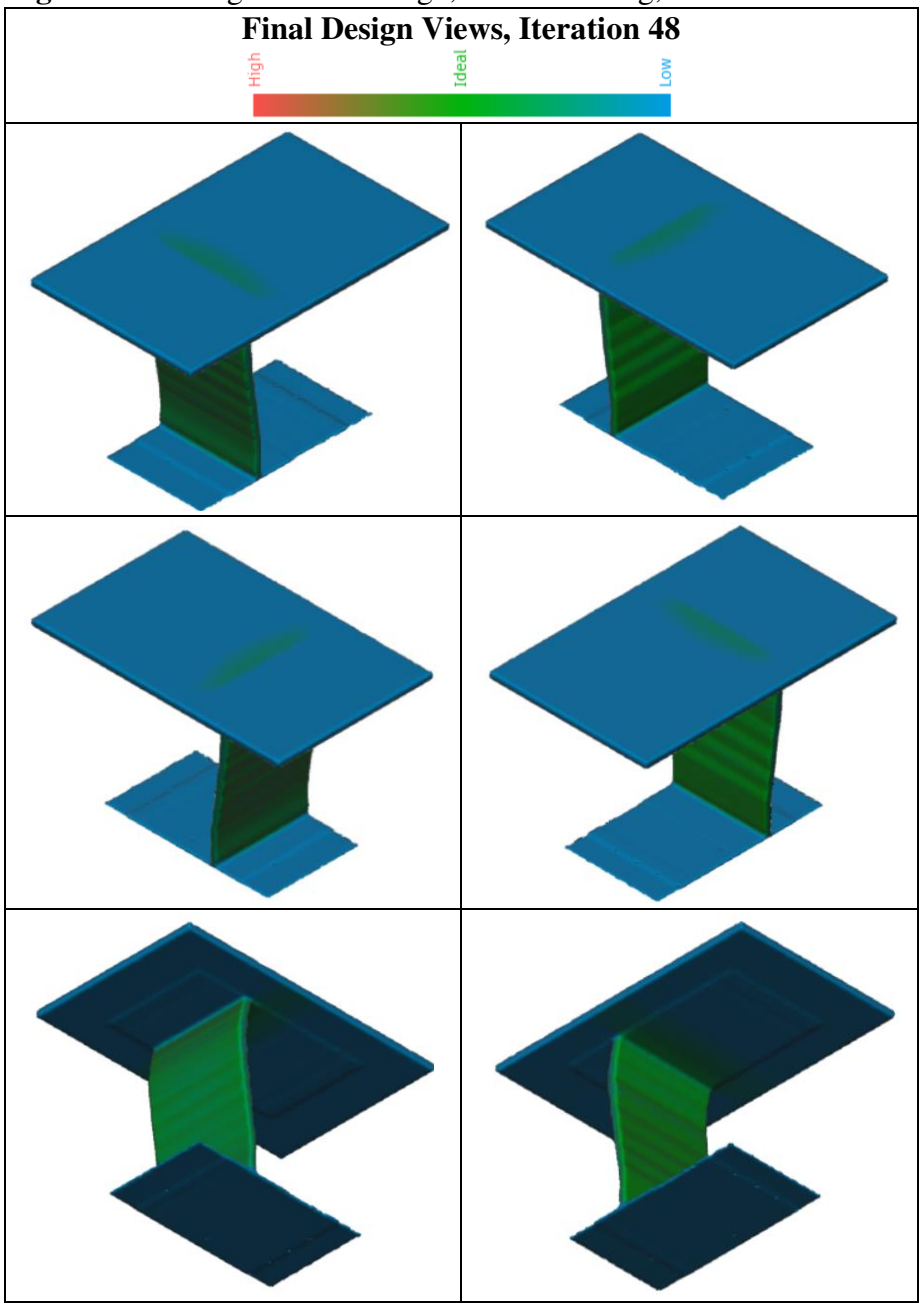

Figure 37. Dining Table-2 Design, Die Casting, X+, X-

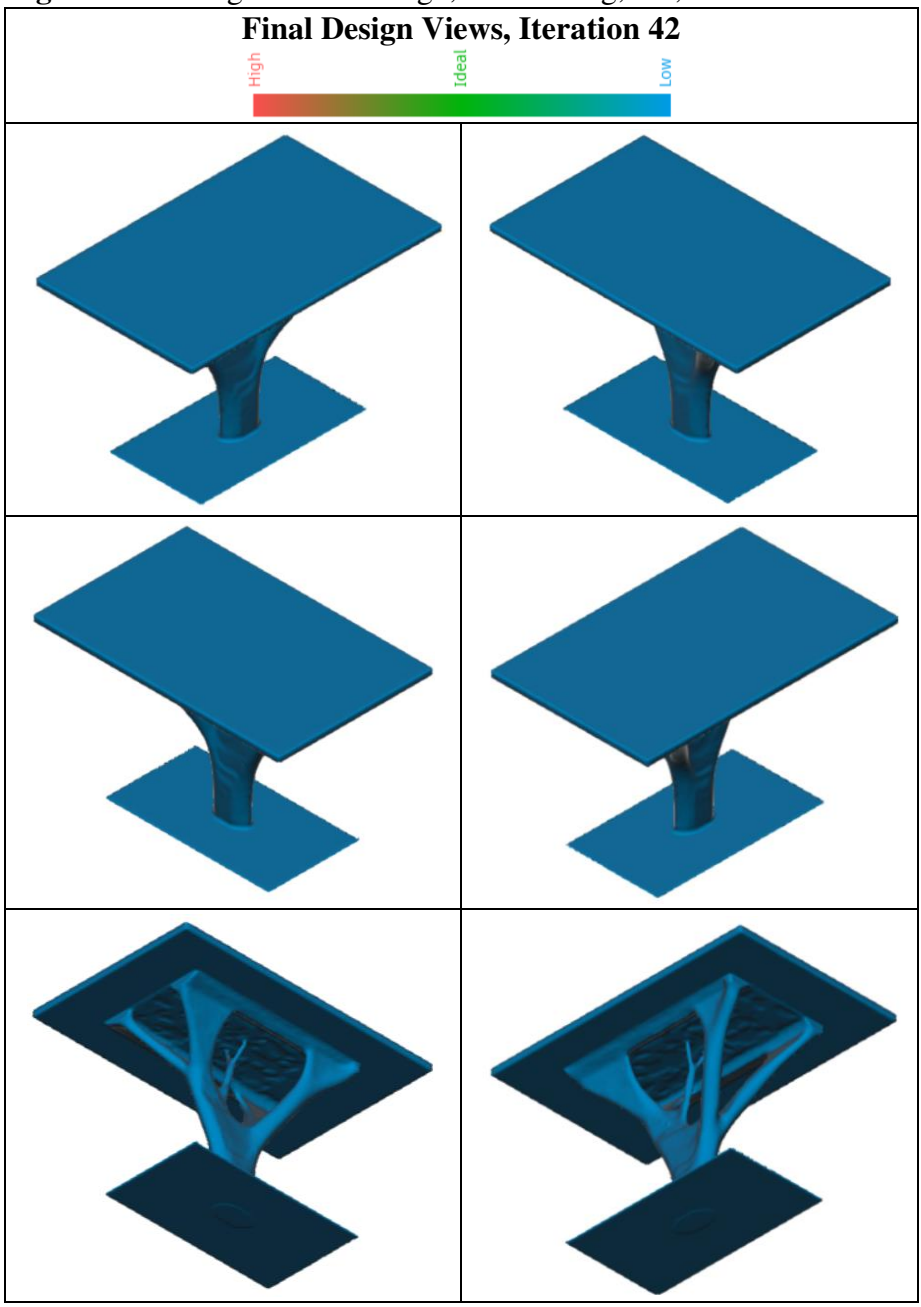

Figure 38. Dining Table-2 Design, Die Casting, Y+, Y-

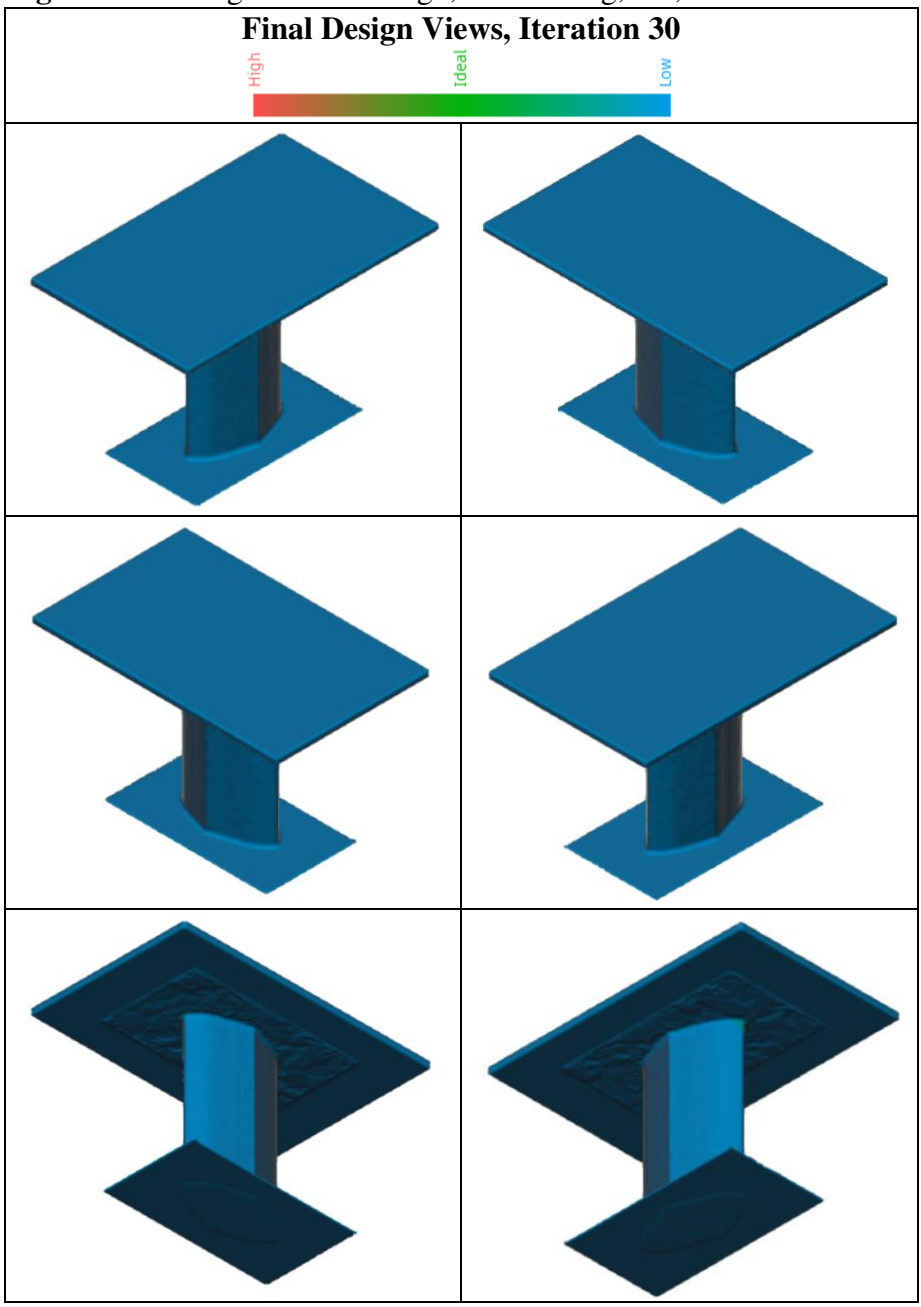

Figure 39. Dining Table-2 Design, Die Casting, Z+, Z-

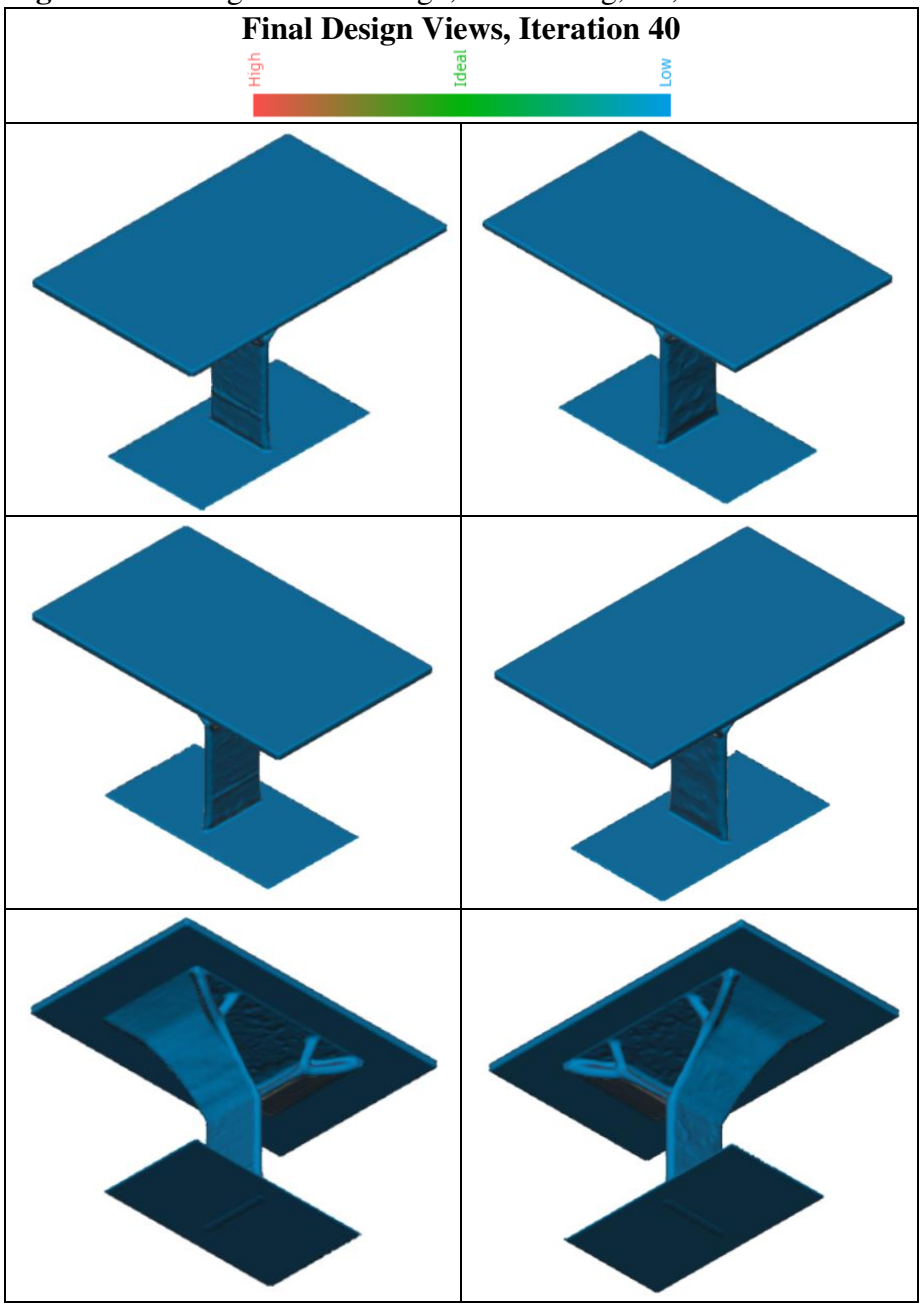

Table 2: The Values Calculated for The Dining Table-2 Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	4.22e+7	33.759	0.3	0.1
Additive	X+	4.359e+7	34.874	0.7	0.16
	X-	4.345e+7	34.76	1.1	0.17
	Y+	9.789e+7	78.311	0.6	0.12
	Y-	6.277e+7	50.219	5.4	5.53
	Z+	4.247e+7	33.973	1.2	1.57
	Z-	4.294e+7	34.352	2.4	3.43
3 axis milling	X+, Y+, X-, Y-	9.272e+7	74.179	0.3	0.4
	X+, Z+, X-, Z-	5.996e+7	47.971	1.6	1.3
	Y+, Z+, Y-, Z-	6.467e+7	51.735	3.9	14.7
	X+, Y+, Z+, X-, Y-, Z-	6.037e+7	48.298	0.6	0.36
5 axis milling	Unrestricted	4.256e+7	34.044	0.3	0.11
2 axis cutting	Z	4.172e+7	33.373	2.4	27.33
Die casting	X+, X-	4.266e+7	34.126	0.3	0.15
	Y+, Y-	7.732e+7	61.859	1.5	0.86
	Z+, Z-	4.209e+7	33.674	0.3	0.23

3.3. Trolley-1 Designs

In this model, obstacle geometry was created to create suitable leg and support forms in the trolley. A force of 60 N was applied to each shelf of the trolley-1. The views of designs created by generative design for the trolley-1 are shown in figures 43-58.

Figure 40. Views of Loads Applied to Trolley-1 Design

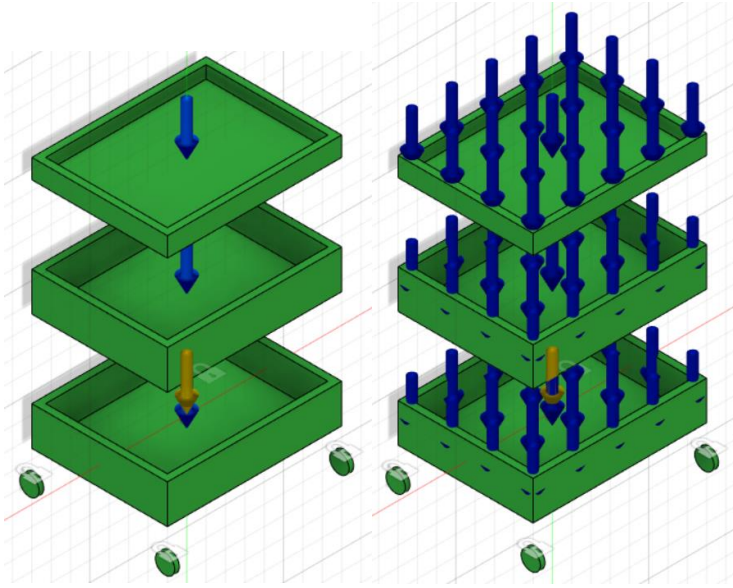

Figure 41. Perspective Views of Preserve and Obstacle Geometries of The Trolley-1

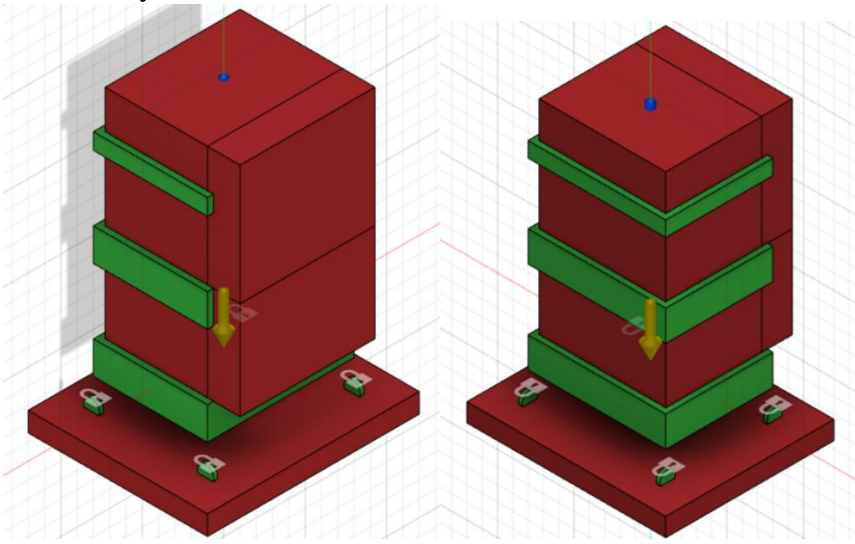

Figure 42. Dimensions of The Trolley-1 Design

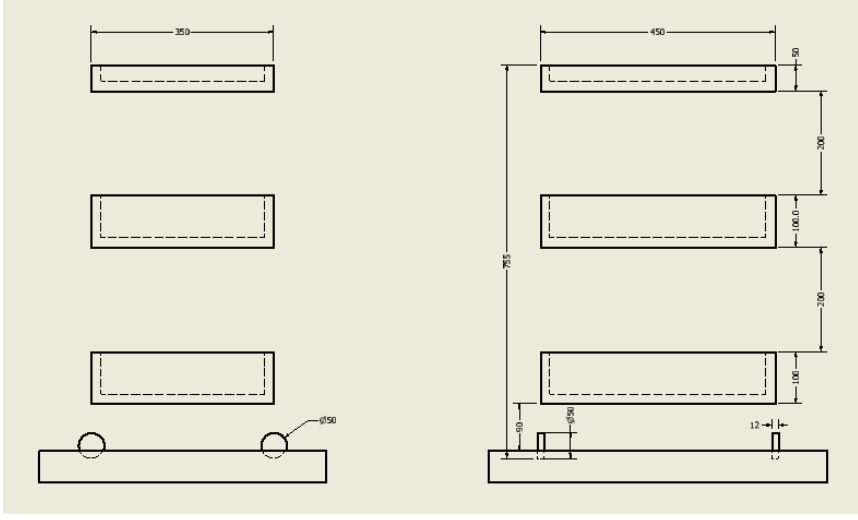

Figure 43. Trolley-1 Design, Unrestricted, -

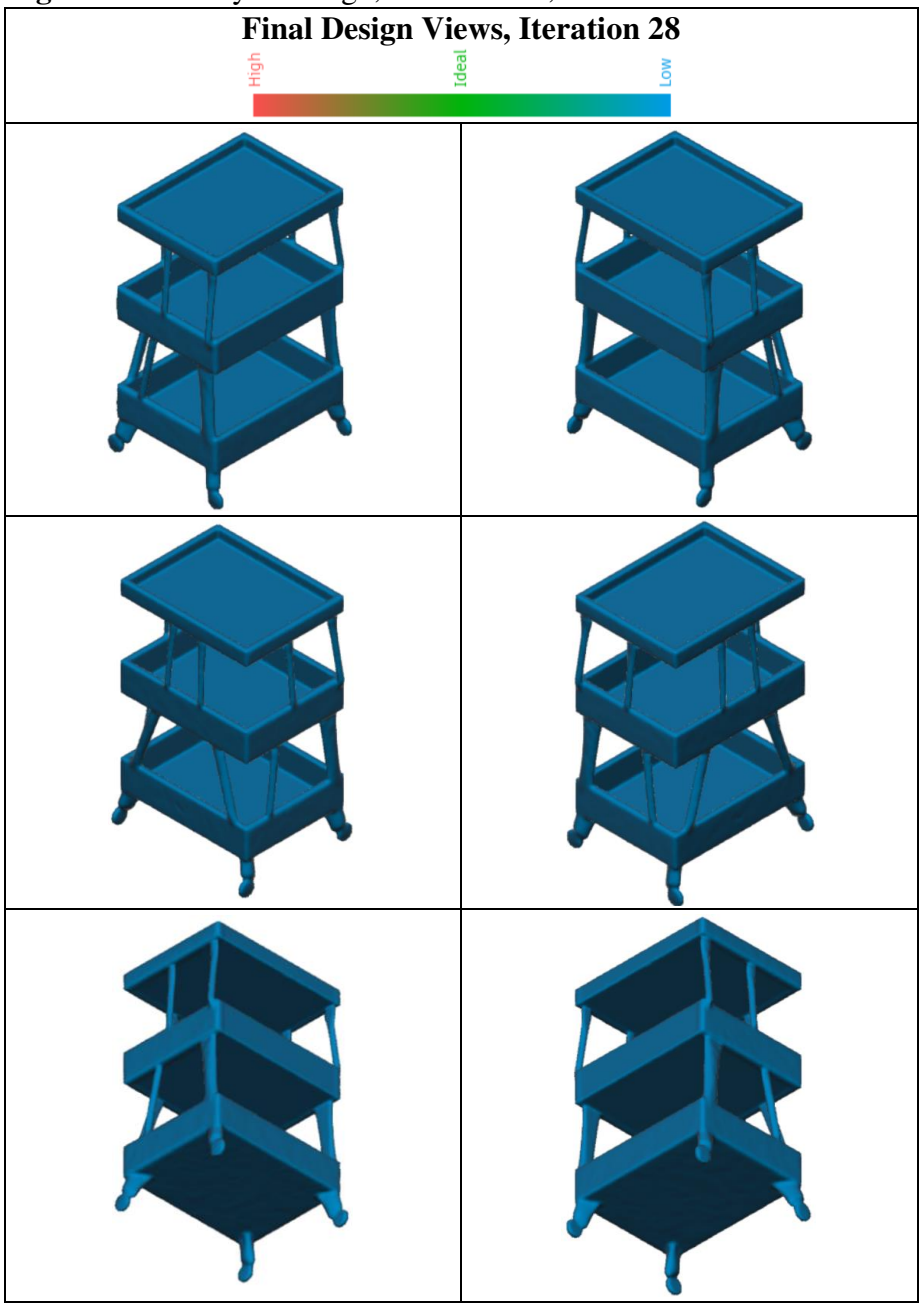

Figure 44. Trolley-1 Design, Additive, X+

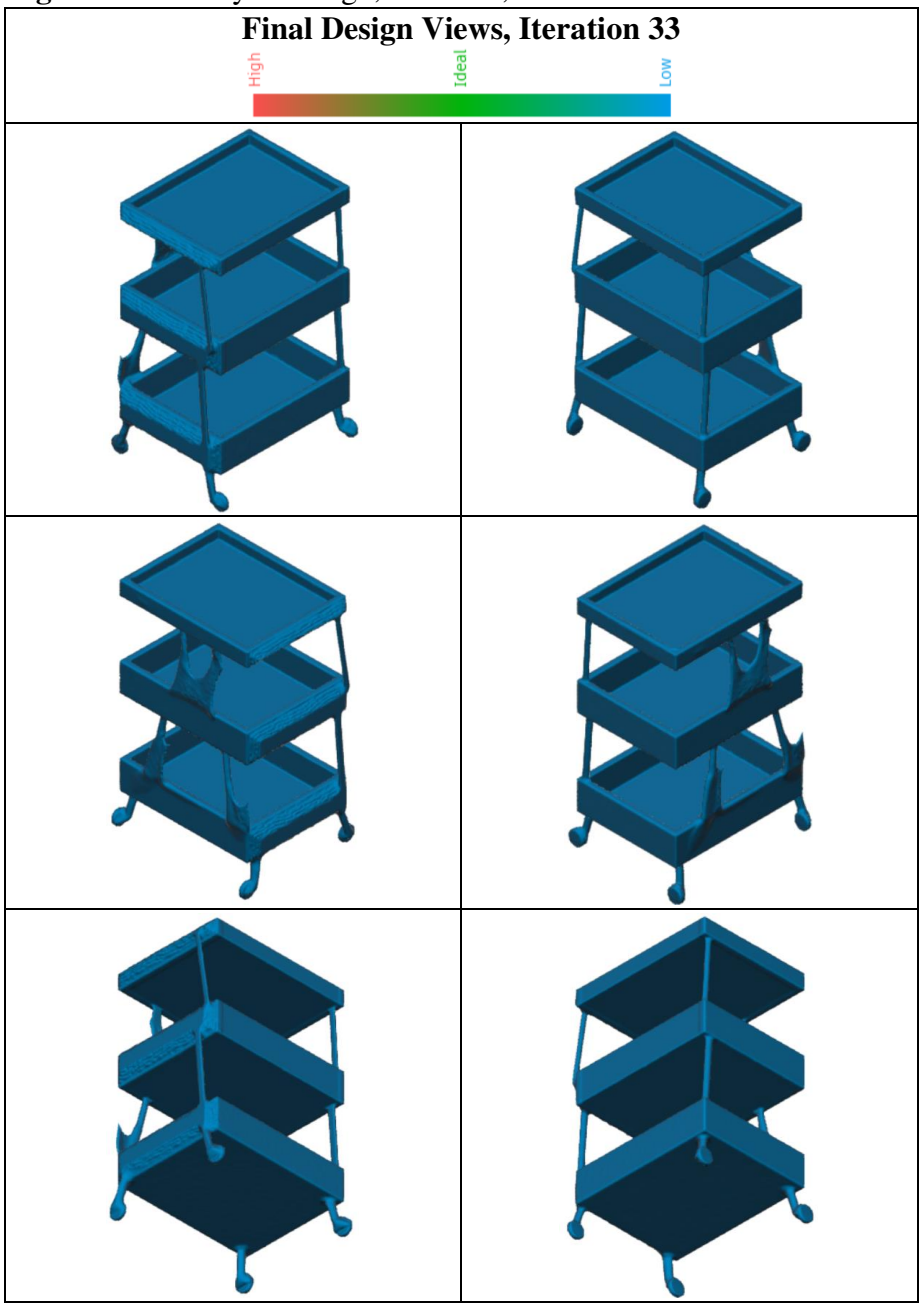

Figure 45. Trolley-1 Design, Additive, X-

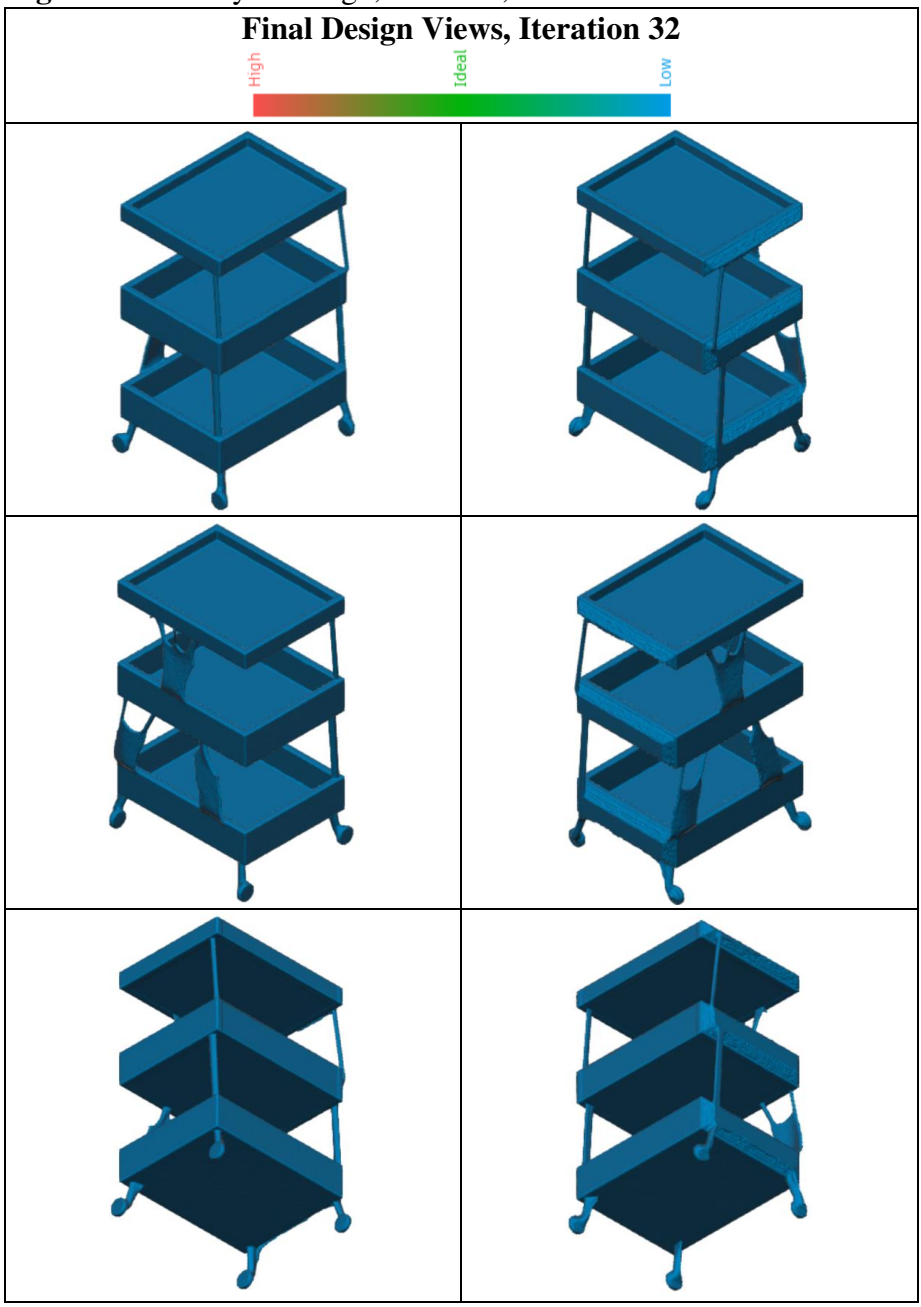

Figure 46. Trolley-1 Design, Additive, Y+

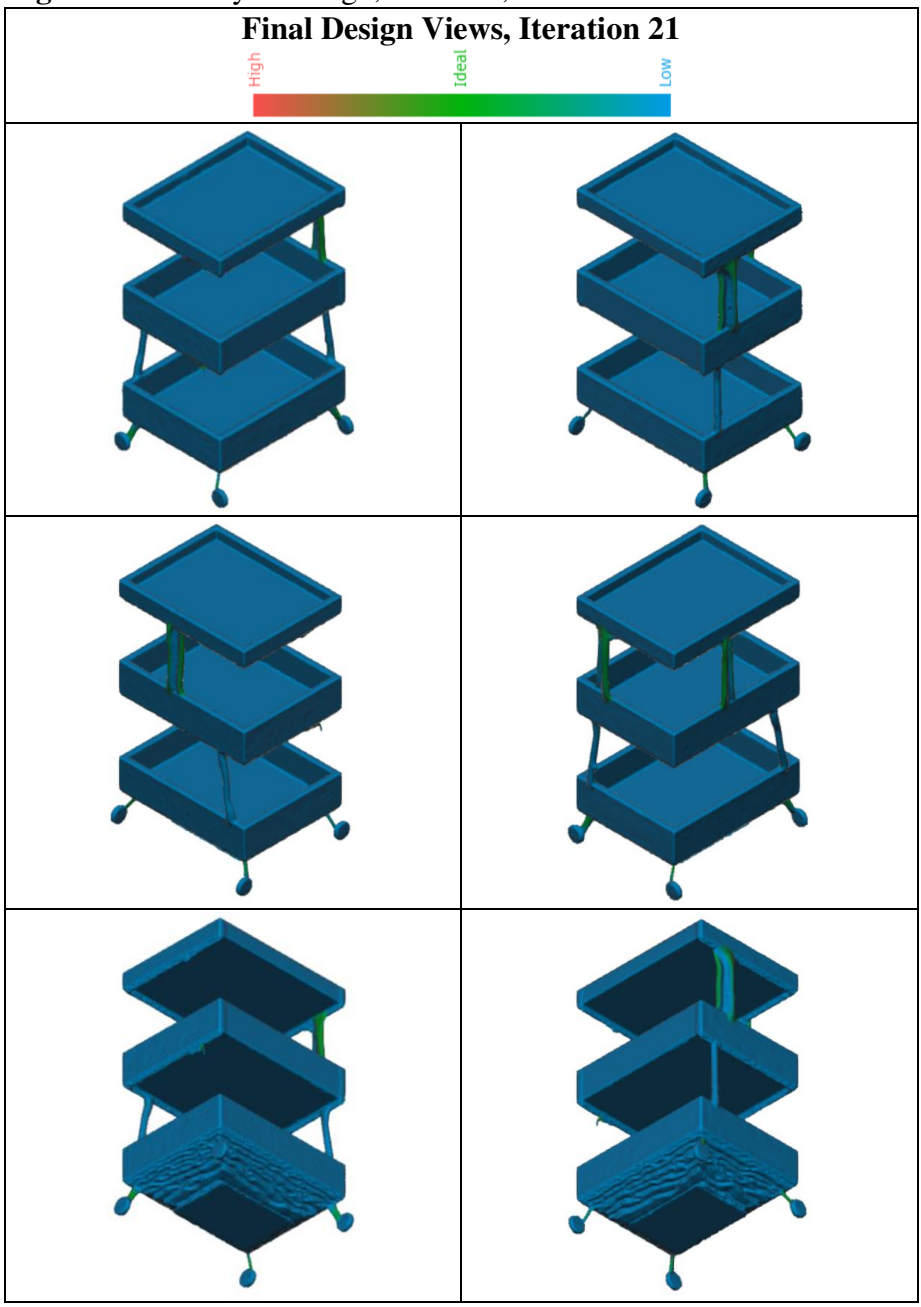

Figure 47. Trolley-1 Design, Additive, Y-

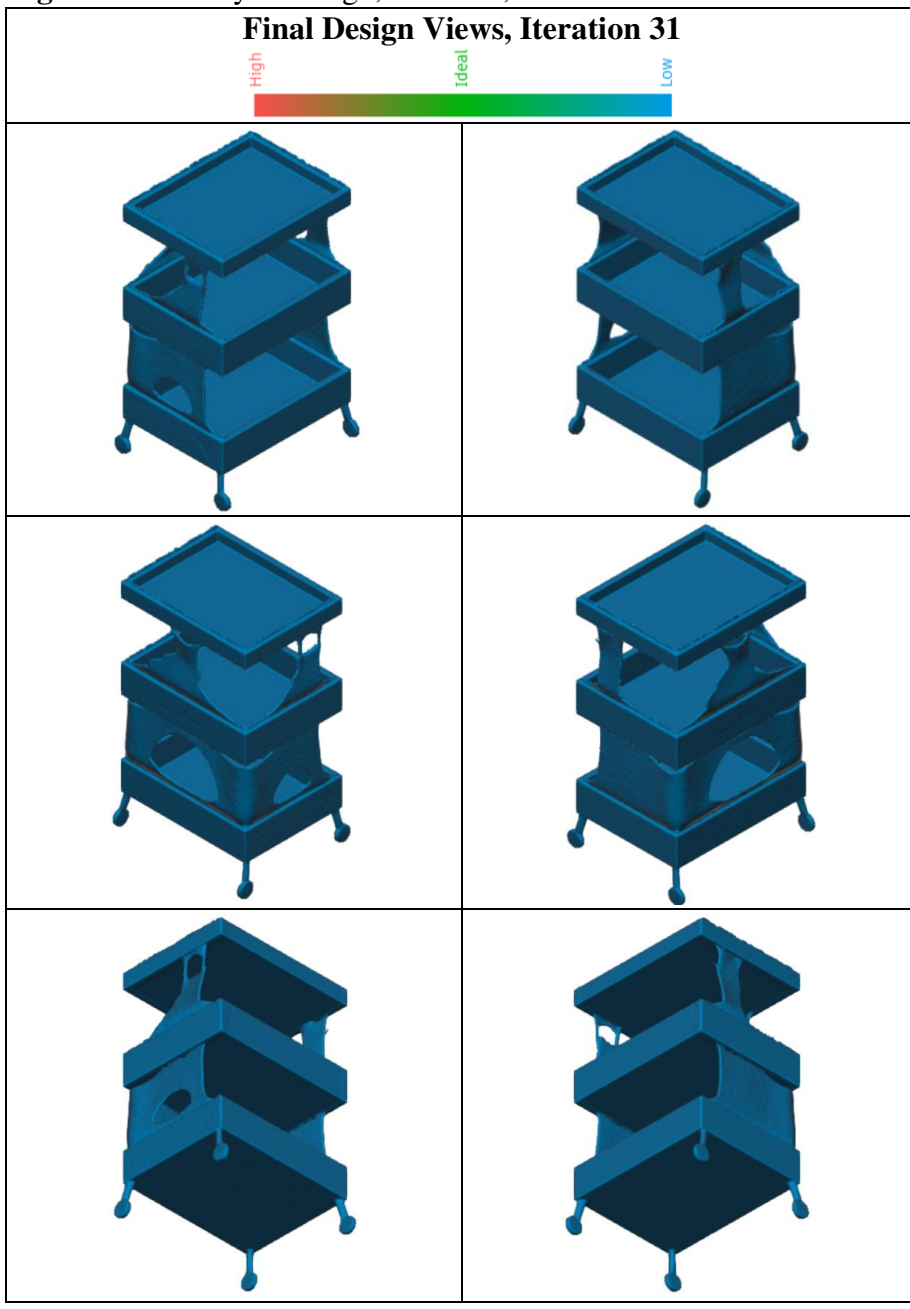

Figure 48. Trolley-1 Design, Additive, Z+

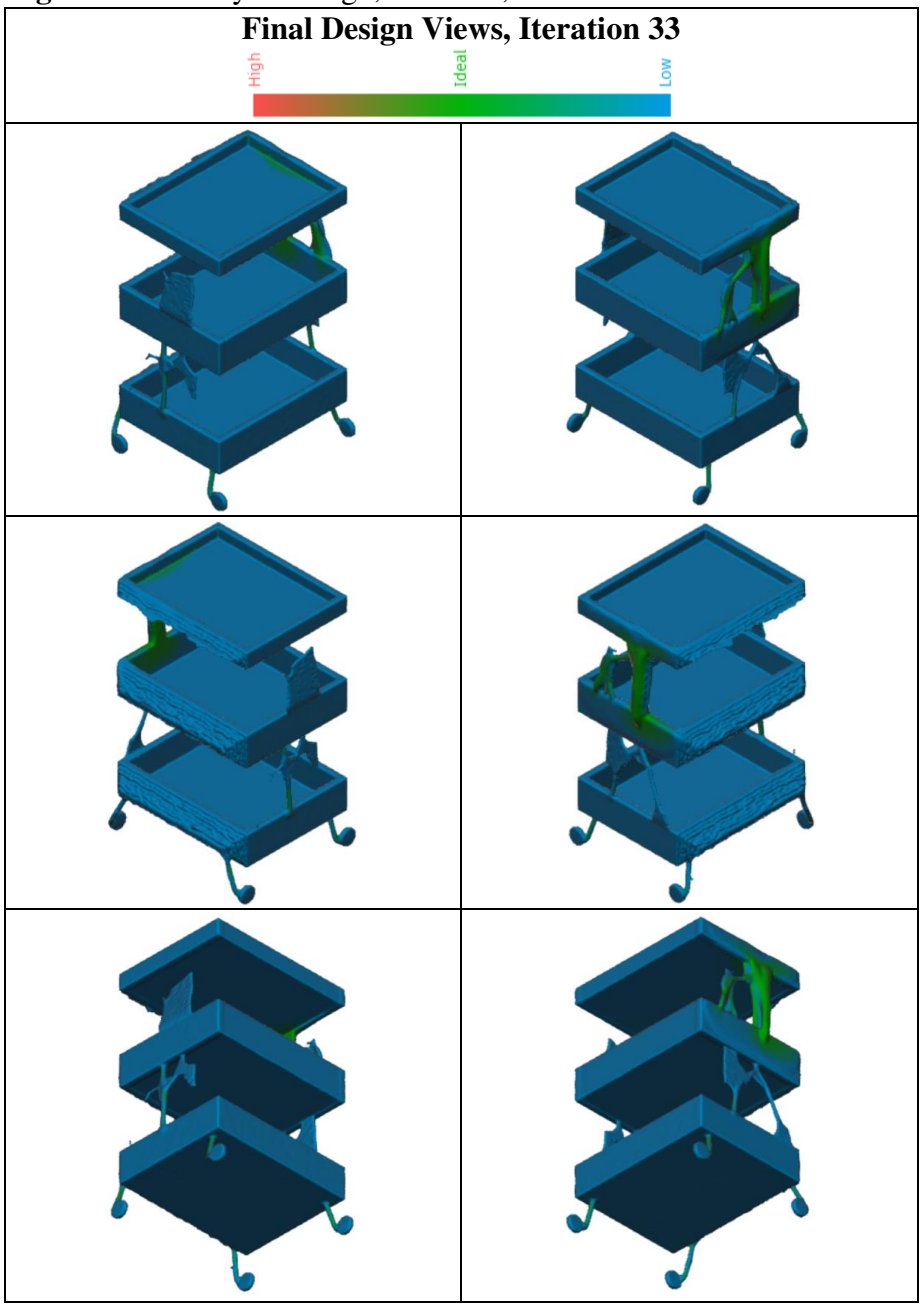

Figure 49. Trolley-1 Design, Additive, Z-

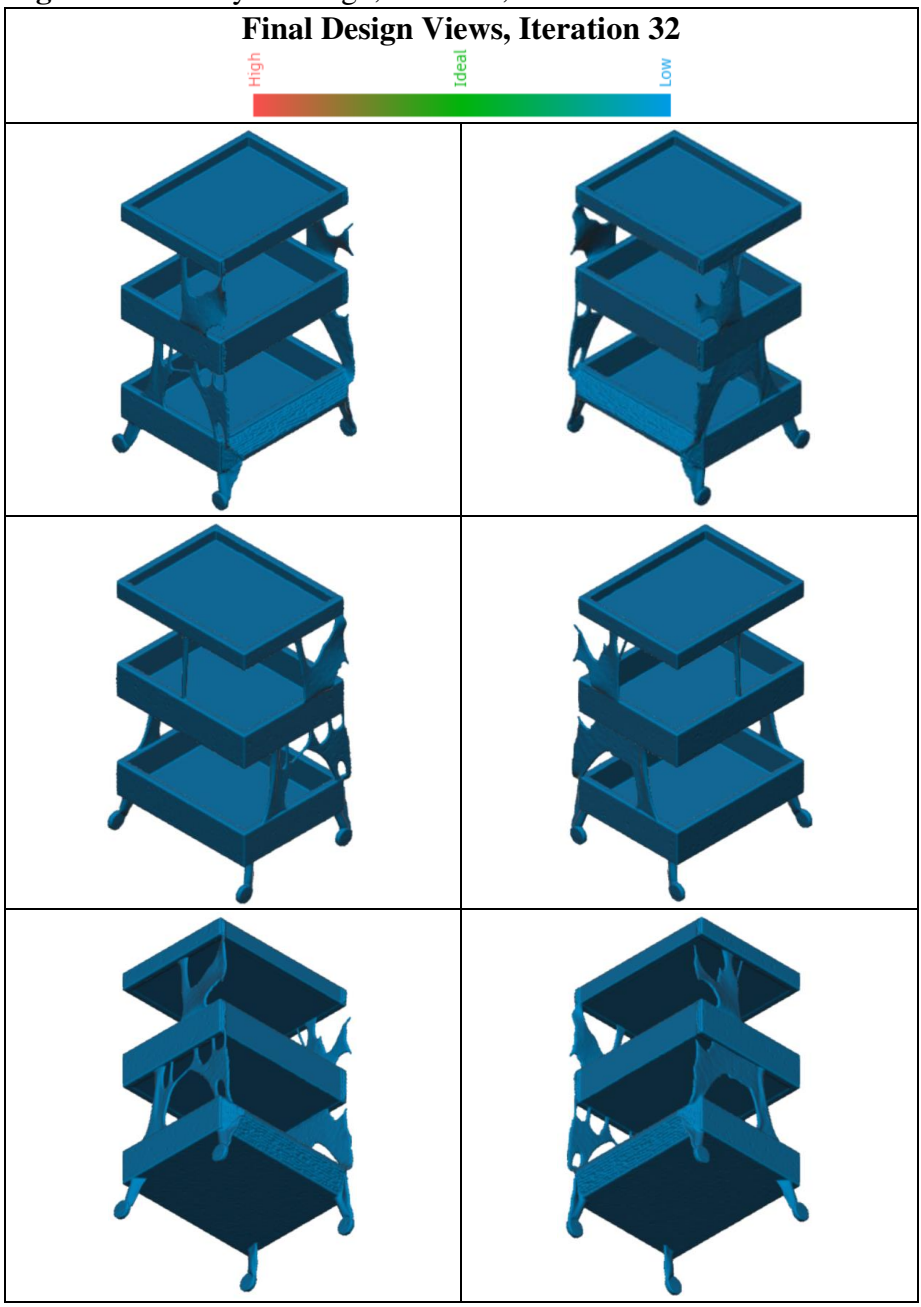

Figure 50. Trolley-1 Design, 3 Axis Milling, X+, Y+, X-, Y-

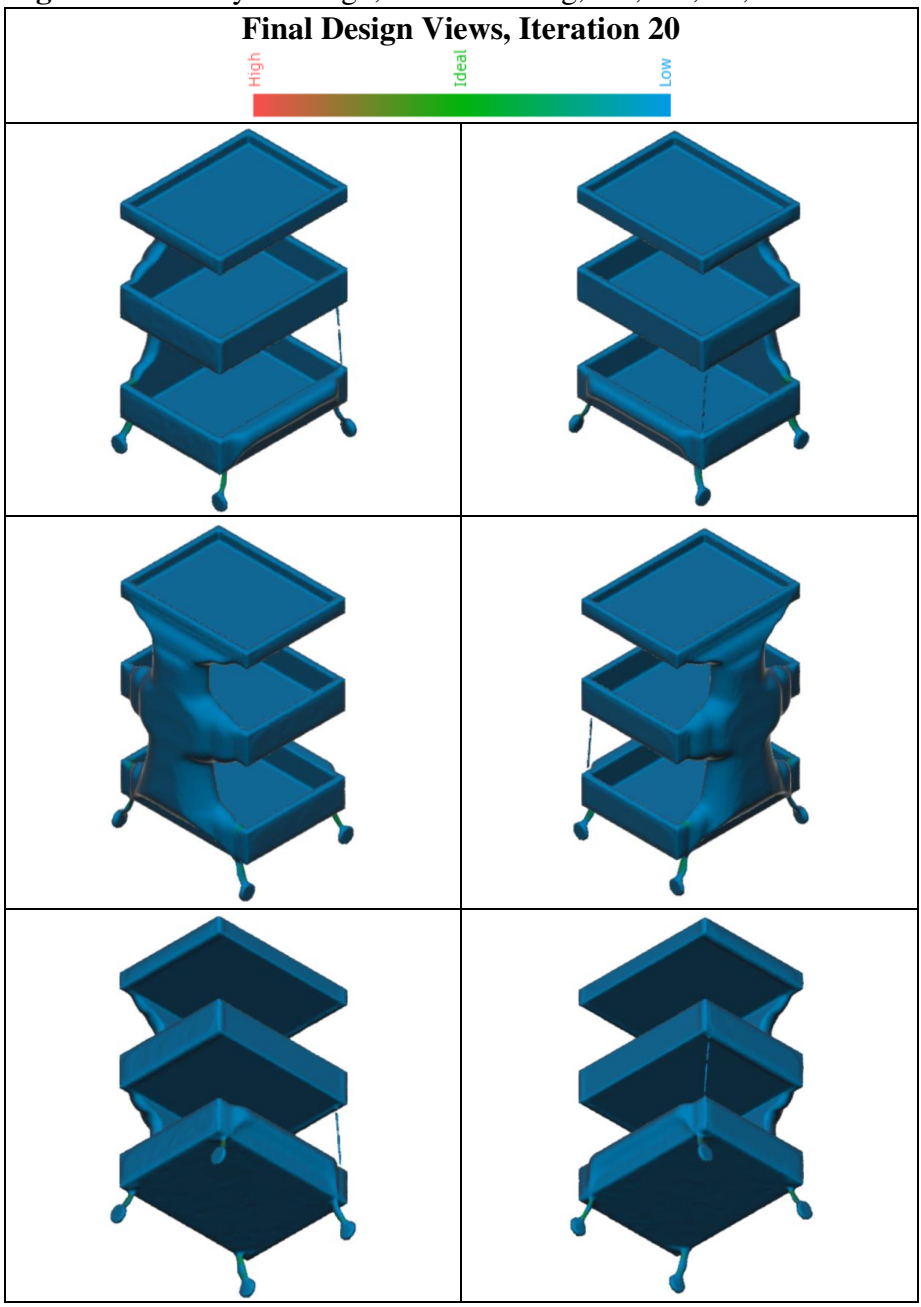

Figure 51. Trolley-1 Design, 3 Axis Milling, X+, Z+, X-, Z-

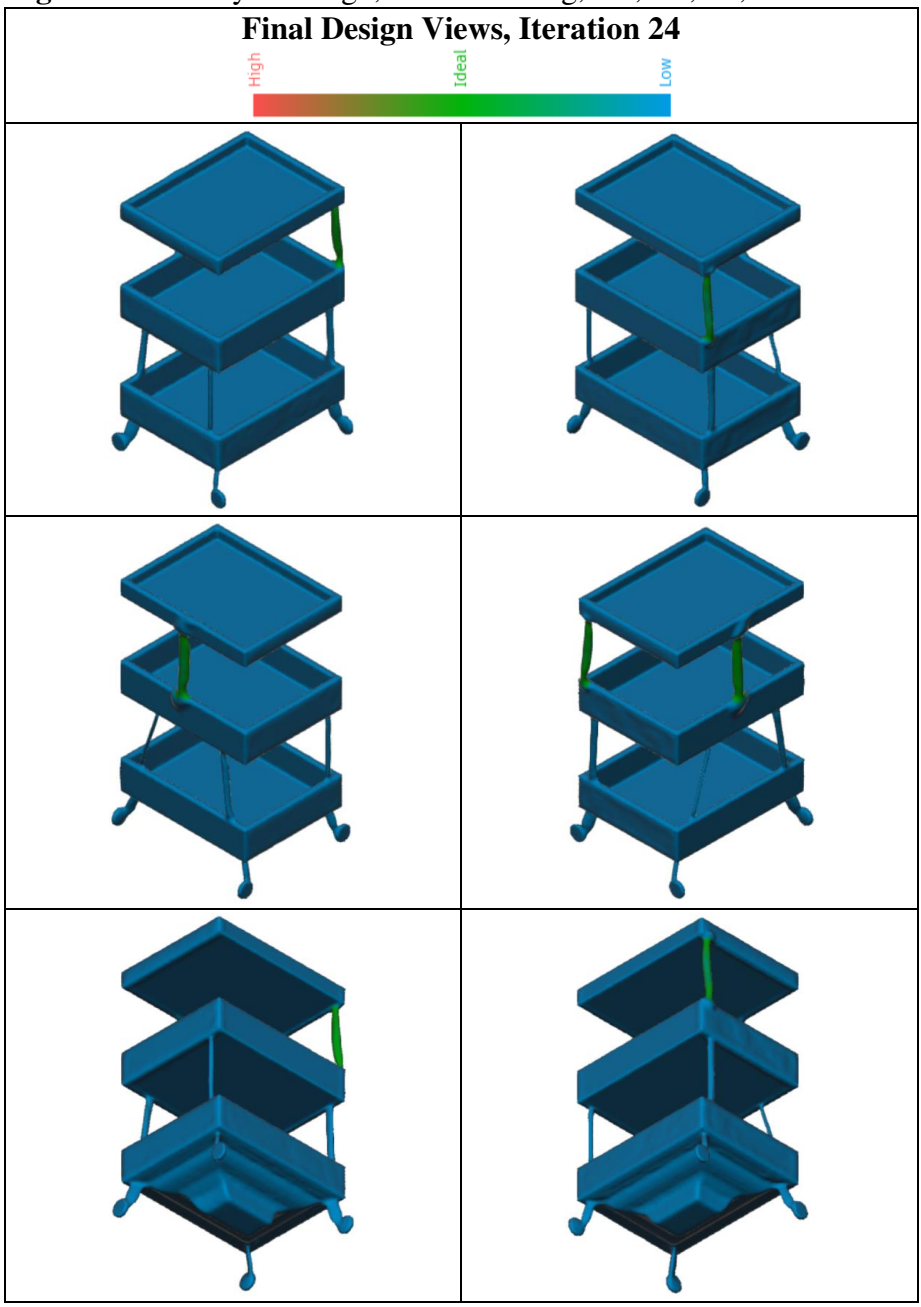

Figure 52. Trolley-1 Design, 3 Axis Milling, Y+, Z+, Y-, Z-

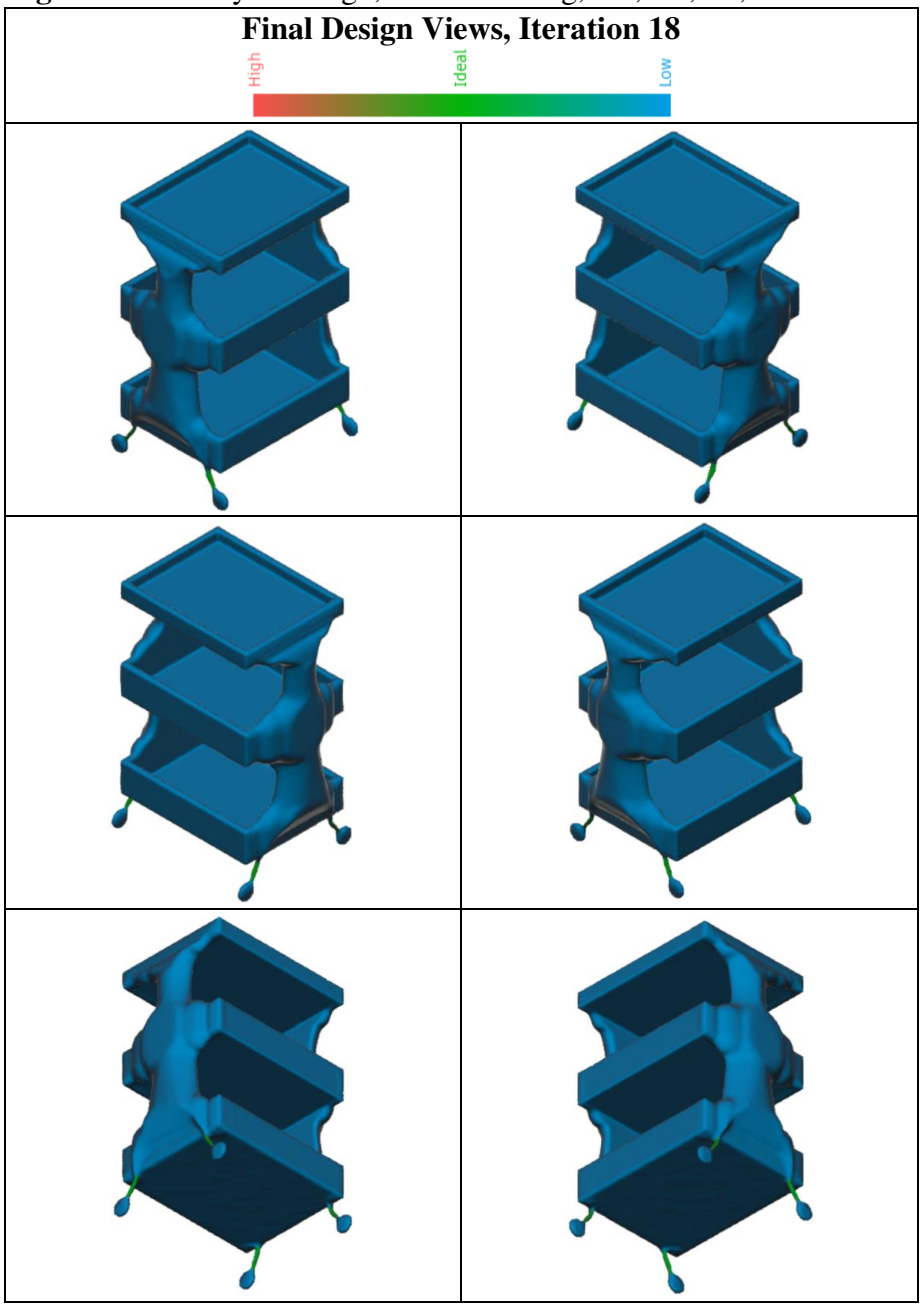

Figure 53. Trolley-1 Design, 3 Axis Milling, X+, Y+, Z+, X-, Y-, Z-

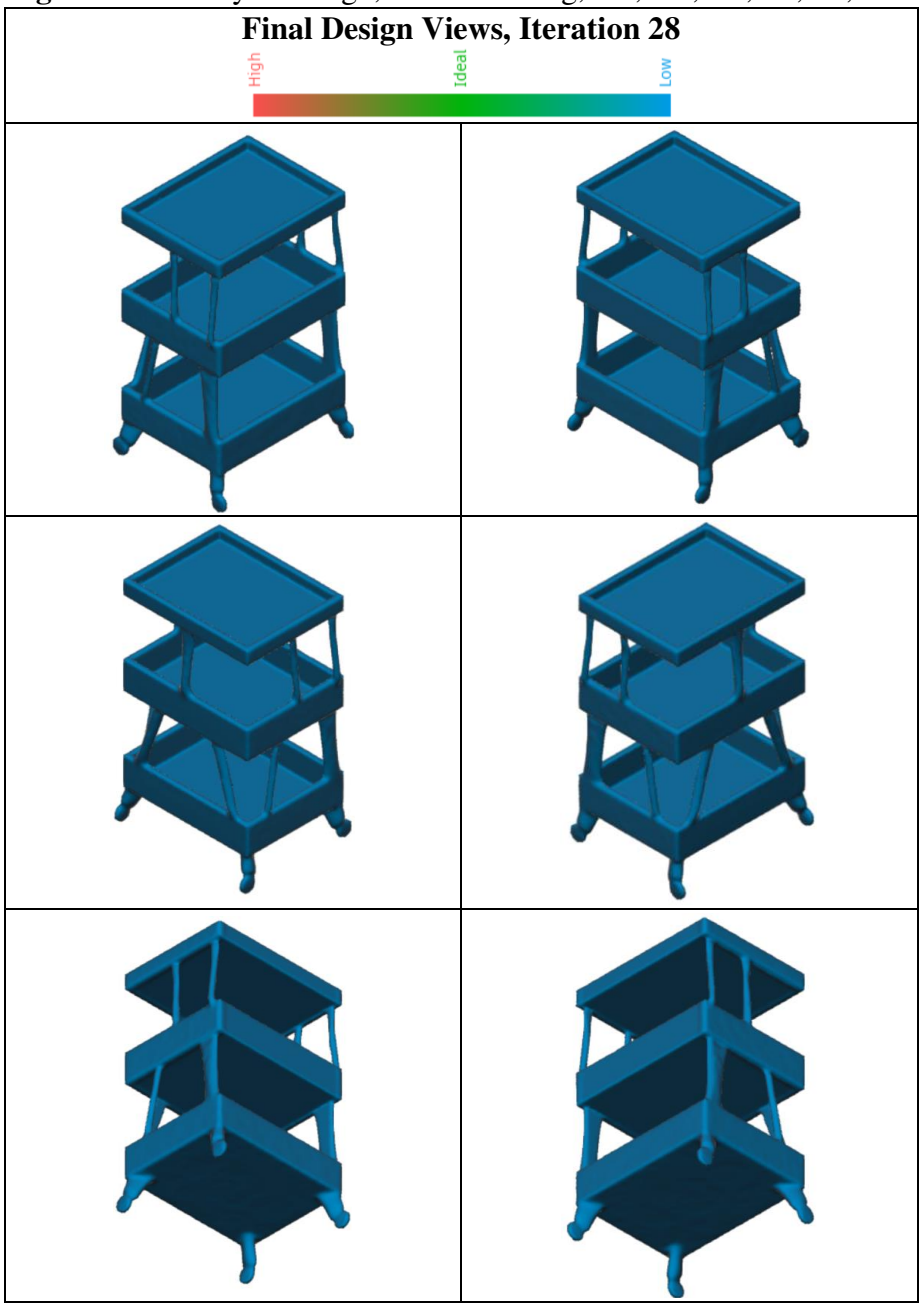

Figure 54. Trolley-1 Design, 5 Axis Milling, Unrestricted

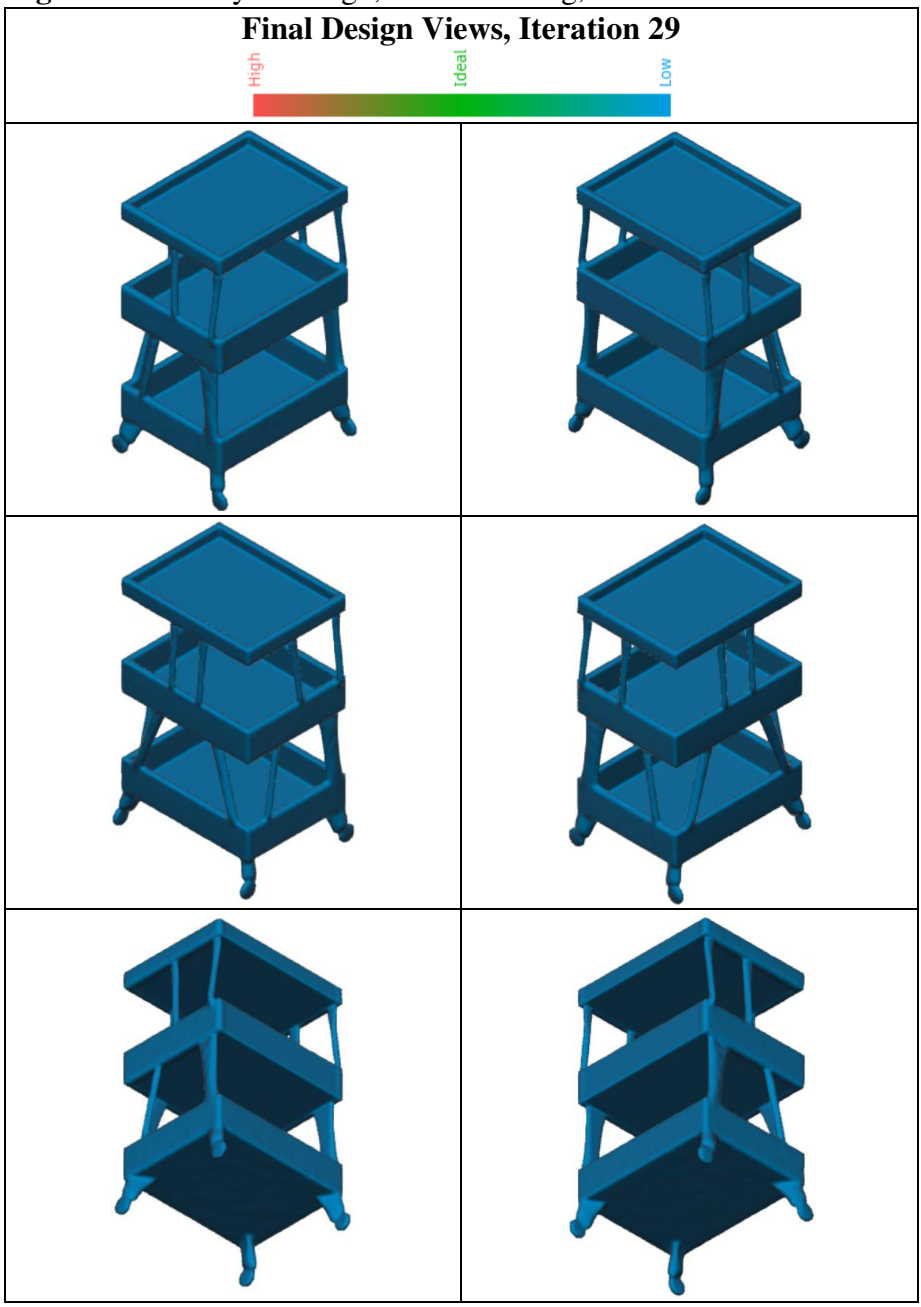

Figure 55. Trolley-1 Design, 2 Axis Cutting, Z

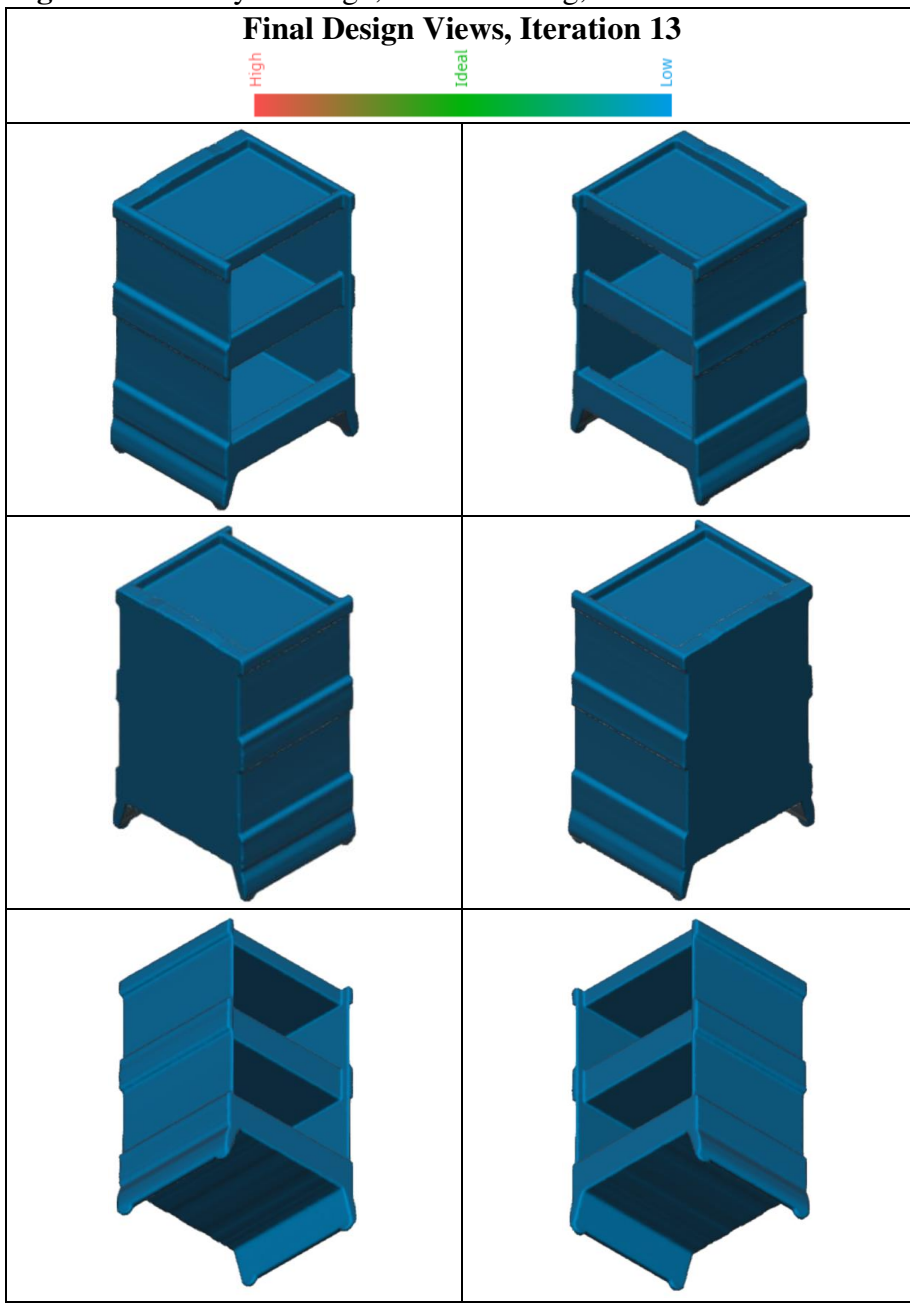

Figure 56. Trolley-1 Design, Die Casting, X+, X-

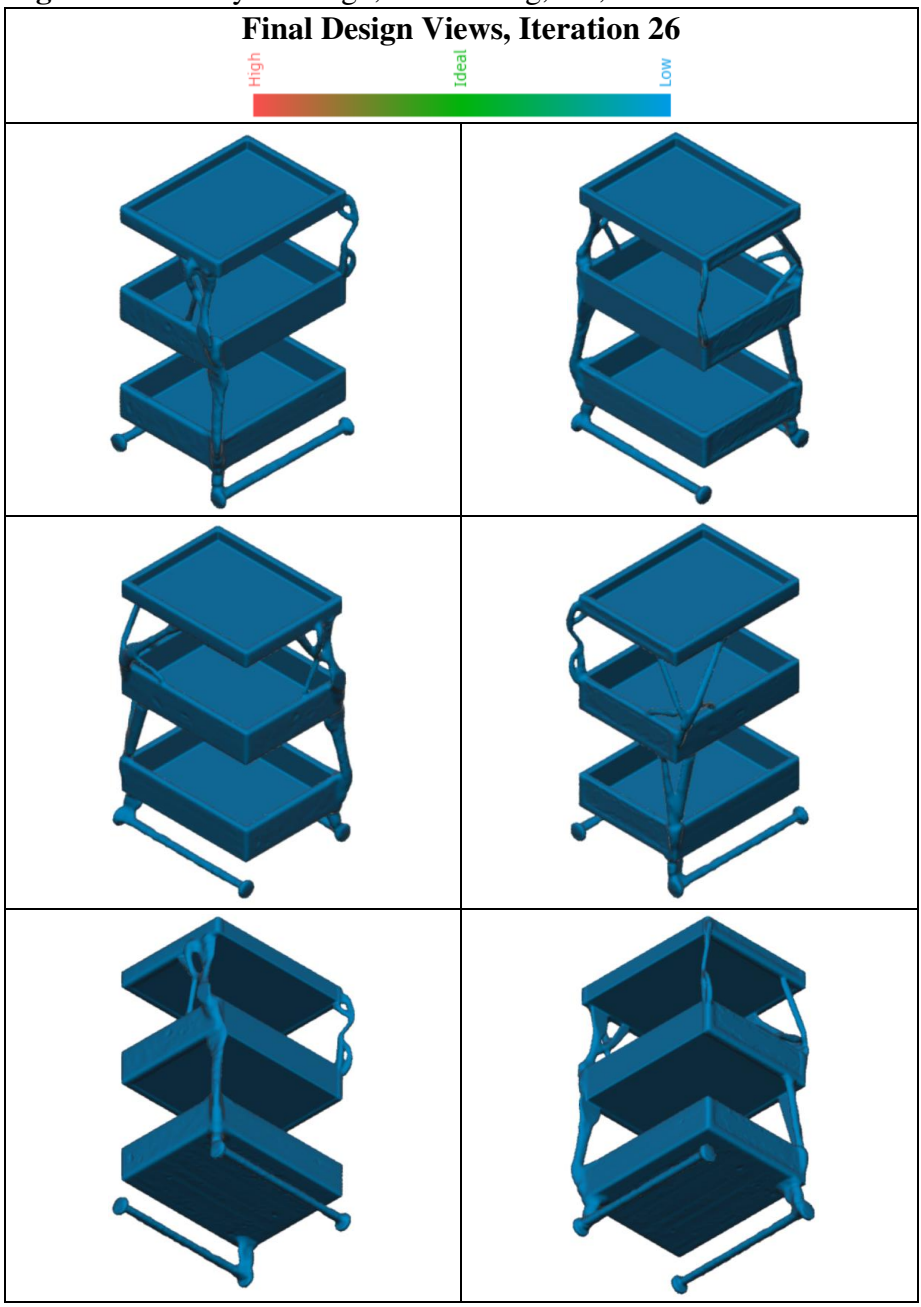

Figure 57. Trolley-1 Design, Die Casting, Y+, Y-

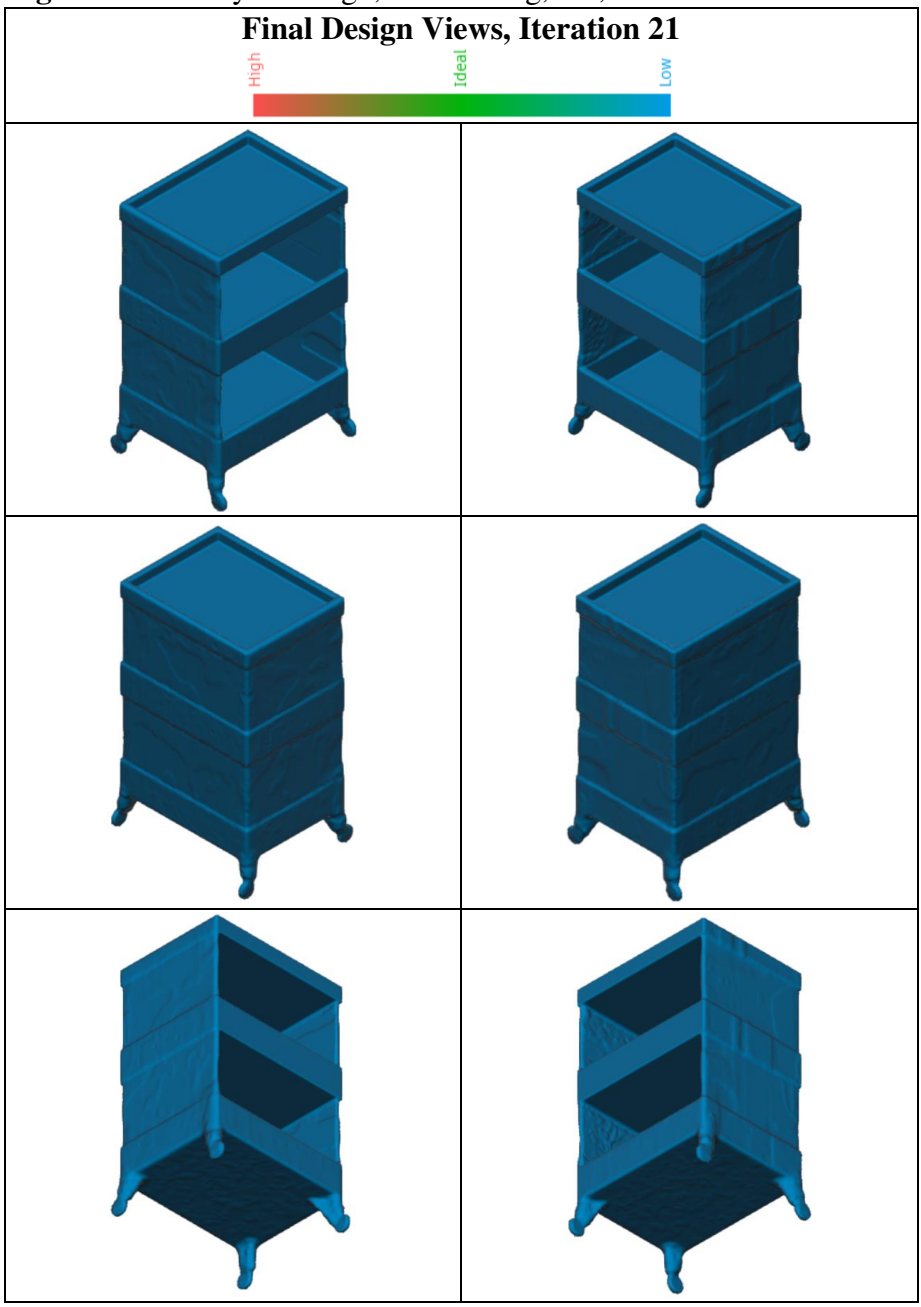

Figure 58. Trolley-1 Design, Die Casting, Z+, Z-

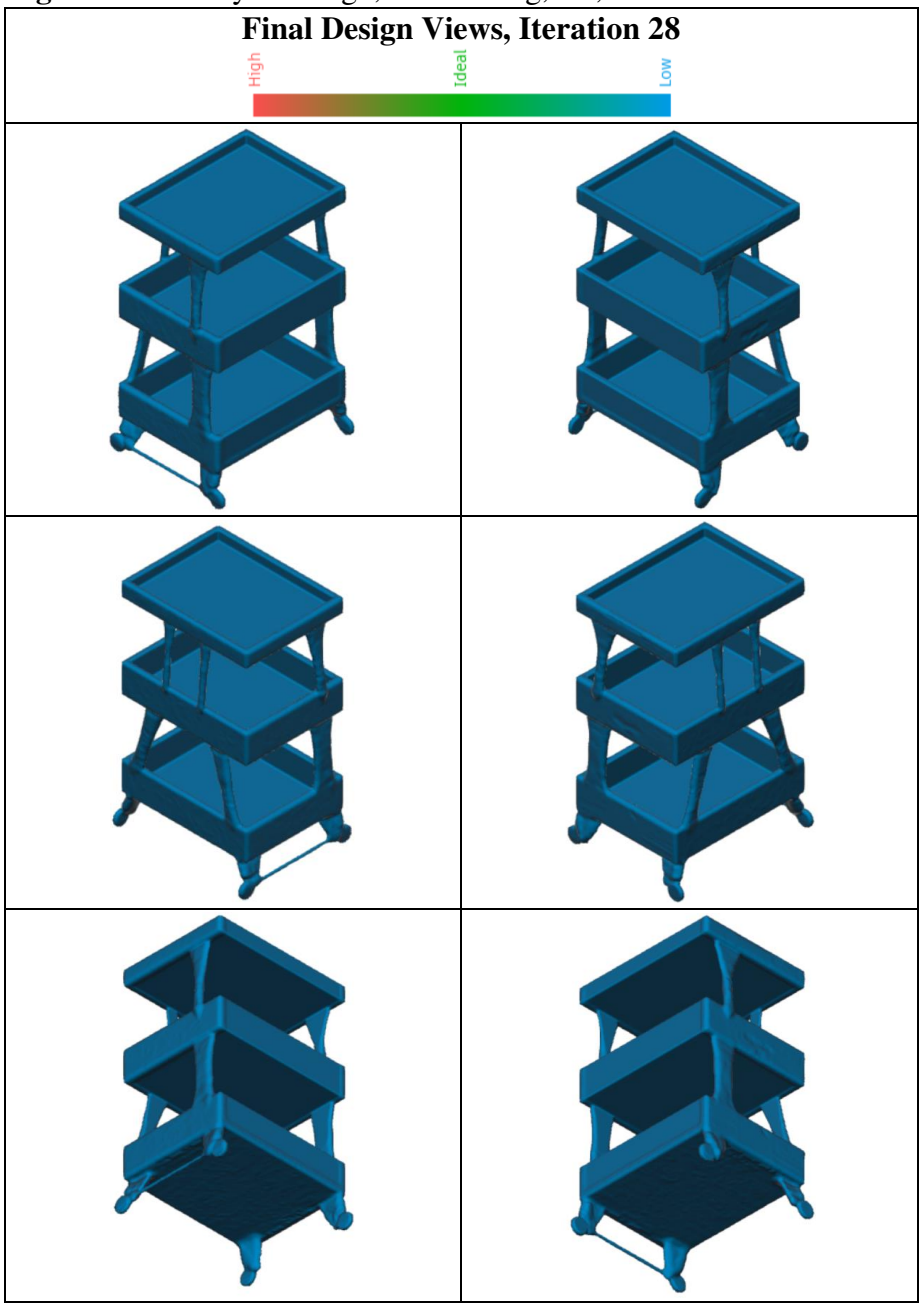

Table 3: The Values Calculated for The Trolley-1 Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	1.614e+7	12.915	0.2	0.05
Additive	X+	1.638e+7	13.1	1	0.15
	X-	1.622e+7	12.973	1.1	0.13
	Y+	2.332e+7	18.658	3.7	3.18
	Y-	1.62e+7	12.959	0.6	0.1
	Z+	1.73e+7	13.838	3.9	9.93
	Z-	1.62e+7	12.959	0.4	0.09
3 axis milling	X+, Y+, X-, Y-	2.315e+7	18.523	2.1	1.71
	X+, Z+, X-, Z-	1.893e+7	15.142	3.9	10.25
	Y+, Z+, Y-, Z-	2.365e+7	18.92	3.7	0.1
	X+, Y+, Z+, X-, Y-, Z-	1.617e+7	12.938	0.3	0.05
5 axis milling	Unrestricted	1.618e+7	12.941	0.2	0.05
2 axis cutting	Z	3.061e+7	24.491	0.1	0.03
Die casting	X+, X-	1.625e+7	12.998	0.3	0.2
	Y+, Y-	2.134e+7	17.072	0.1	0.03
	Z+, Z-	1.647e+7	13.173	0.2	0.05

3.4. Trolley-2 Designs

In this model, different obstacle geometries were created to create suitable leg and support forms in the trolley. A force of 60 N was applied to each shelf of the trolley-2. The dimensions used for the trolley-2 are the same as those used for the trolley-1. The views of designs created by generative design for the trolley-2 are shown in figures 60-75.

Figure 59. Perspective Views of Preserve and Obstacle Geometries of The Trolley-2

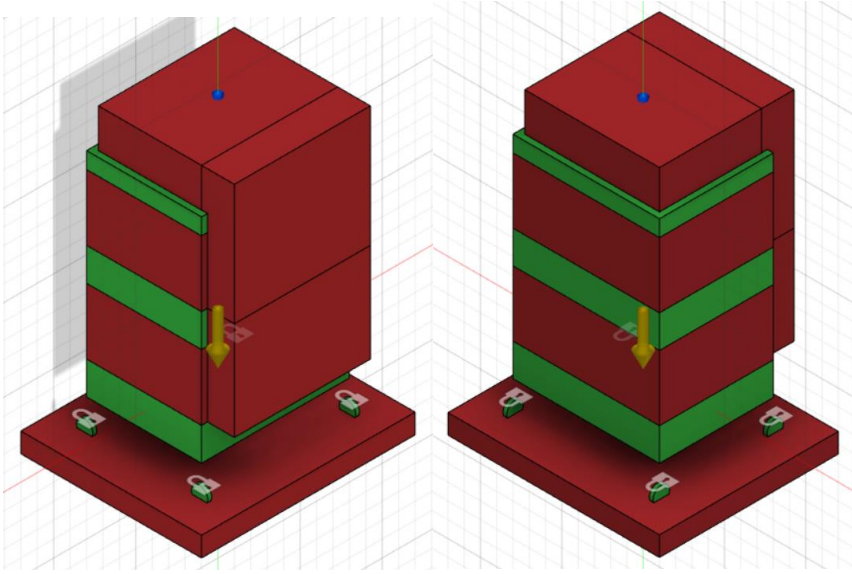

Figure 60. Trolley-2 Design, Unrestricted, -

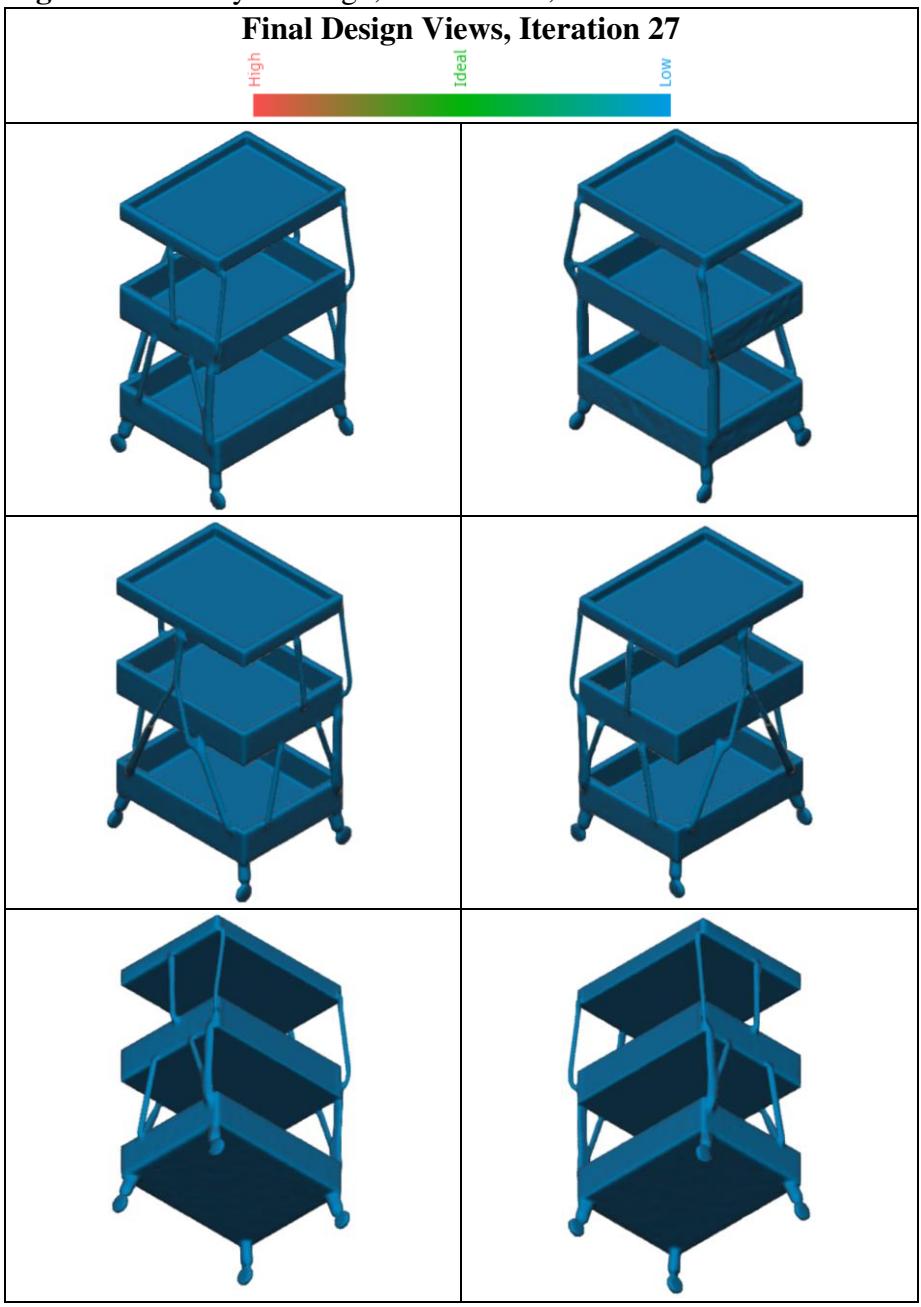

Figure 61. Trolley-2 Design, Additive, X+

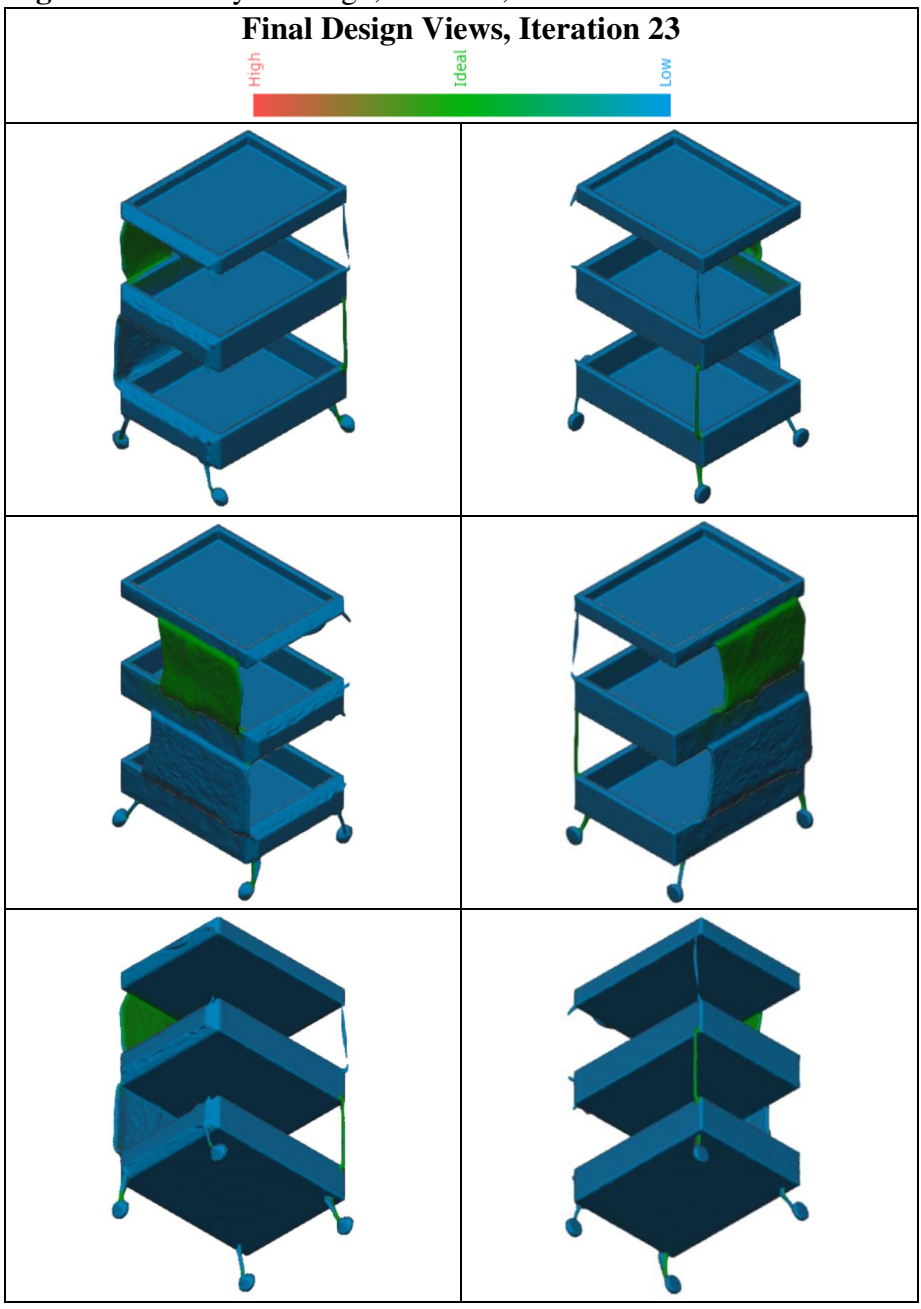

Figure 62. Trolley-2 Design, Additive, X-

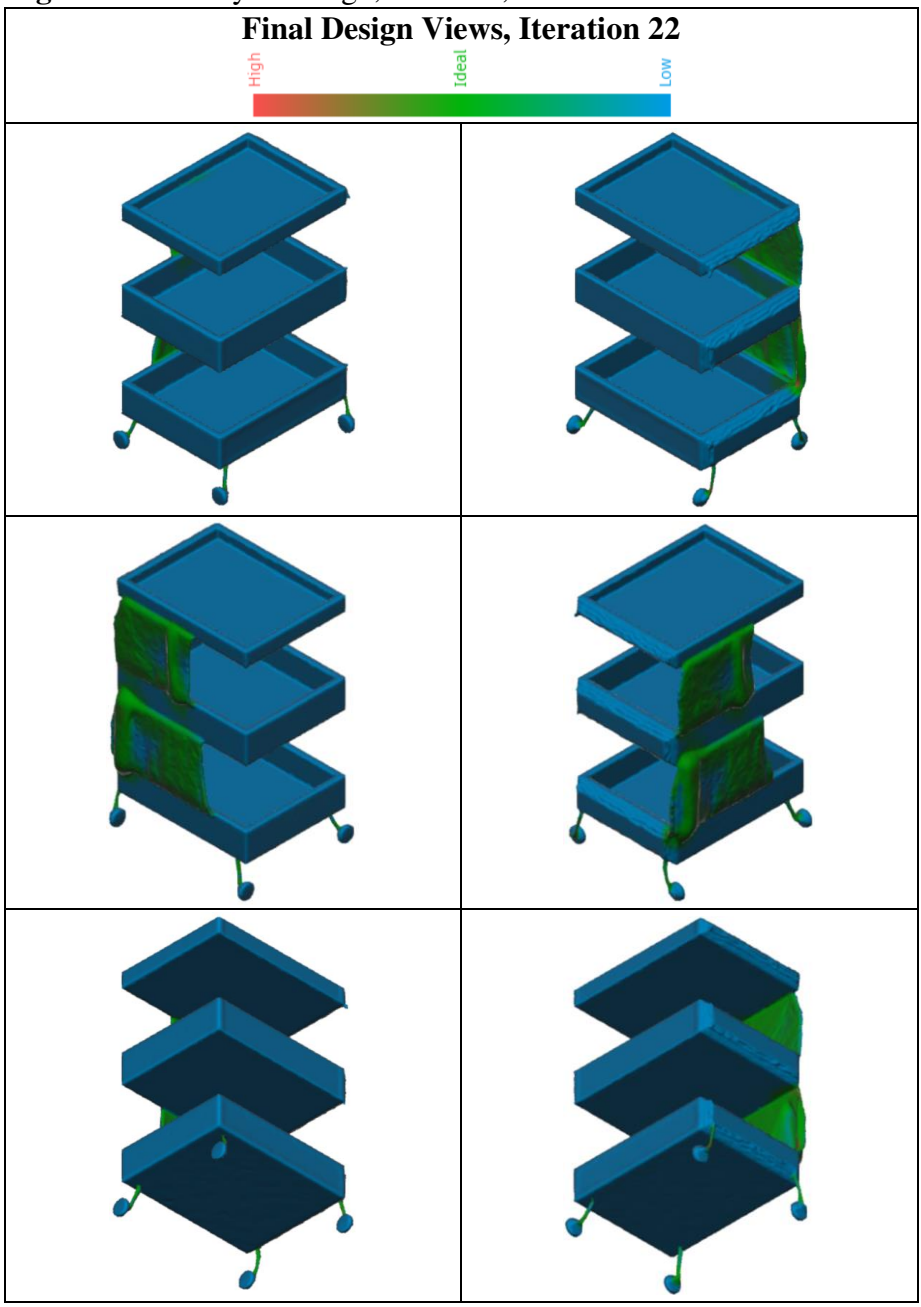

Figure 63. Trolley-2 Design, Additive, Y+

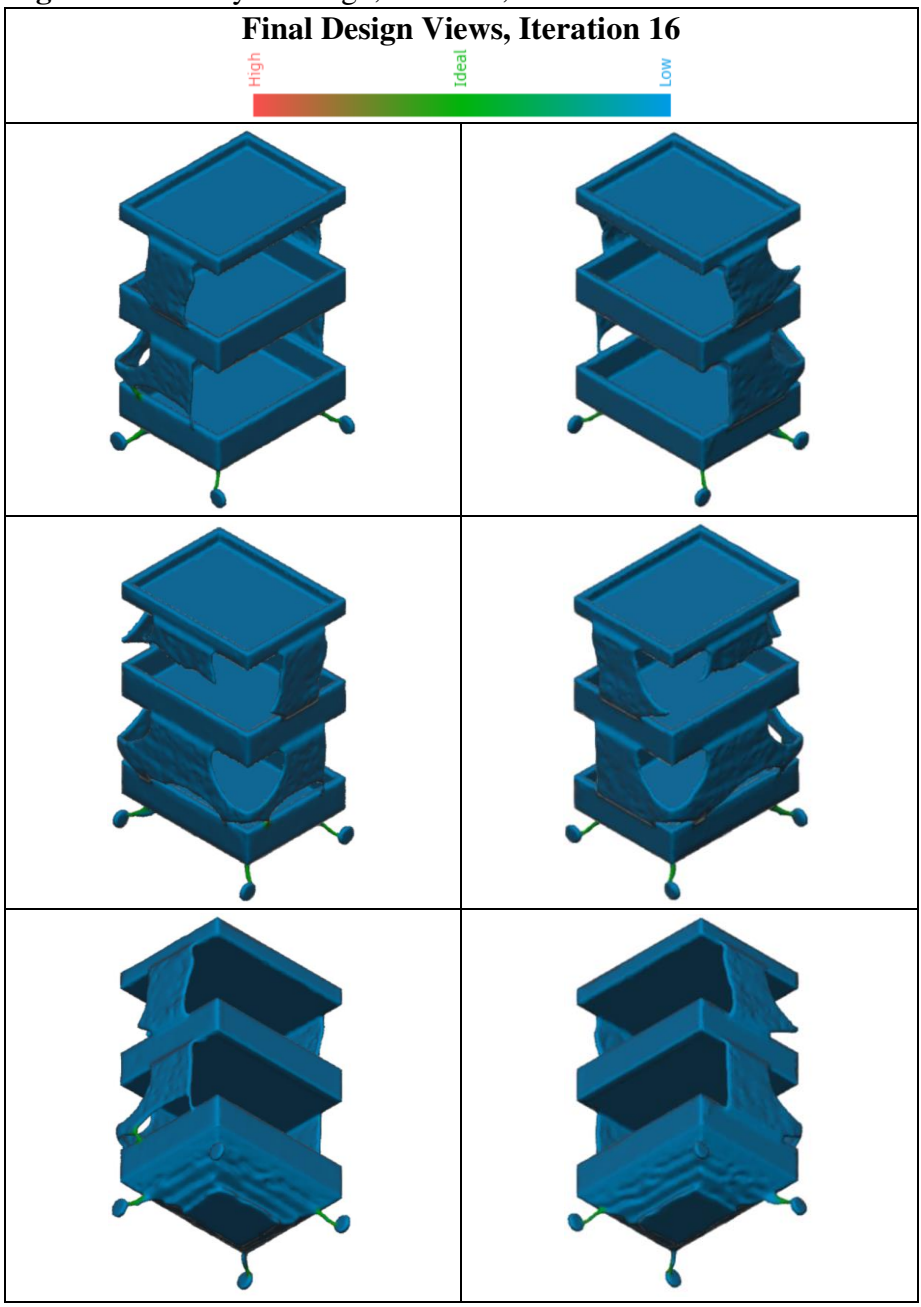

Figure 64. Trolley-2 Design, Additive, Y-

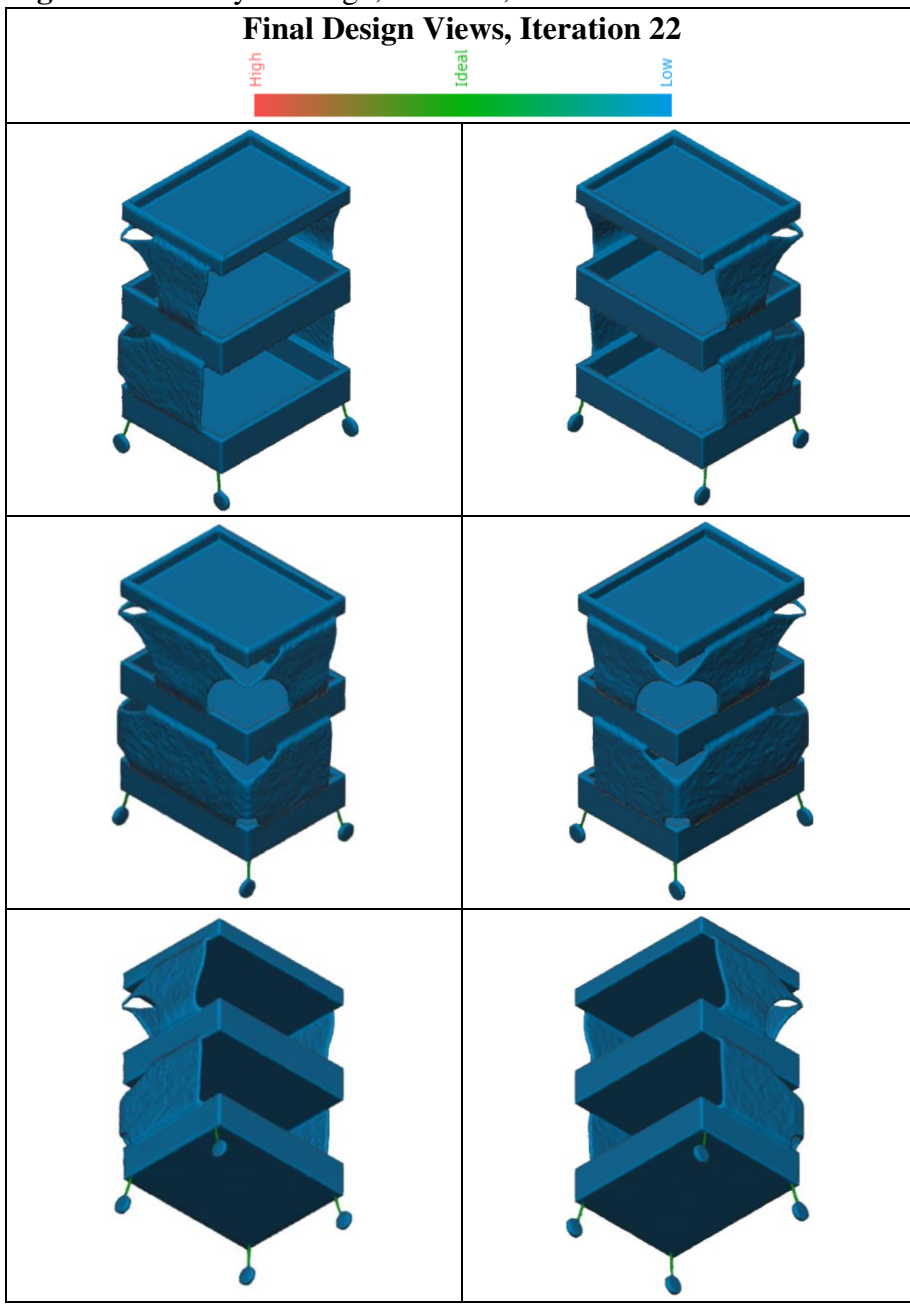

Figure 65. Trolley-2 Design, Additive, Z+

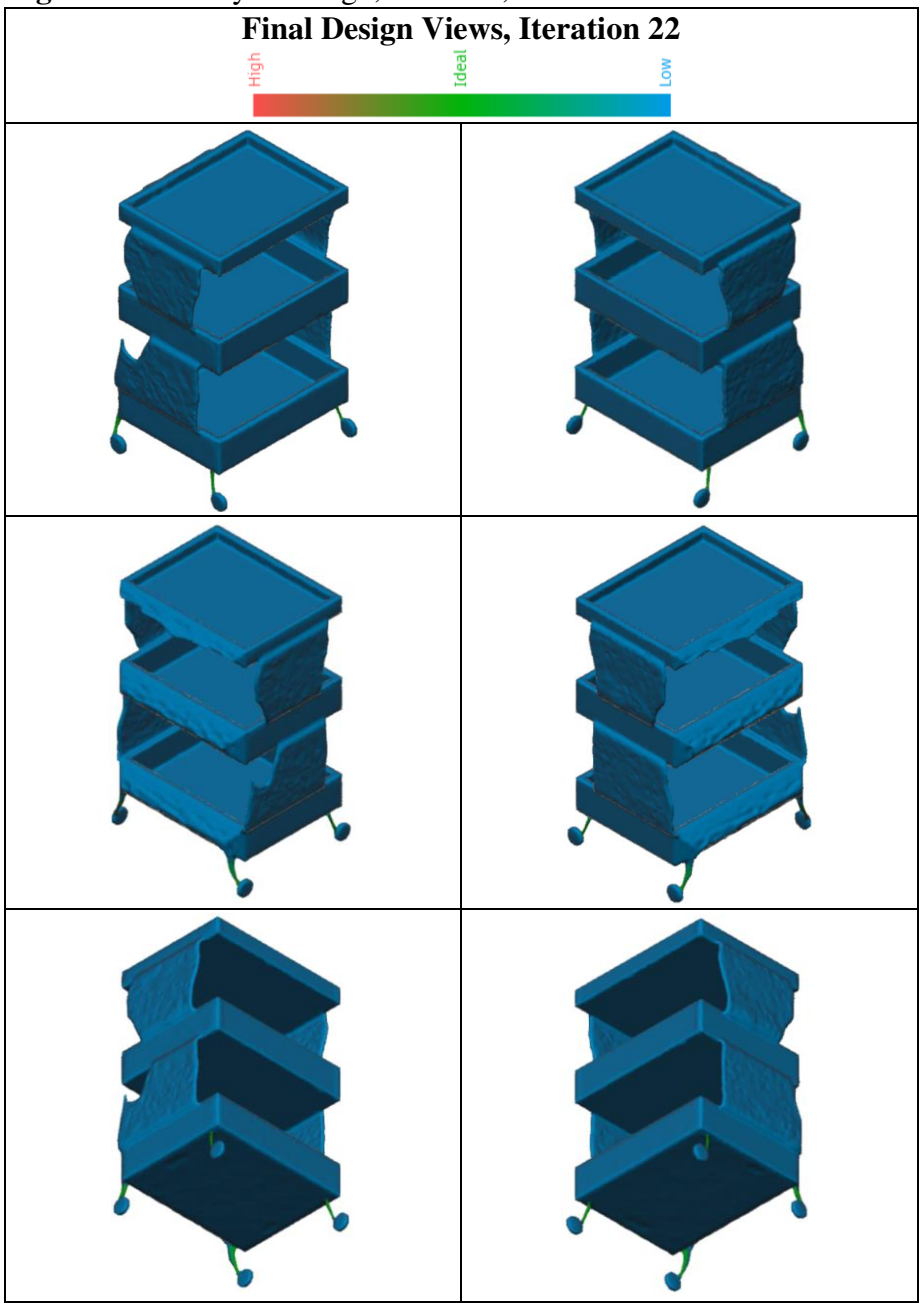

Figure 66. Trolley-2 Design, Additive, Z-

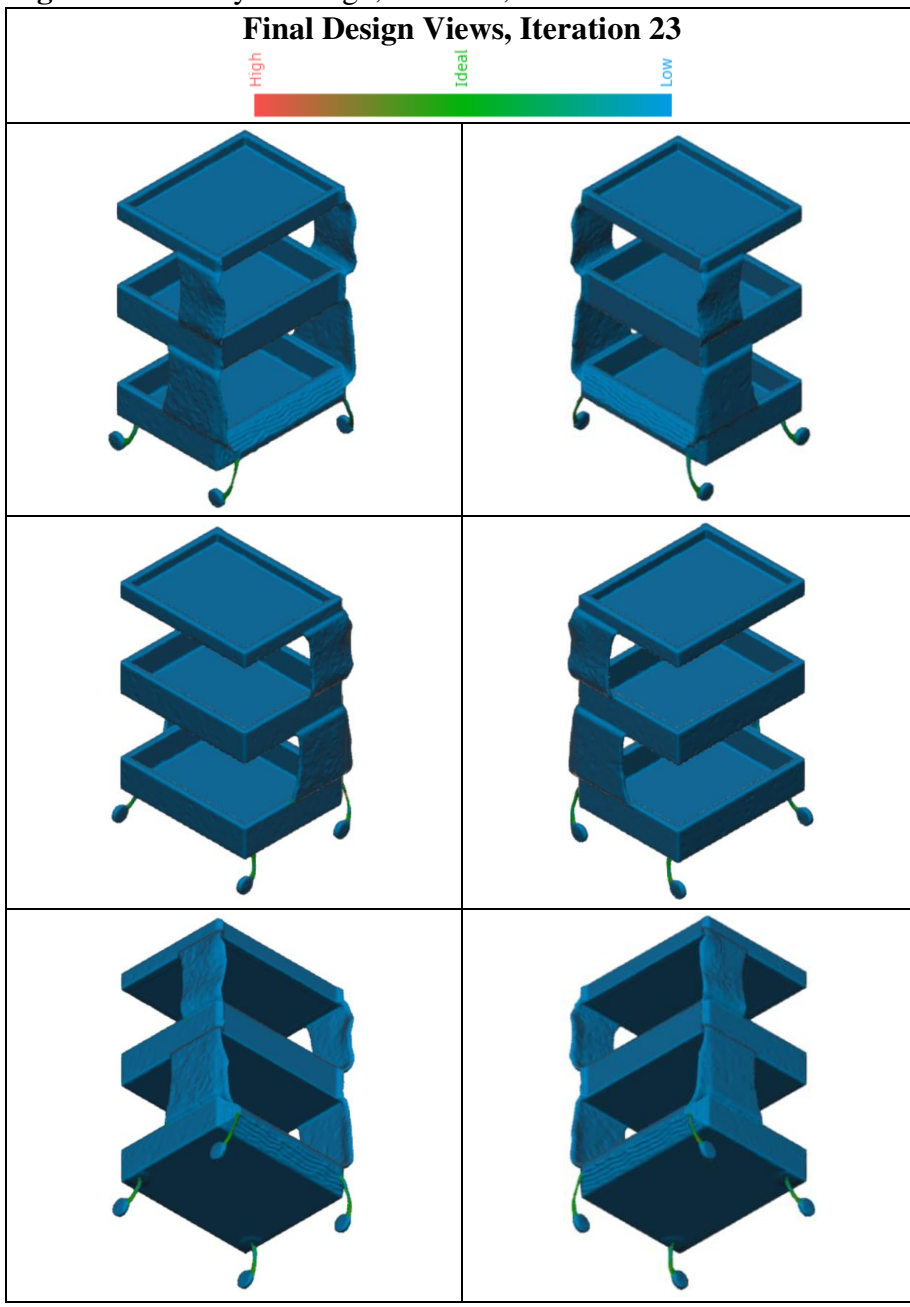

Figure 67. Trolley-2 Design, 3 Axis Milling, X+, Y+, X-, Y-

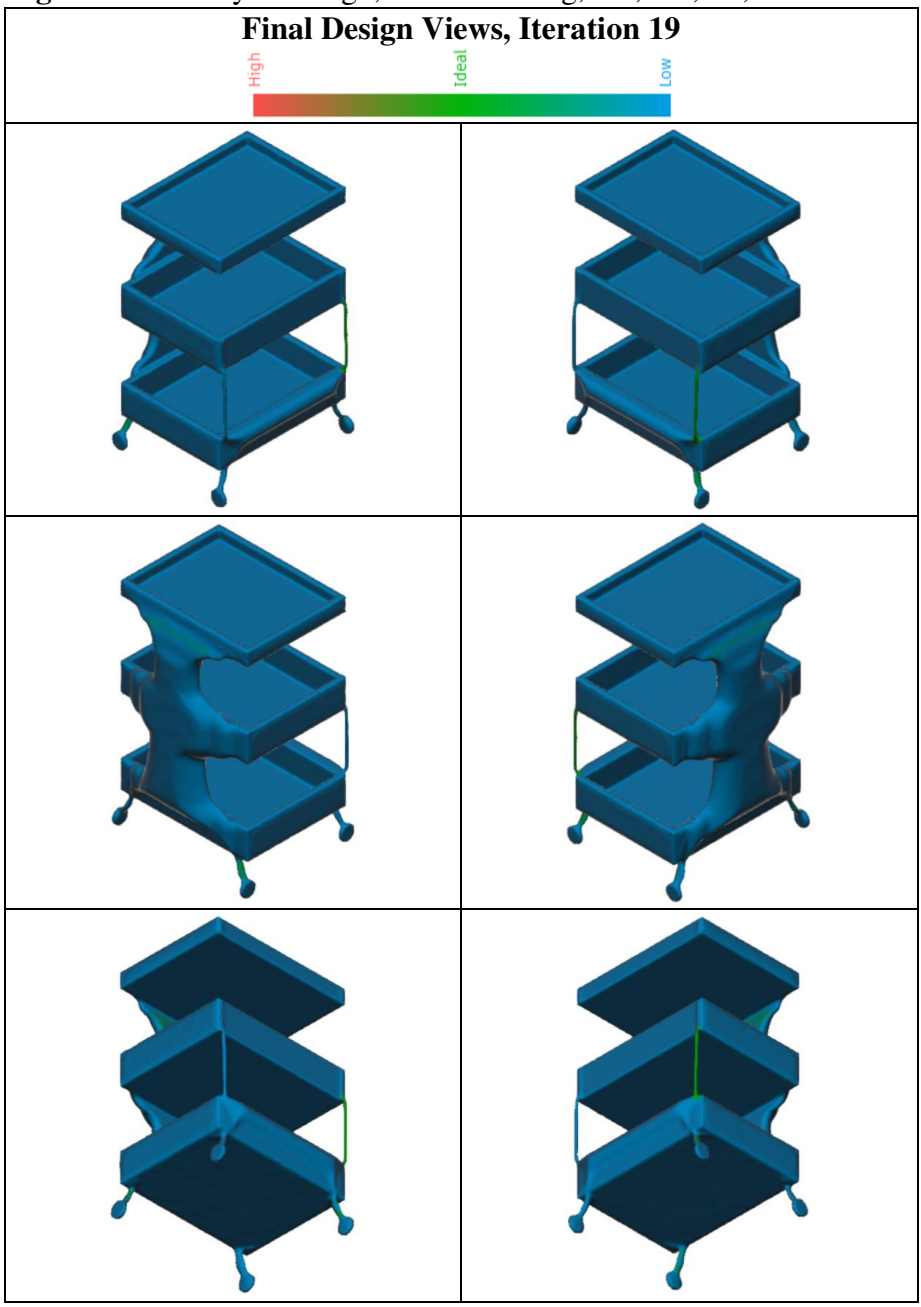

Figure 68. Trolley-2 Design, 3 Axis Milling, X+, Z+, X-, Z-

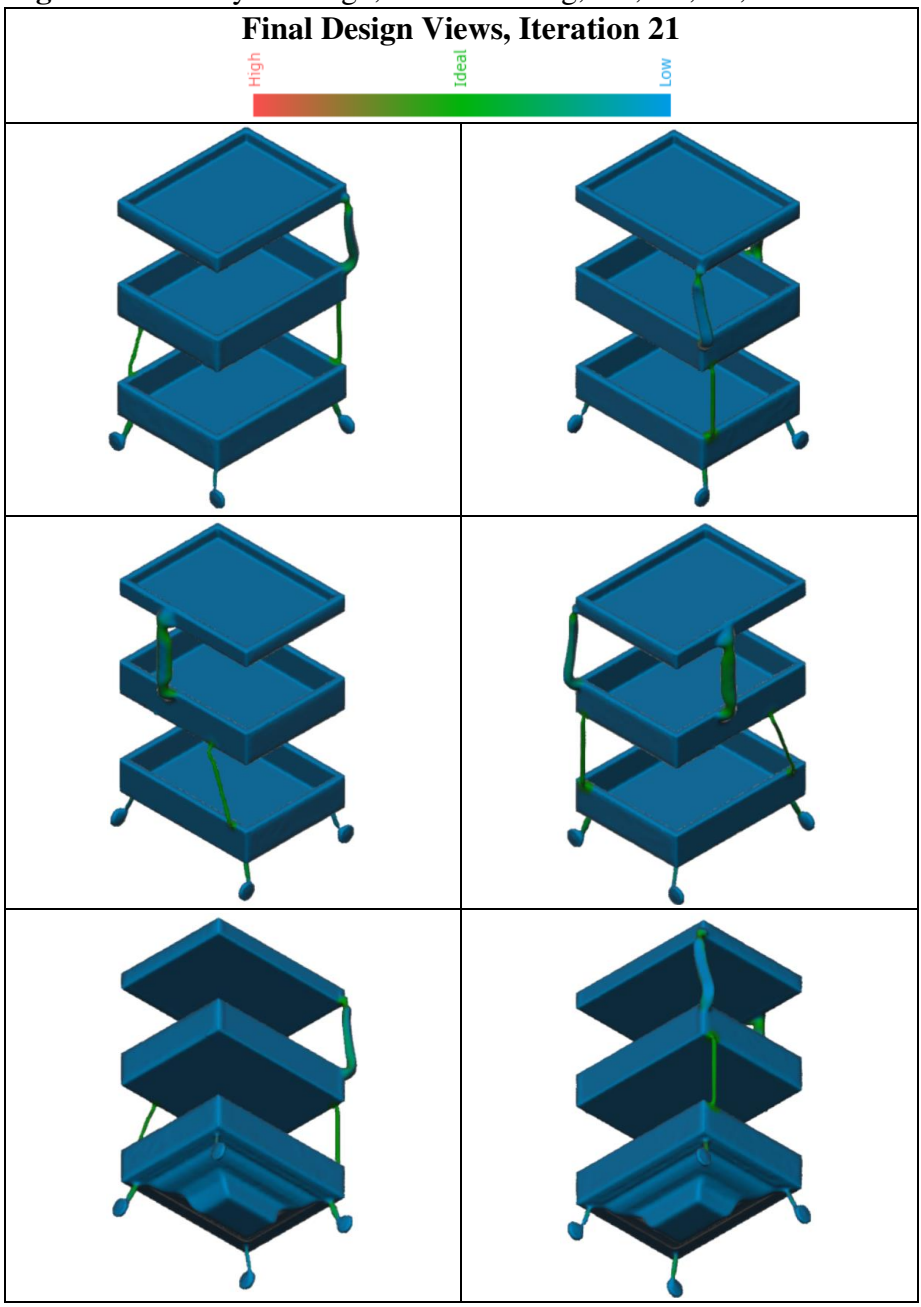

Figure 69. Trolley-2 Design, 3 Axis Milling, Y+, Z+, Y-, Z-

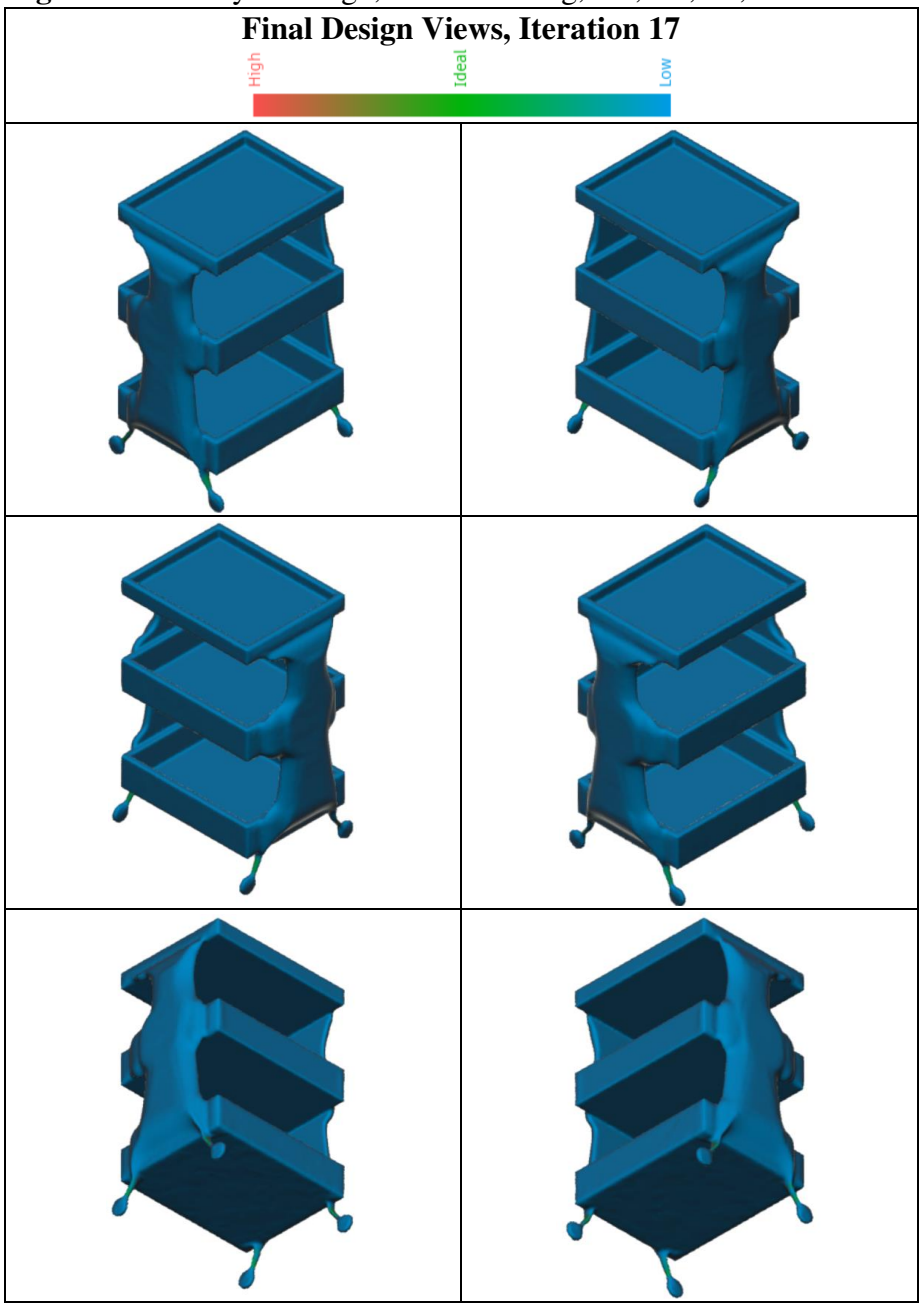

Figure 70. Trolley-2 Design, 3 Axis Milling, X+, Y+, Z+, X-, Y-, Z-

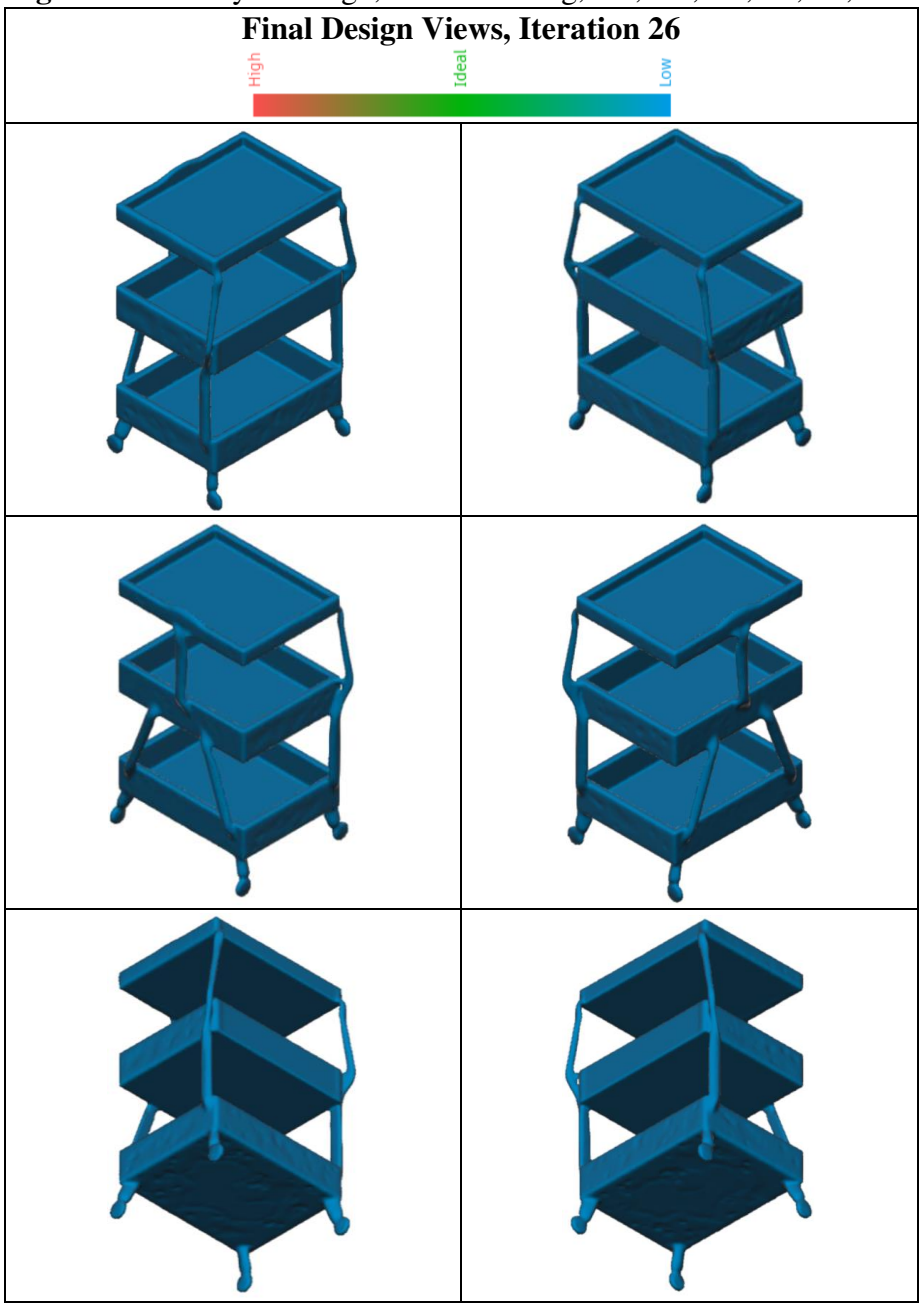

Figure 71. Trolley-2 Design, 5 Axis Milling, Unrestricted

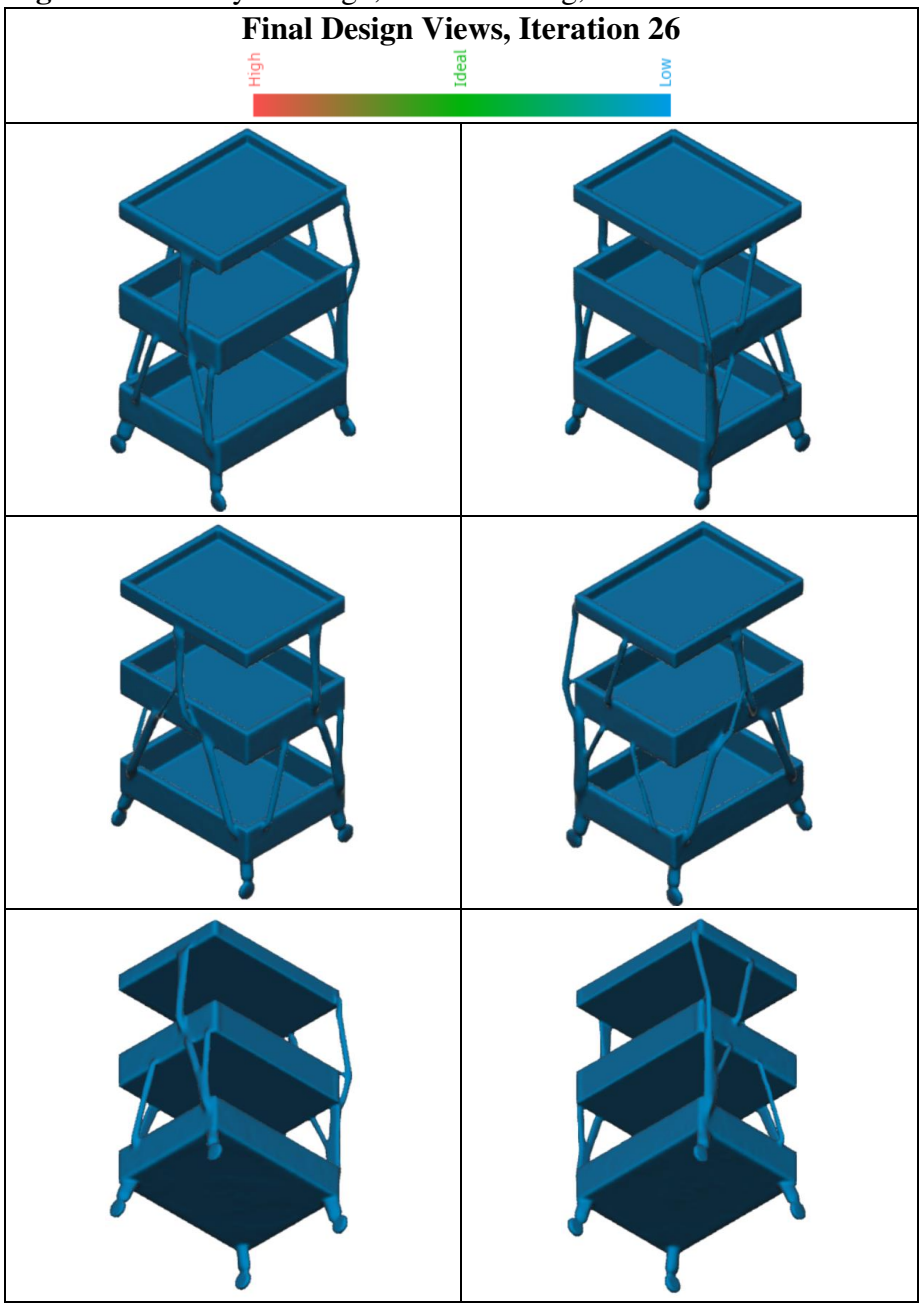

Figure 72. Trolley-2 Design, 2 Axis Cutting, Z

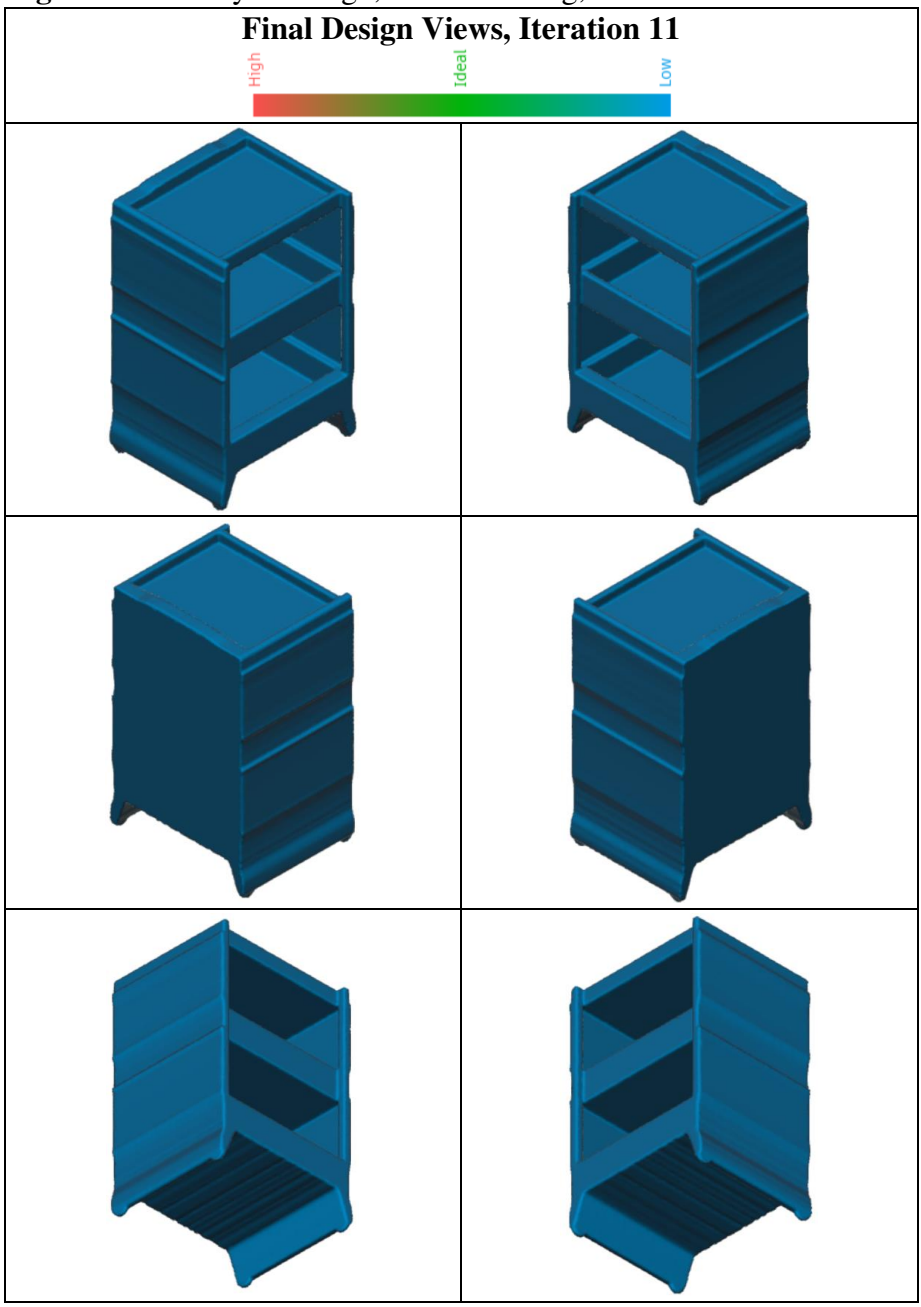

Figure 73. Trolley-2 Design, Die Casting, X+, X-

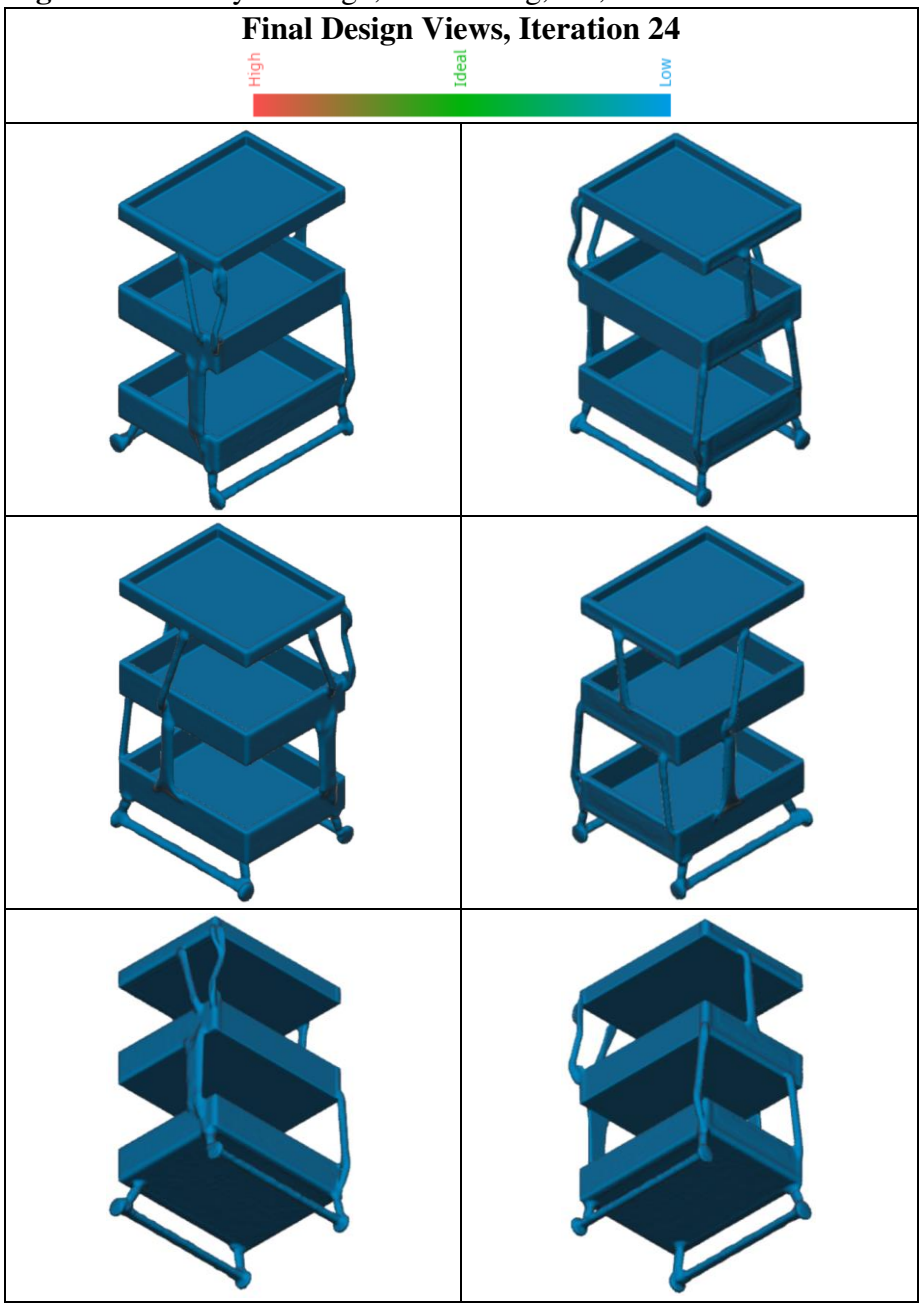

Figure 74. Trolley-2 Design, Die Casting, Y+, Y-

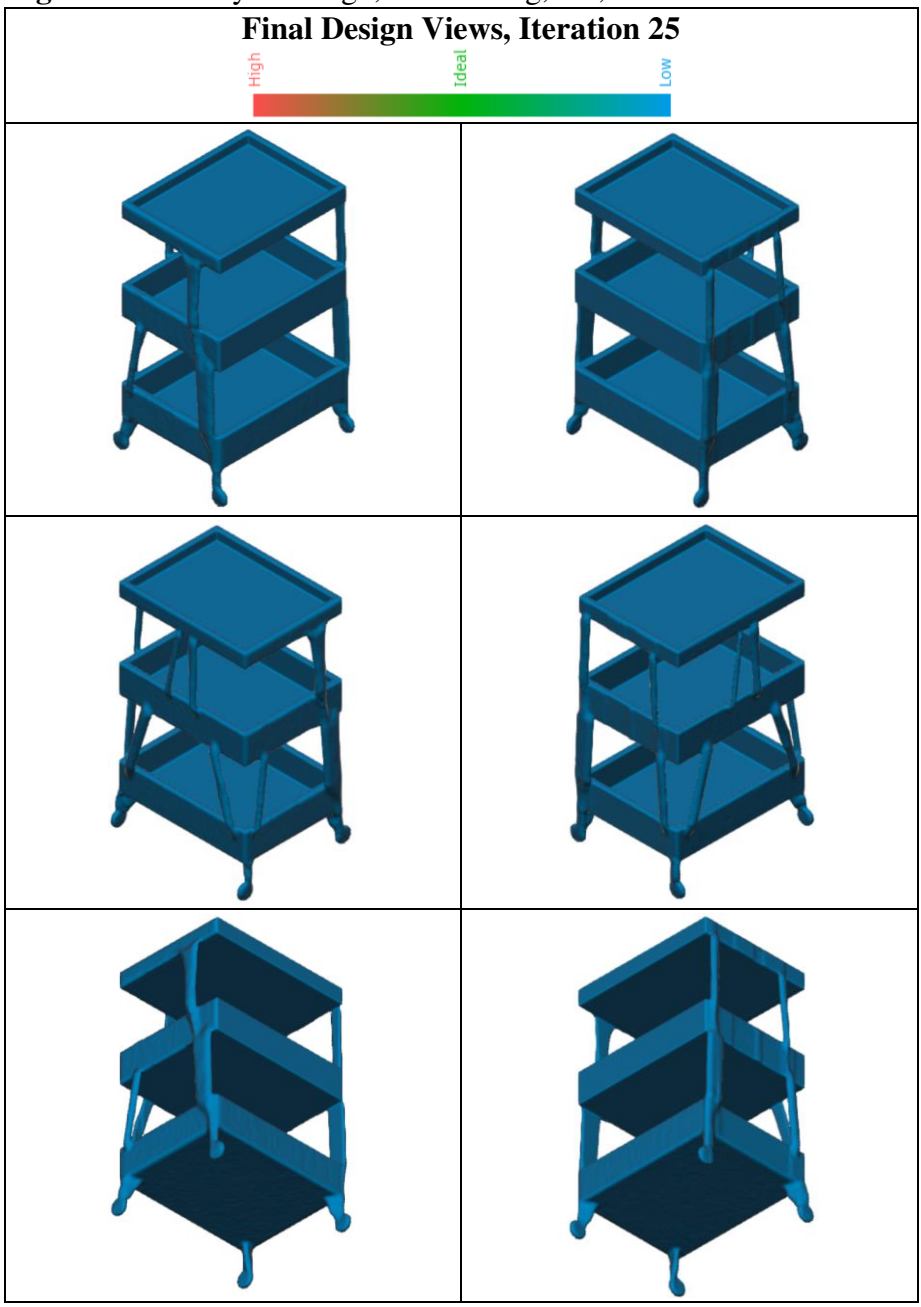

Figure 75. Trolley-2 Design, Die Casting, Z+, Z-

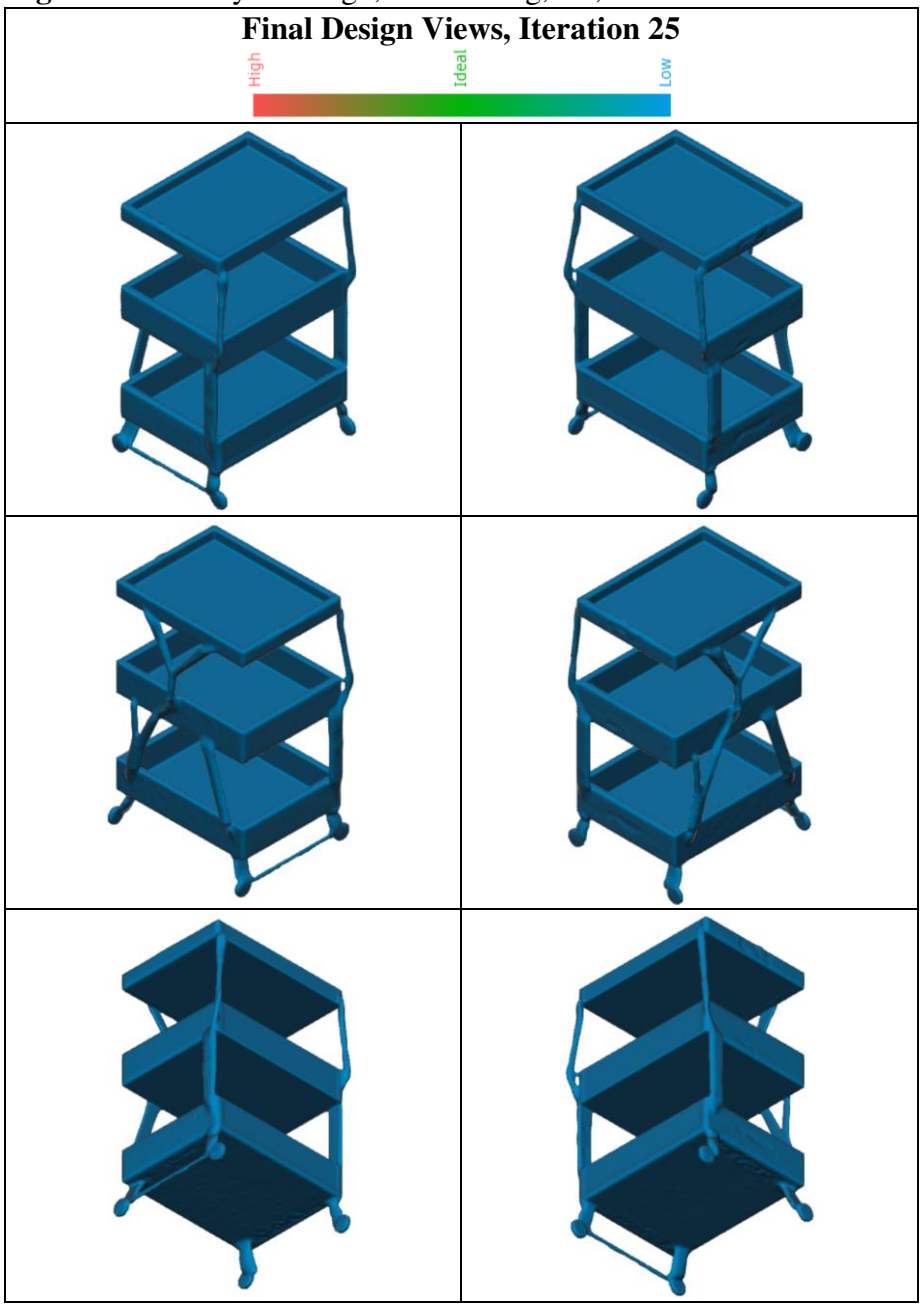

Table 4: The Values Calculated for The Trolley-2 Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	1.565e+7	12.522	0.4	0.08
Additive	X+	1.711e+7	13.685	3.9	18.8
	X-	1.732e+7	13.855	3.9	30.66
	Y+	2.475e+7	19.799	3.8	1.07
	Y-	1.786e+7	14.291	3.9	0.18
	Z+	1.89e+7	15.123	3.9	0.29
	Z-	1.718e+7	13.747	3.9	0.66
3 axis milling	X+, Y+, X-, Y-	2.105e+7	16.838	3.9	2.51
	X+, Z+, X-, Z-	1.914e+7	15.315	3.8	308.18
	Y+, Z+, Y-, Z-	2.232e+7	17.859	1.6	0.08
	X+, Y+, Z+, X-, Y-, Z-	1.583e+7	12.661	0.6	0.08
5 axis milling	Unrestricted	1.572e+7	12.577	0.4	0.07
2 axis cutting	Z	2.891e+7	23.128	0.2	0.04
Die casting	X+, X-	1.629e+7	13.035	0.4	0.11
	Y+, Y-	1.599e+7	12.791	0.3	0.07
	Z+, Z-	1.57e+7	12.56	0.4	0.09

3.5. School Bench and Desk Design

In this model, obstacle geometries were created to create suitable leg and support forms/constructions in the school bench and desk. A force of 560 N was applied to the backrest of the school bench, while a force of 1600 N was applied to the seat of the school bench. A force of 500 N was applied onto the school desk. The views of designs created by generative design for the school bench and desk are shown in figures 80-95.

Figure 76. Perspective Views of the School Bench and Desk and the Loads Applied to It

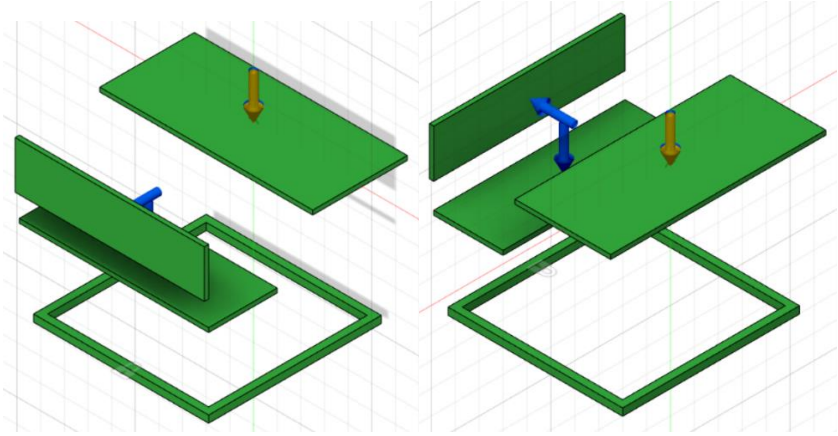

Figure 77. Front and Side Views of the School Bench and Desk and the Loads Applied to It

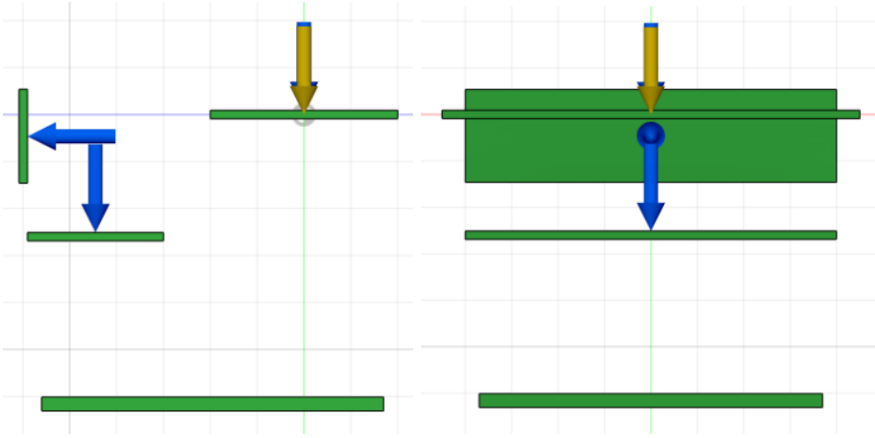

Figure 78. Perspective Views of Preserve and Obstacle Geometries of The School Bench and Desk

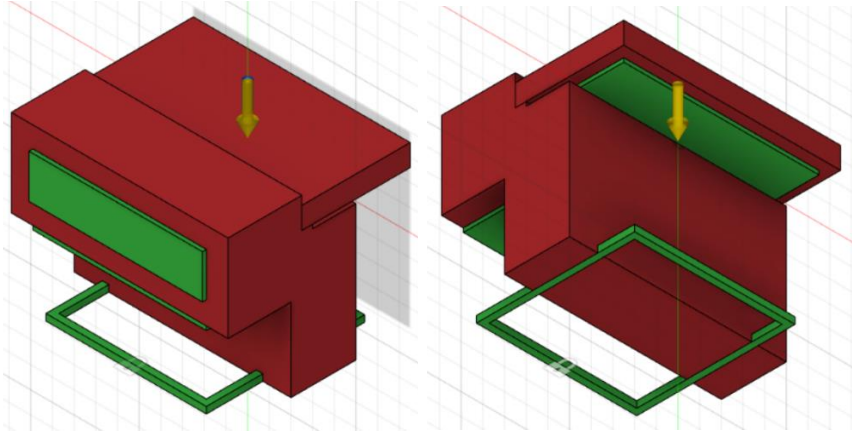

Figure 79. Dimensions of The School Bench and Desk

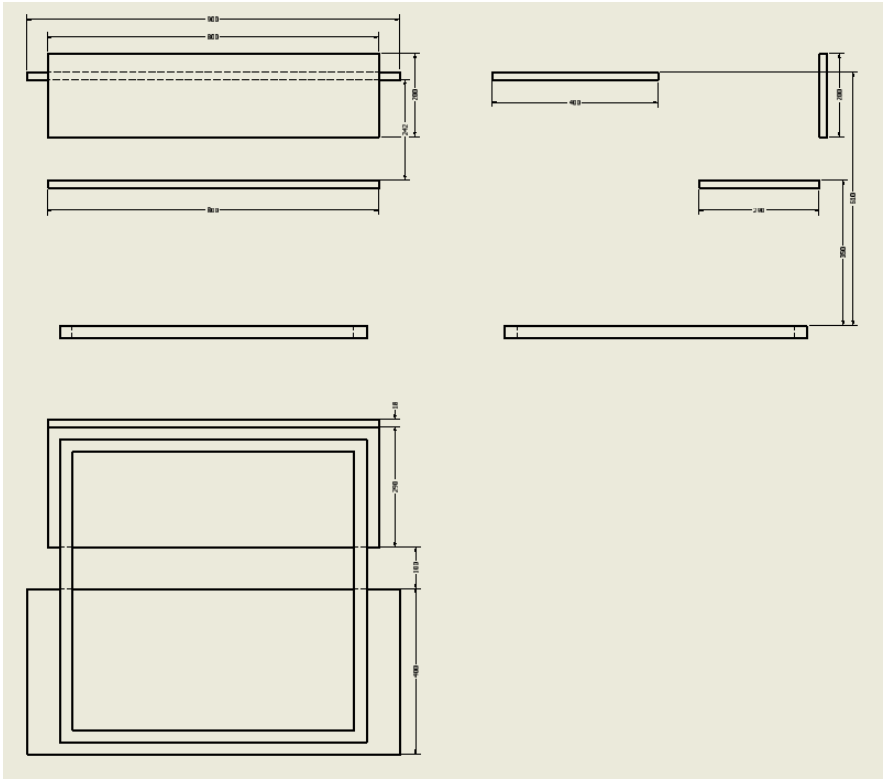

Figure 80. School Bench and Desk Design, Unrestricted, -

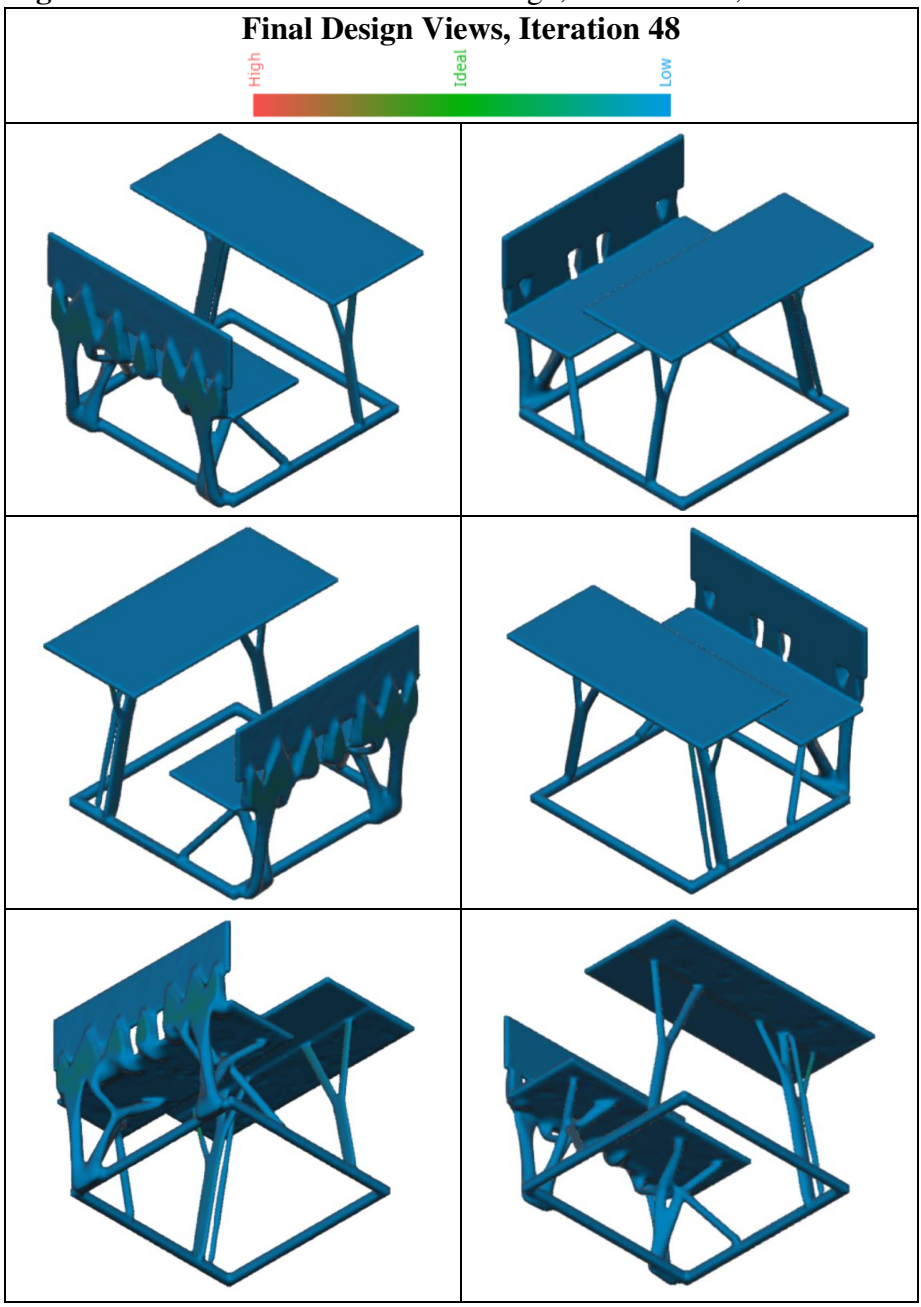

Figure 81. School Bench and Desk Design, Additive, X+

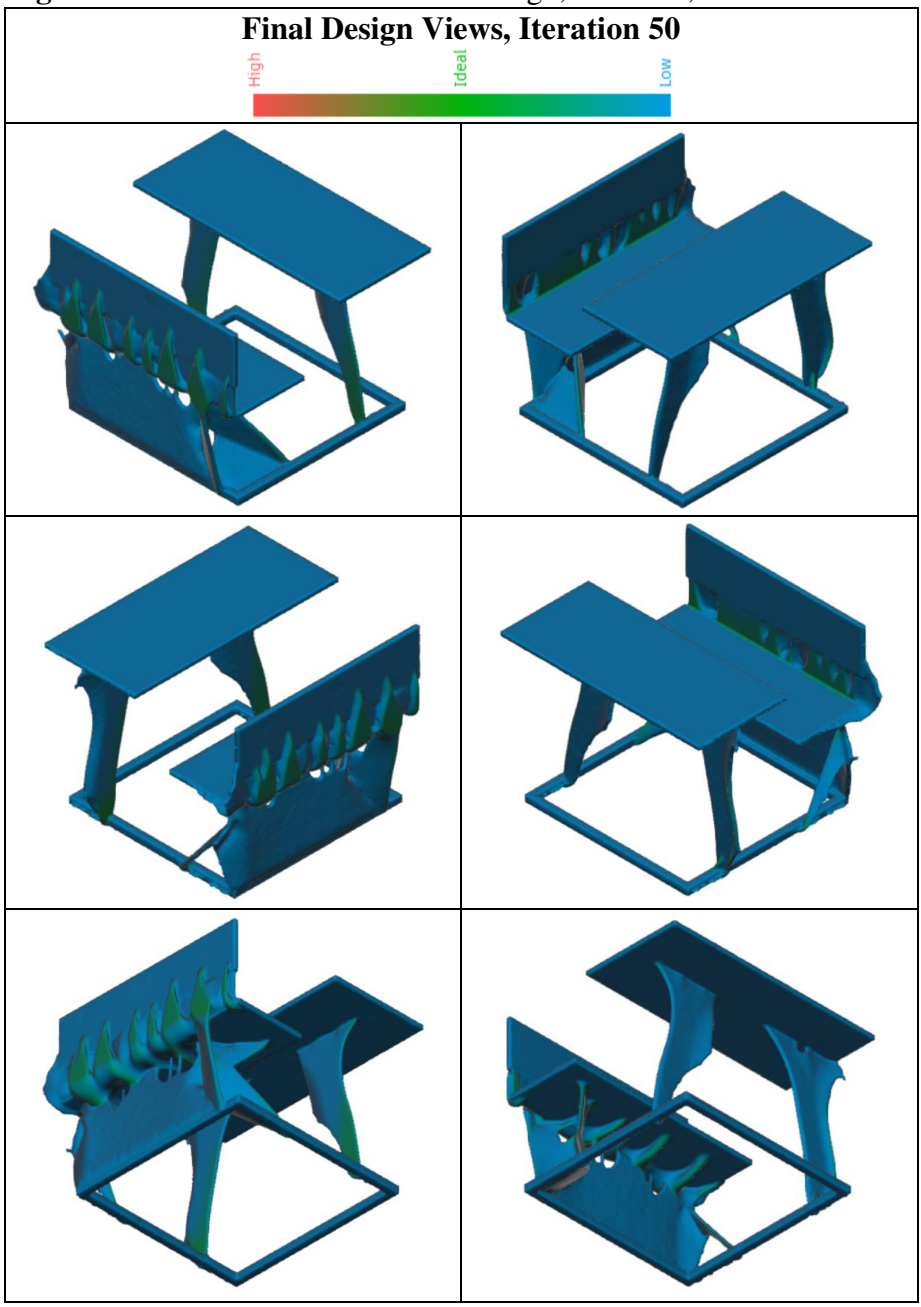

Figure 82. School Bench and Desk Design, Additive, X-

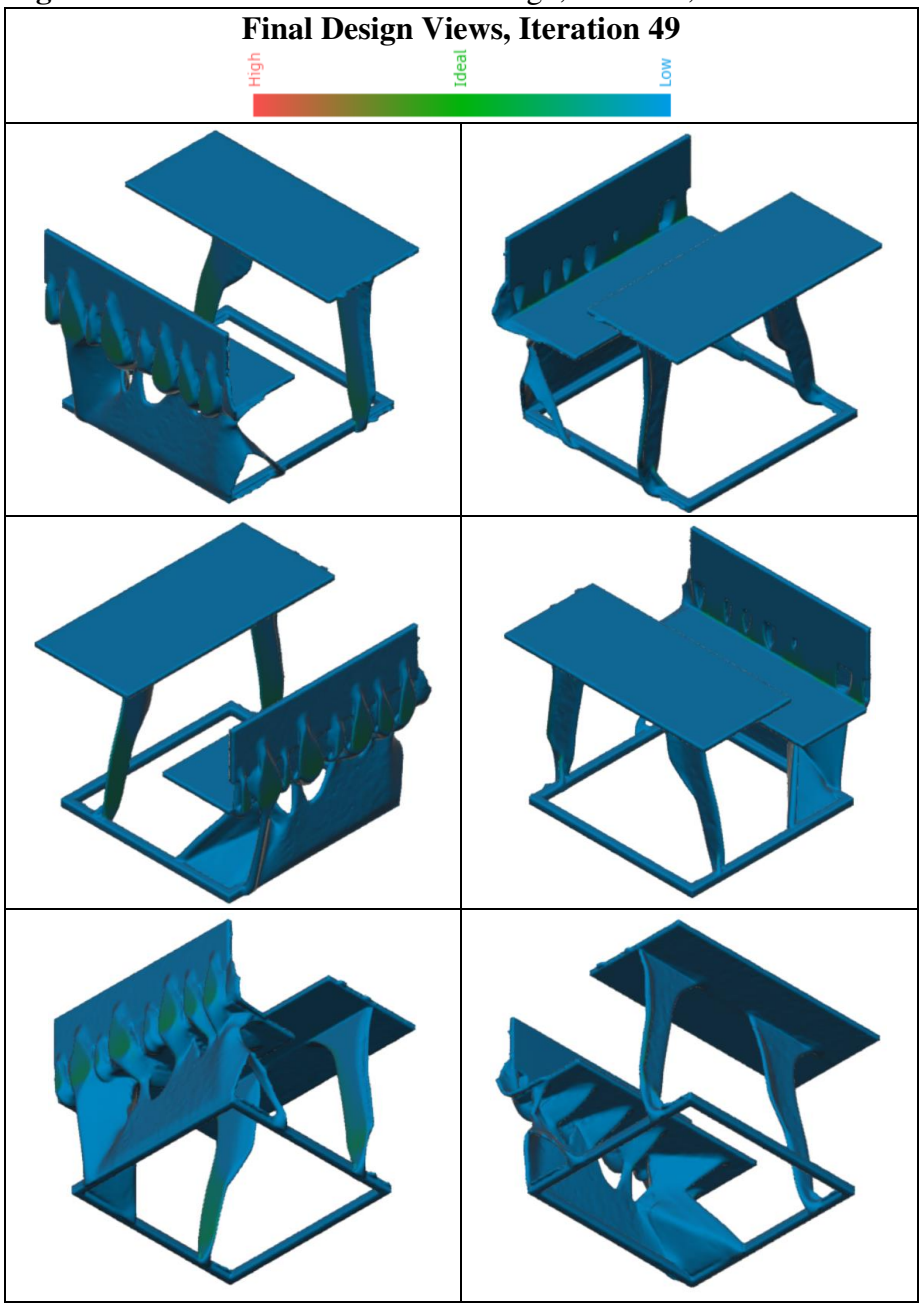

Figure 83. School Bench and Desk Design, Additive, Y+

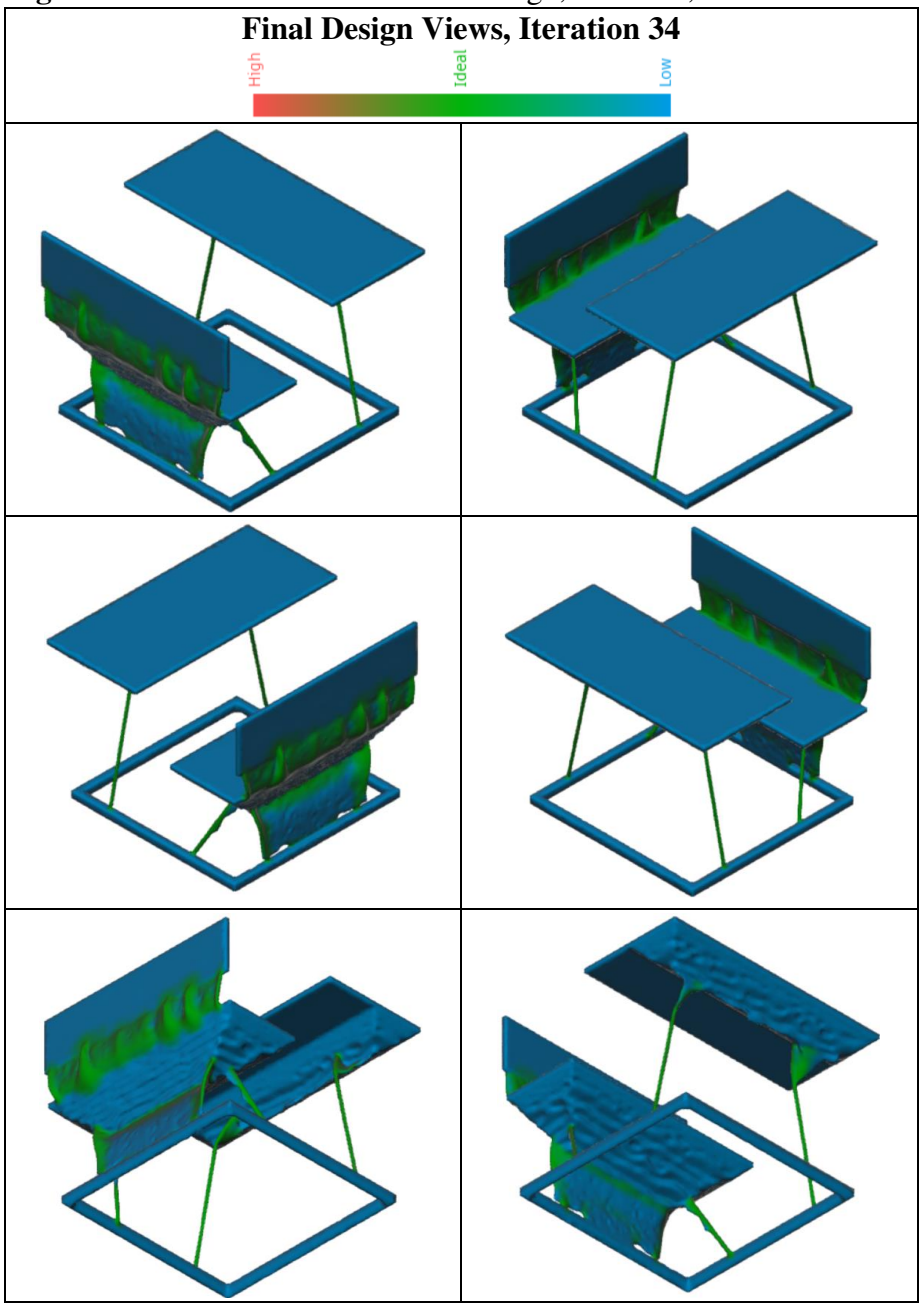

Figure 84. School Bench and Desk Design, Additive, Y-

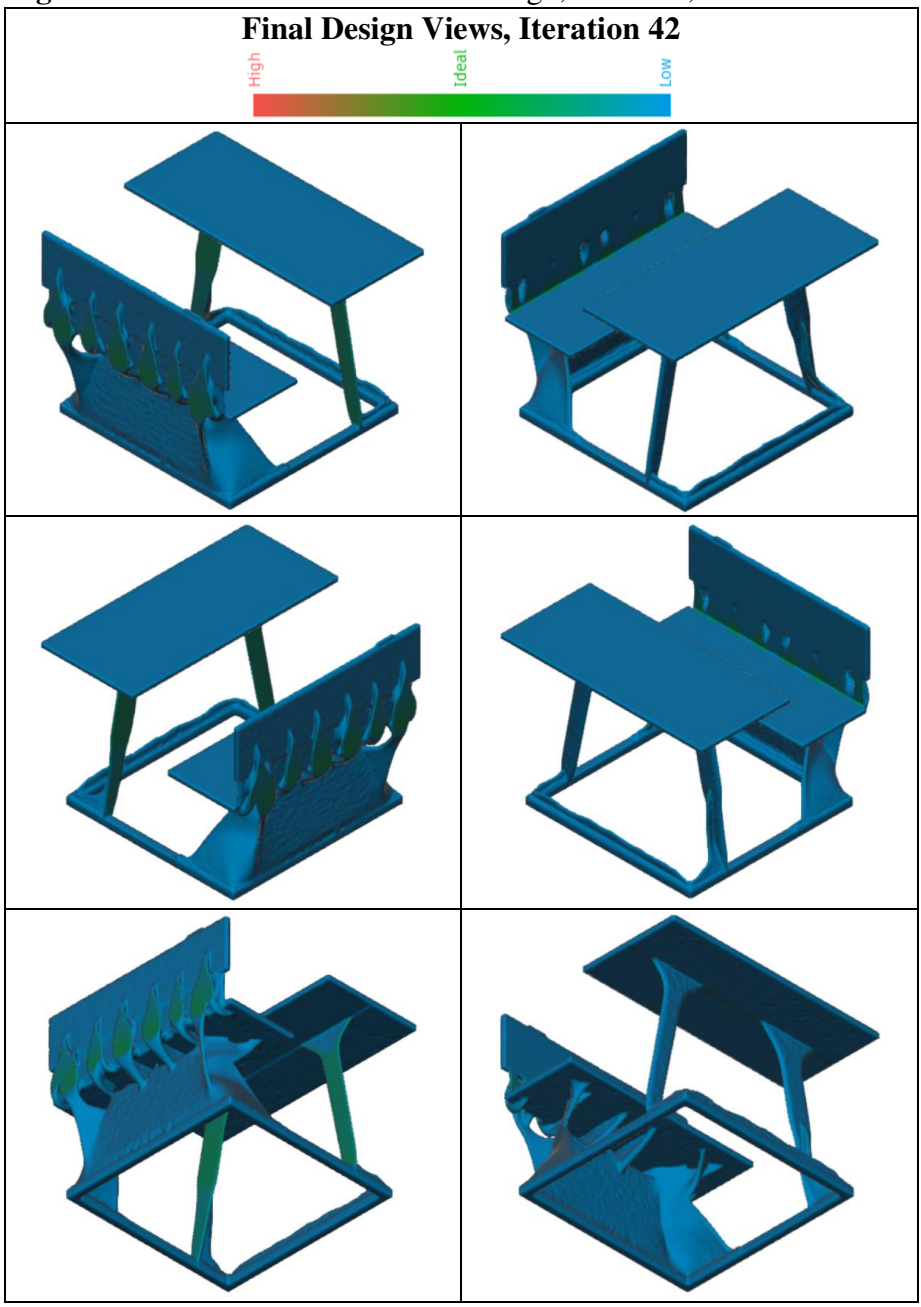

Figure 85. School Bench and Desk Design, Additive, Z+

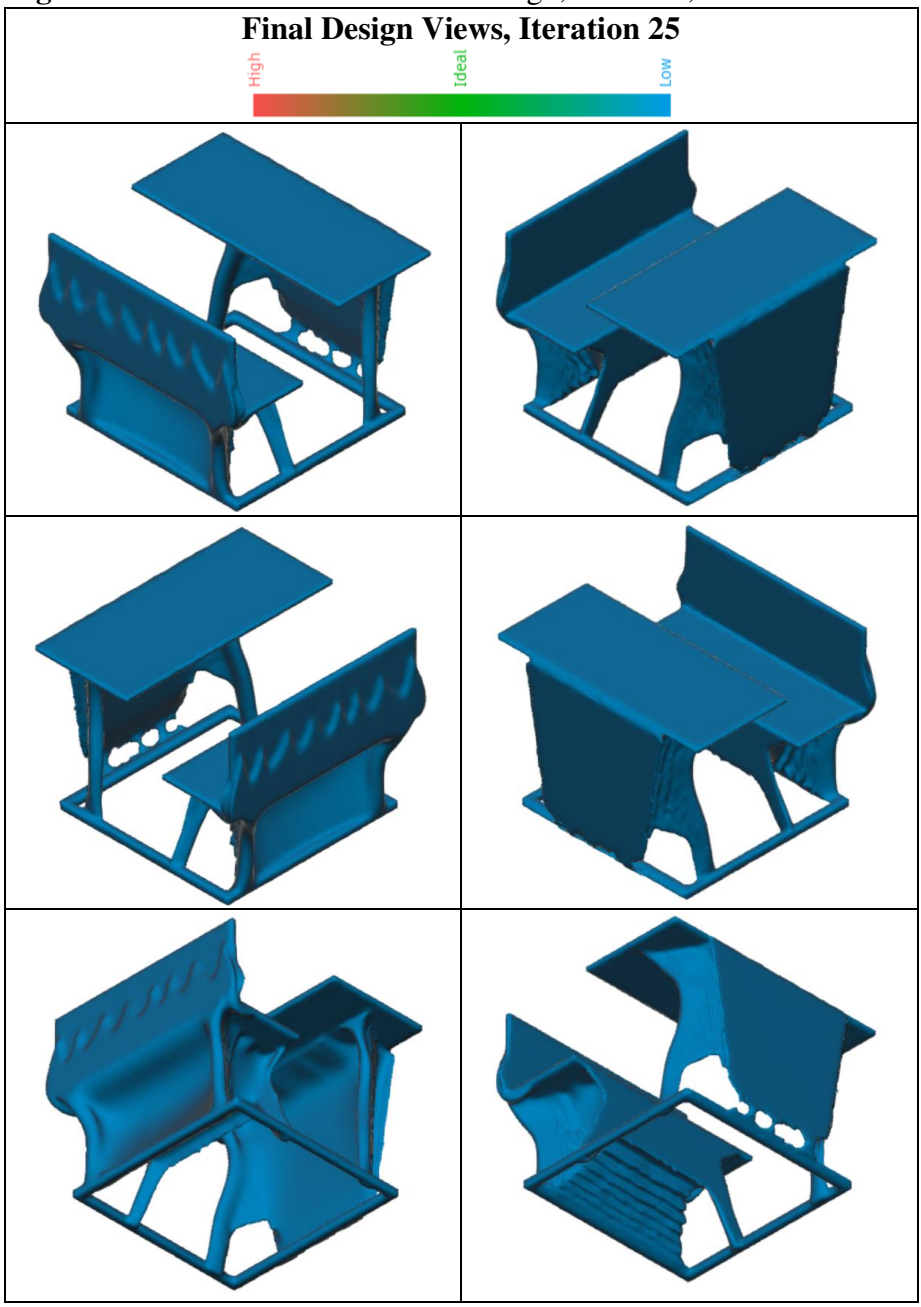

Figure 86. School Bench and Desk Design, Additive, Z-

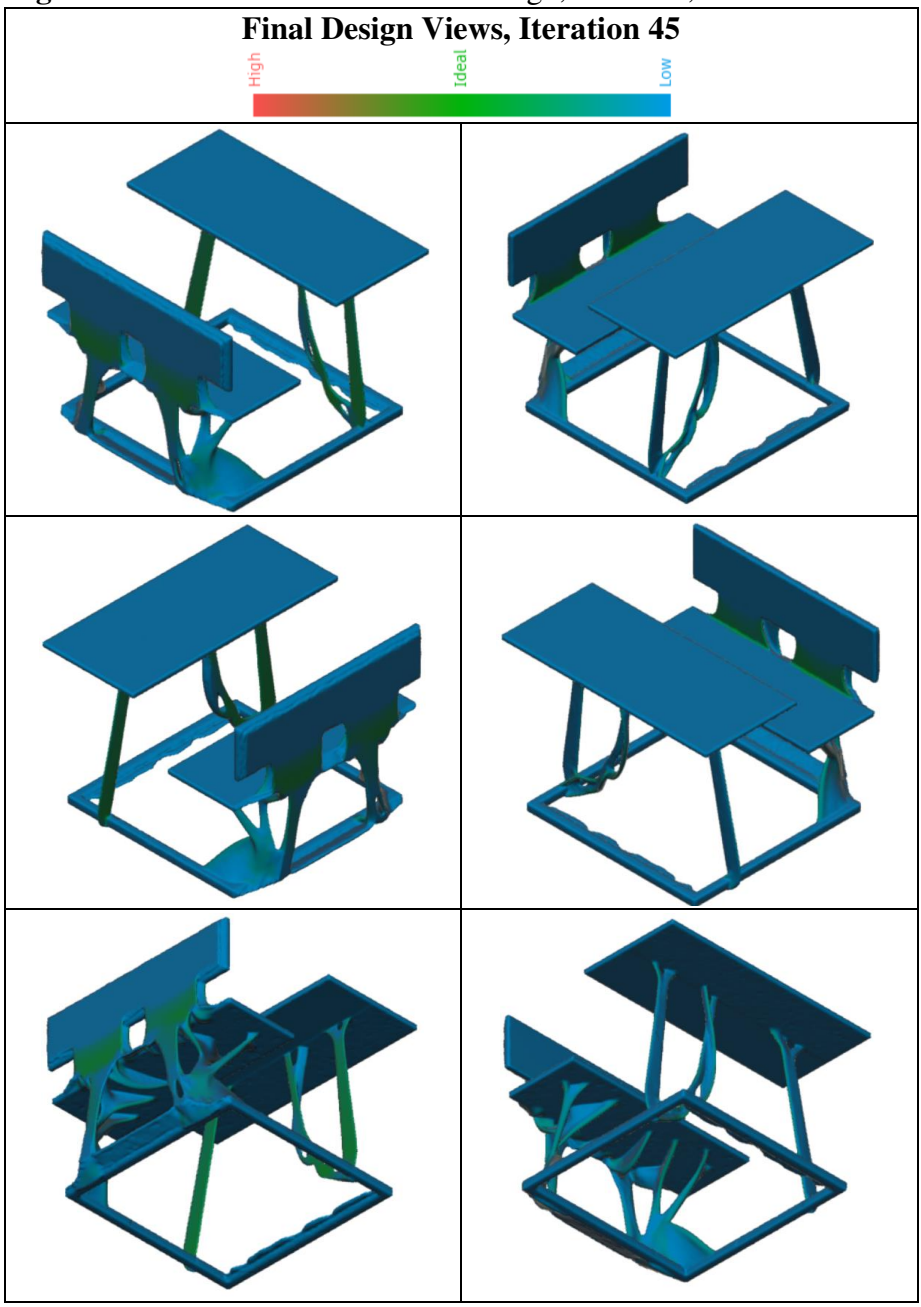

Figure 87. School Bench and Desk Design, 3 Axis Milling, X+, Y+, X-, Y-

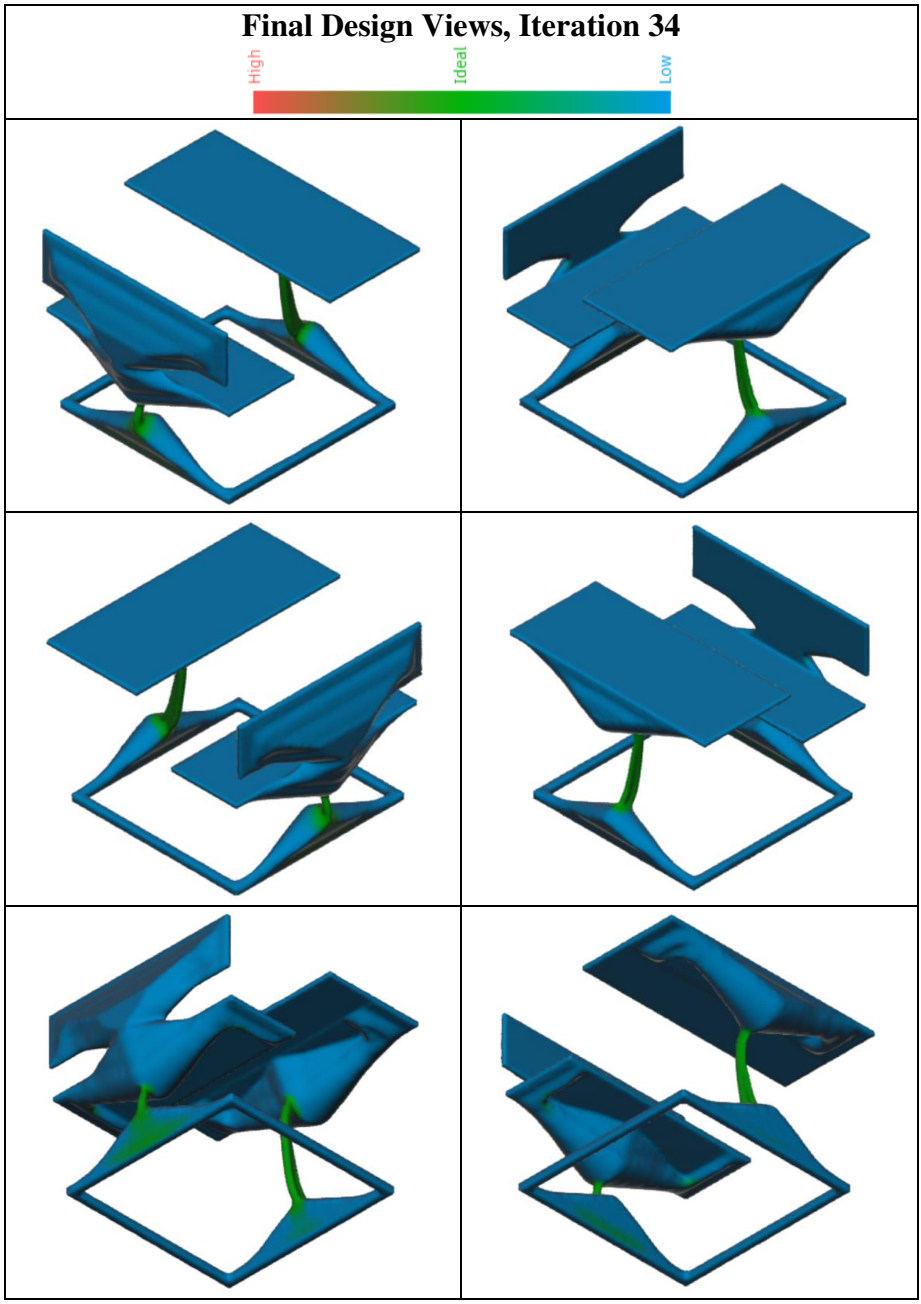

Figure 88. School Bench and Desk Design, 3 Axis Milling, X+, Z+, X-, Z-

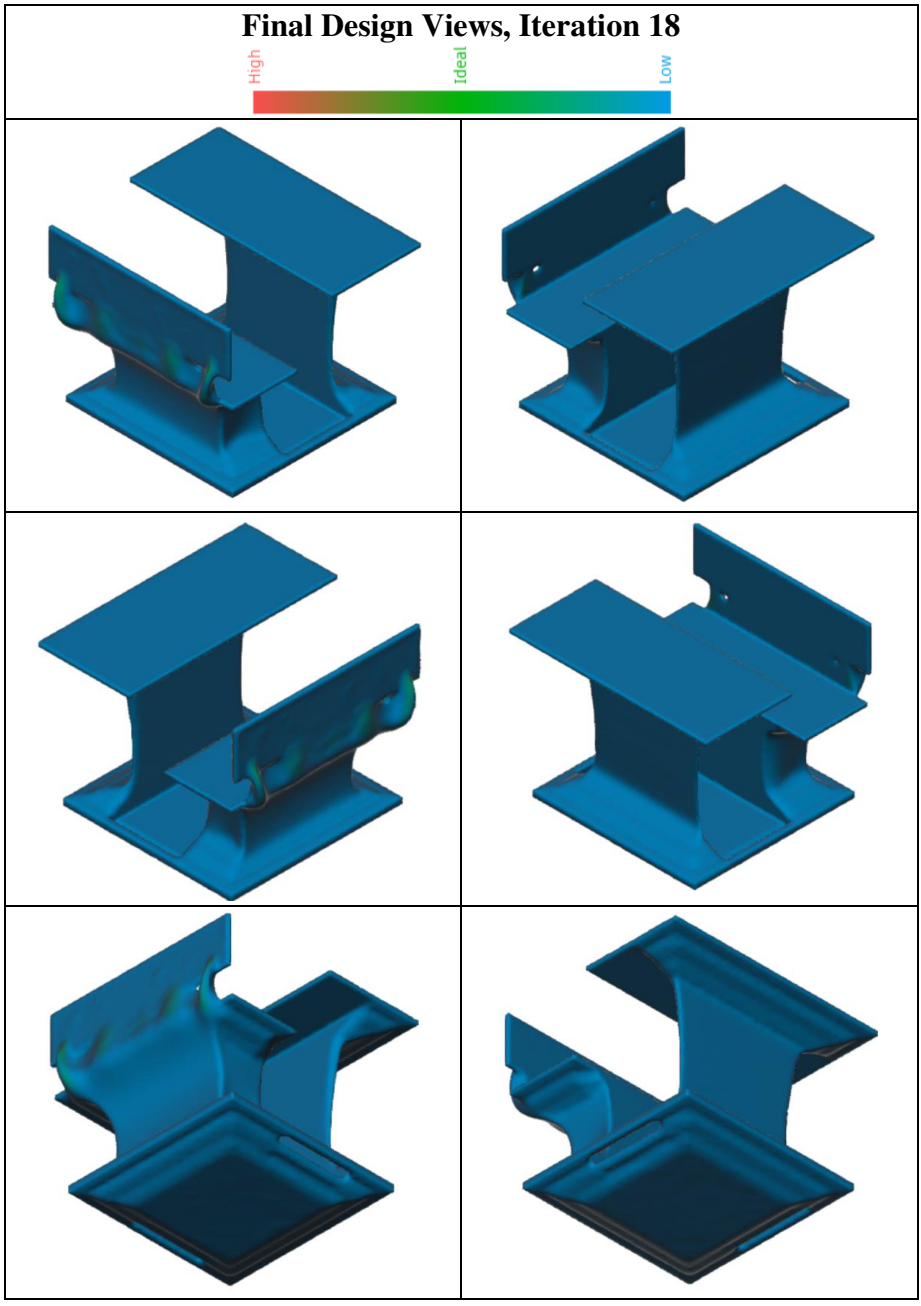

Figure 89. School Bench and Desk Design, 3 Axis Milling, Y+, Z+, Y-, Z-

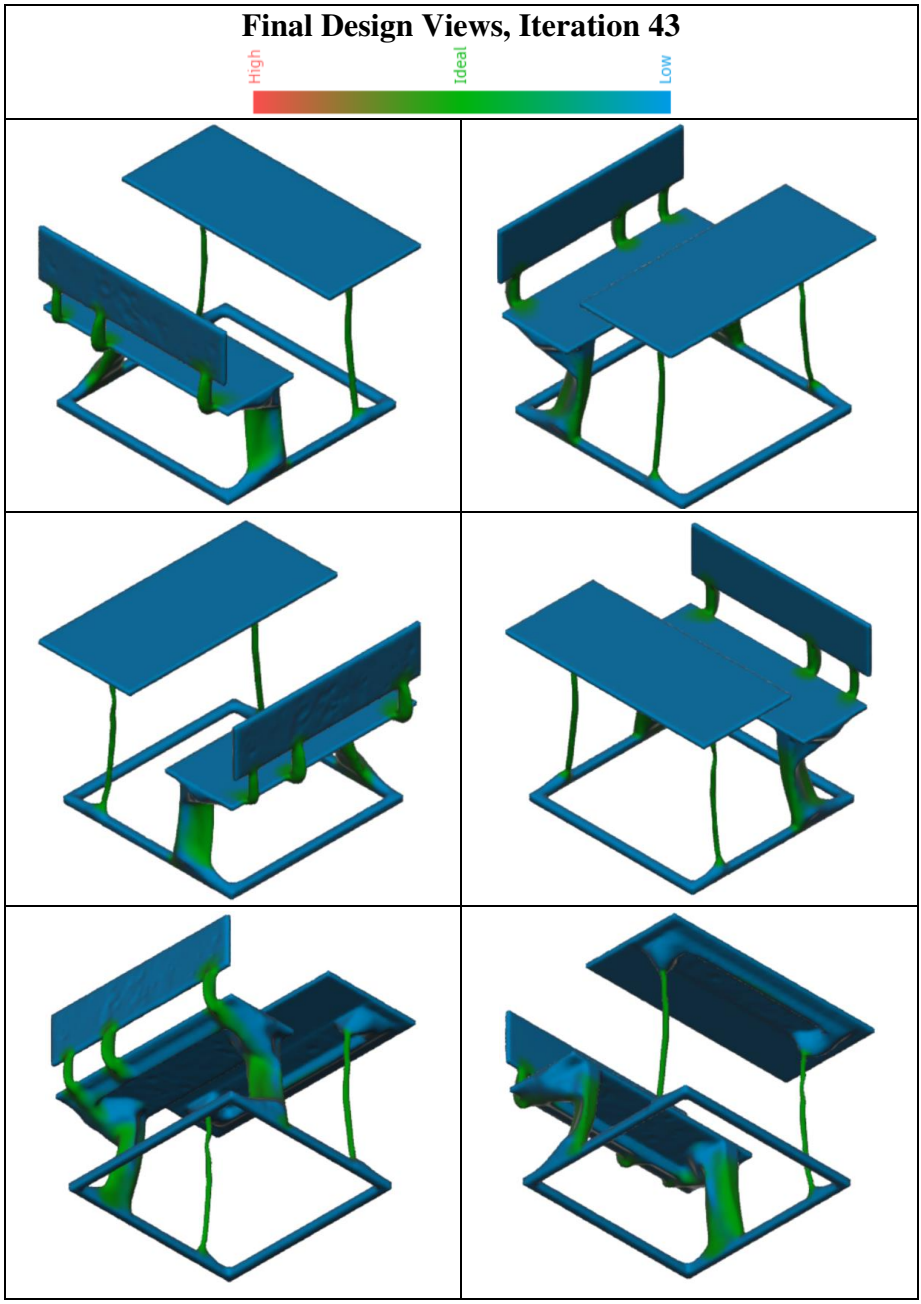

Figure 90. School Bench and Desk Design, 3 Axis Milling, X+, Y+, Z+, X-, Y-, Z-

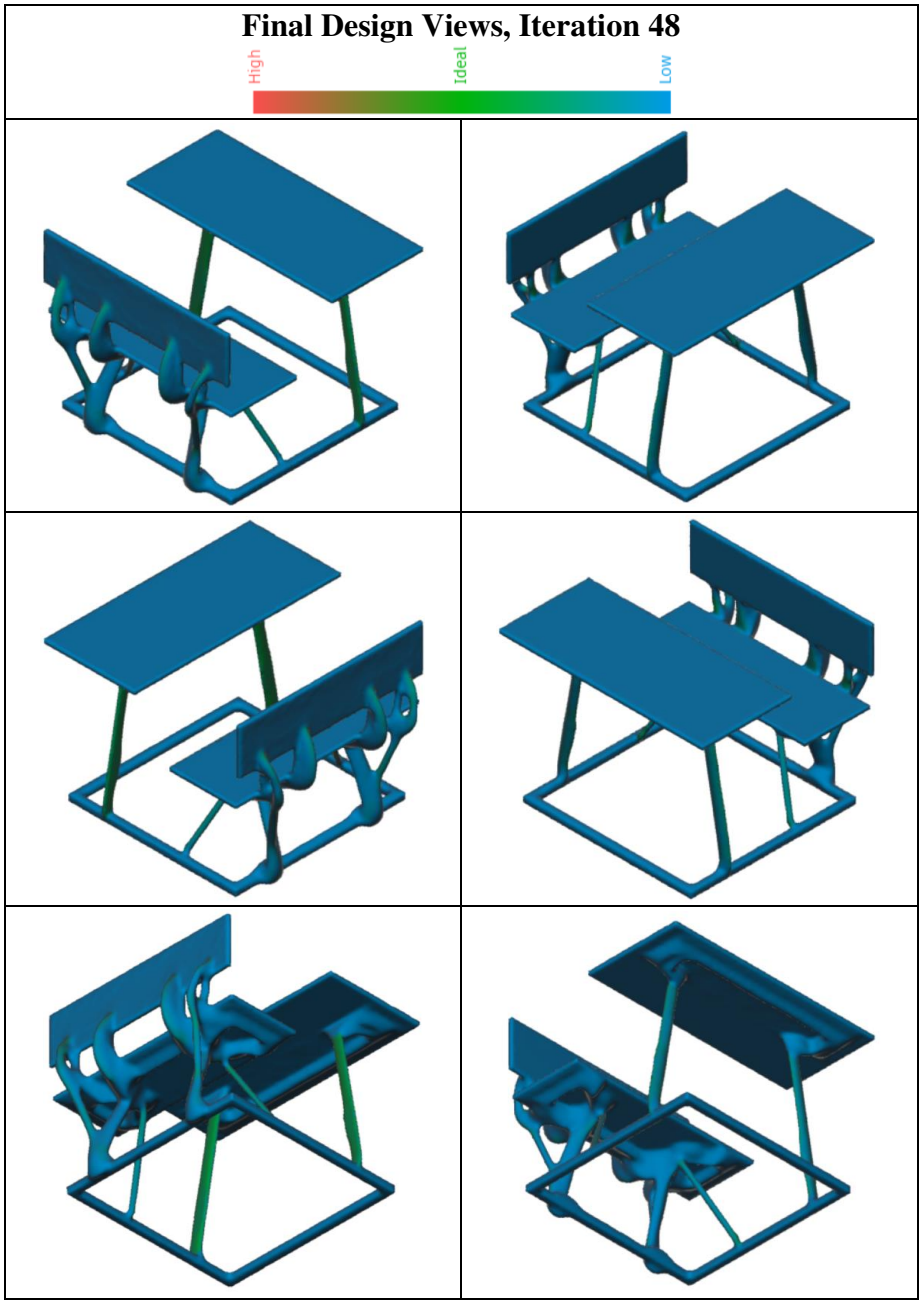

Figure 91. School Bench and Desk Design, 5 Axis Milling, Unrestricted

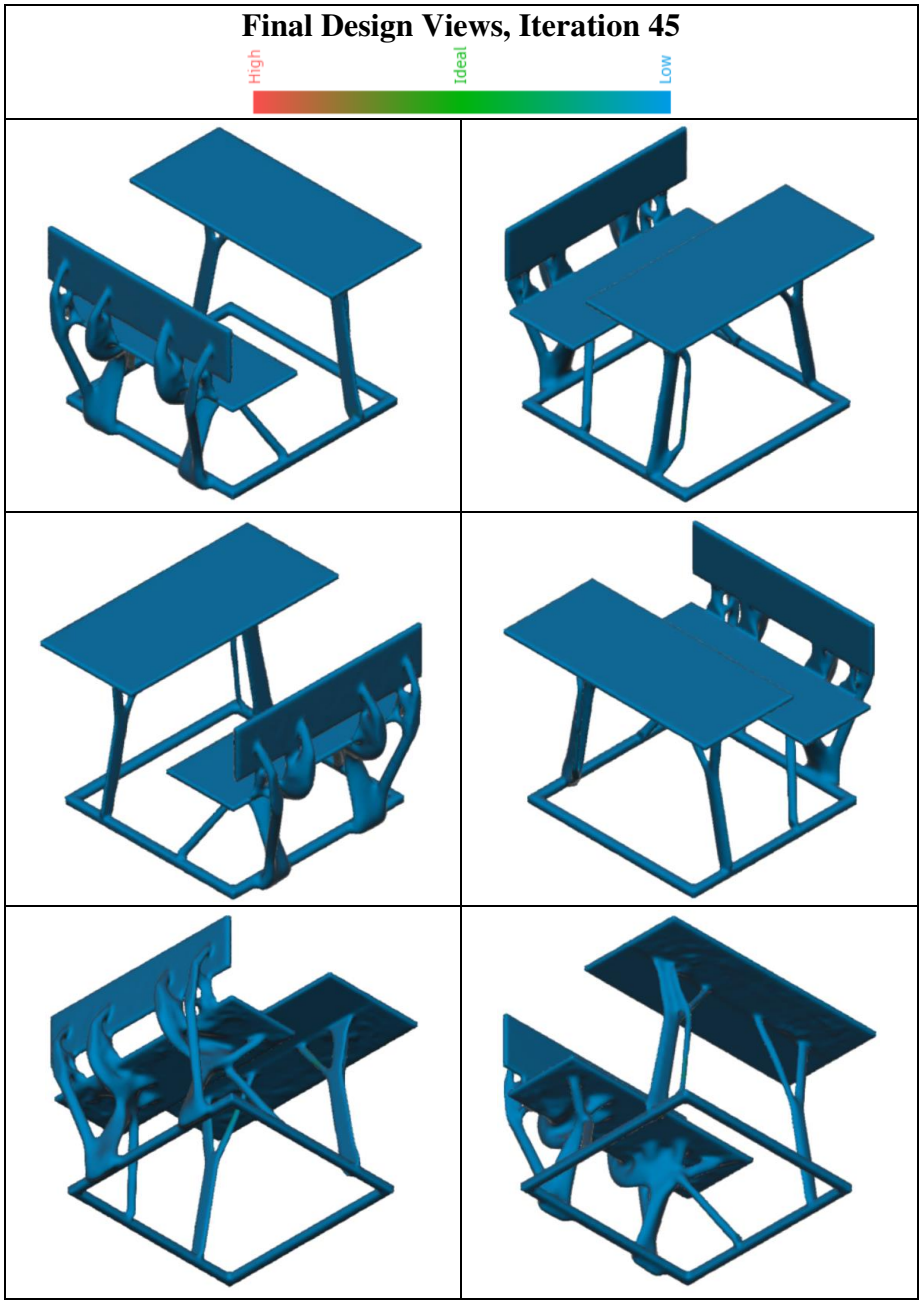

Figure 92. School Bench and Desk Design, 2 Axis Cutting, Z

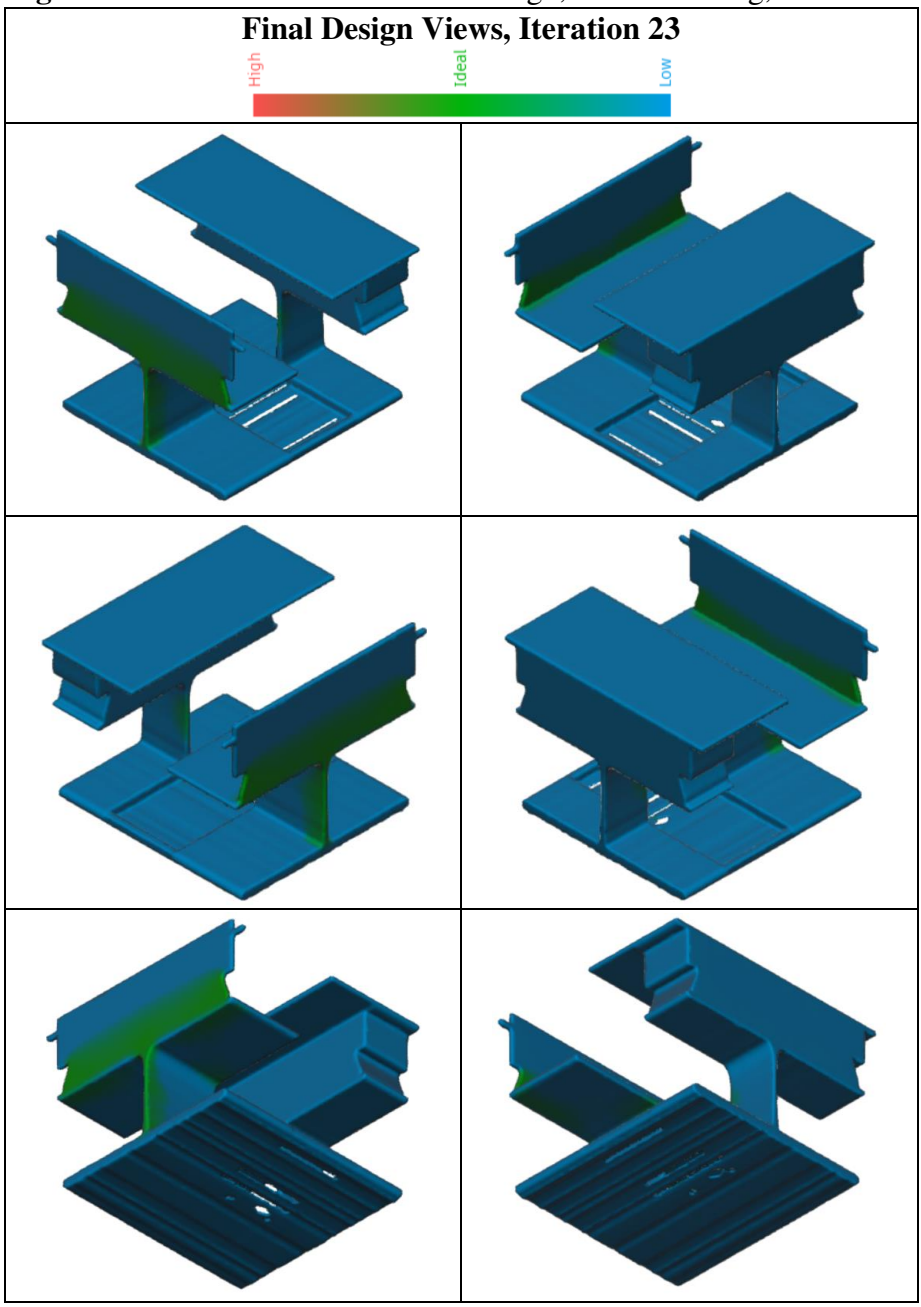

Figure 93. School Bench and Desk Design, Die Casting, X+, X-

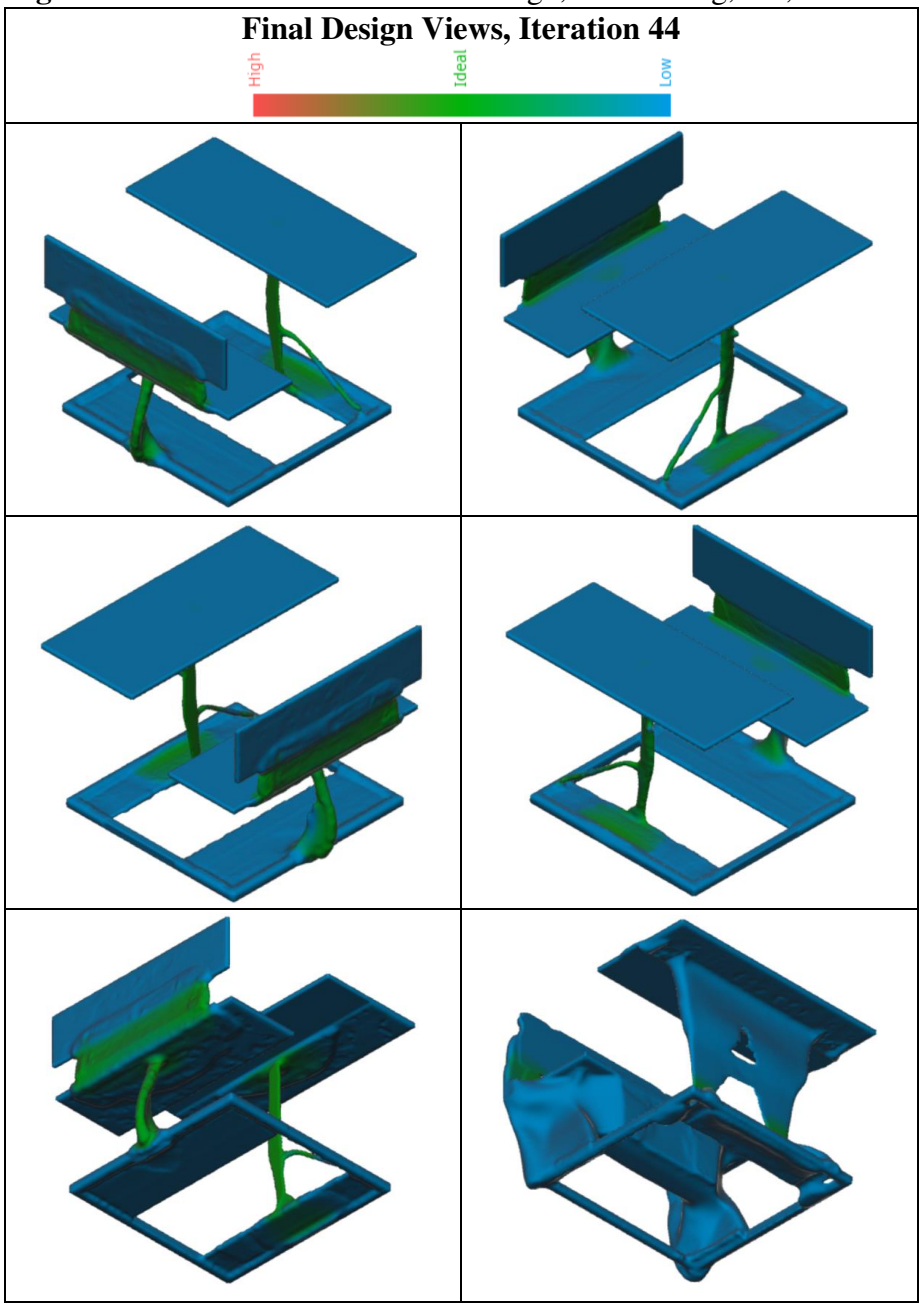

Figure 94. School Bench and Desk Design, Die Casting, Y+, Y-

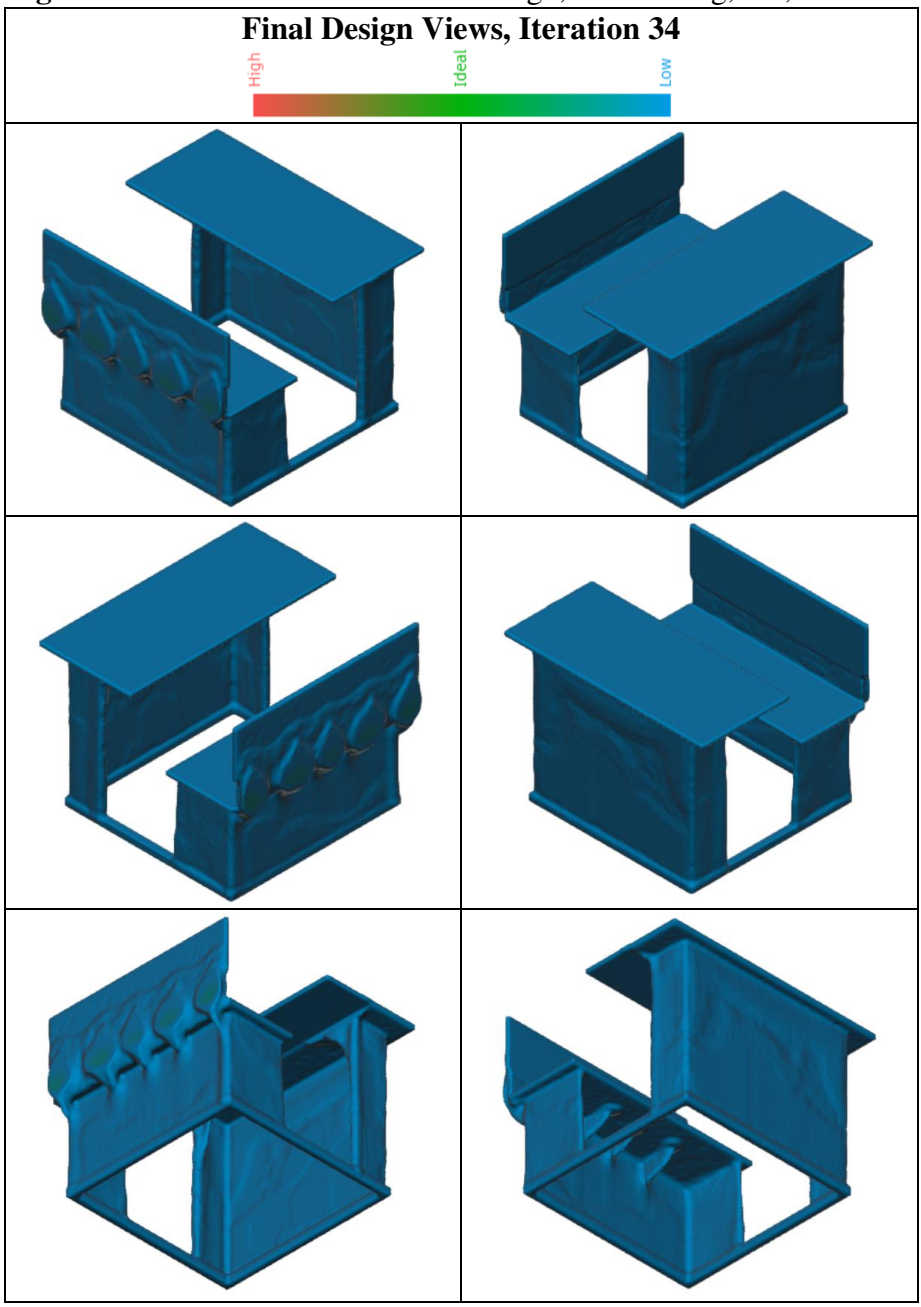

Figure 95. School Bench and Desk Design, Die Casting, Z+, Z-

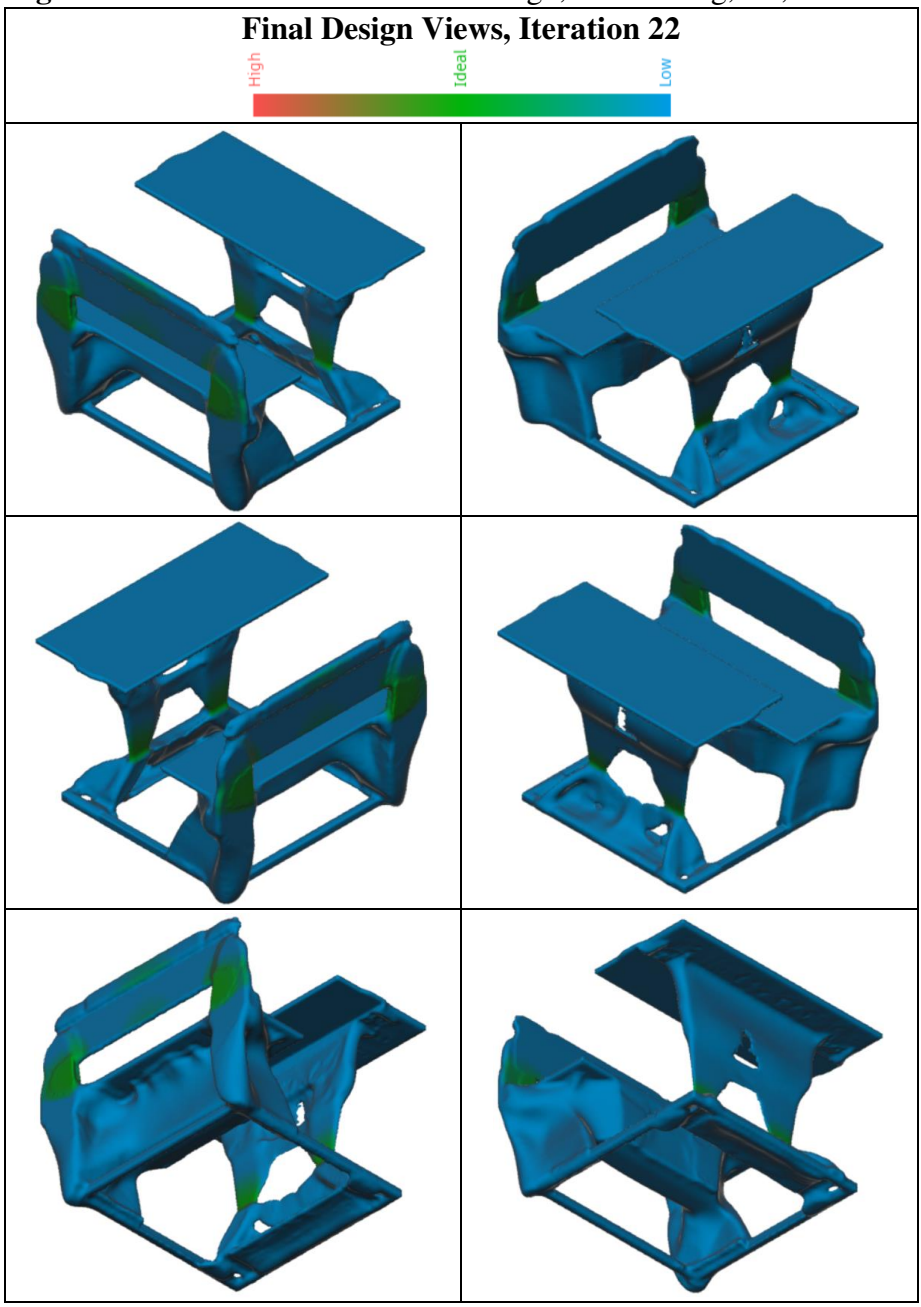

Table 5: The Values Calculated for The School Bench and Desk Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	2.605e+7	20.837	1.2	2.2
Additive	X+	2.702e+7	21.62	1.6	6.01
	X-	2.807e+7	22.459	1.4	5.72
	Y+	4.299e+7	34.392	3.9	6.67
	Y-	2.614e+7	20.914	1.5	6.79
	Z+	6.704e+7	53.634	1.2	0.75
	Z-	2.618e+7	20.944	1.7	9.44
3 axis milling	X+, Y+, X-, Y-	4.663e+7	37.301	3.9	20.16
	X+, Z+, X-, Z-	9.469e+7	75.753	1.1	1.14
	Y+, Z+, Y-, Z-	2.698e+7	21.581	3.9	52.51
	X+, Y+, Z+, X-, Y-, Z-	2.644e+7	21.155	1.7	8
5 axis milling	Unrestricted	2.619e+7	20.95	1.1	2.65
2 axis cutting	Z	7.703e+7	61.627	2.7	3.09
Die casting	X+, X-	2.877e+7	23.014	3.8	19.71
	Y+, Y-	4.123e+7	32.985	0.8	0.9
	Z+, Z-	6.851e+7	54.808	3.3	4.71

3.6. Rocking Chair Designs

In this model, obstacle geometries were created to create suitable leg and support forms/constructions in the rocking chair. A force of 440 N was applied to the backrest of the rocking chair, while a force of 1100 N was applied to the seat of the rocking chair. A force of 50 N was applied to each armrest of the rocking chair. The views of designs created by generative design for the rocking chair are shown in figures 99-114.

Figure 96. Perspective Views of the Rocking Chair and the Loads Applied to It

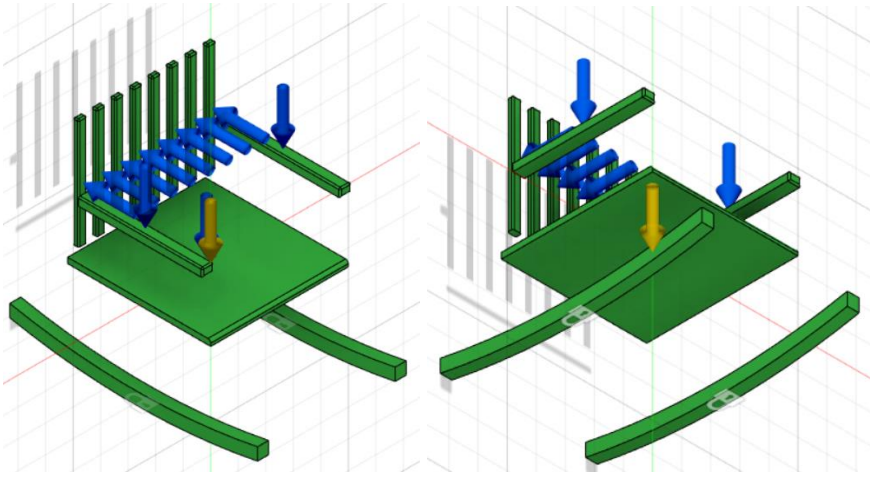

Figure 97. Perspective Views of Preserve and Obstacle Geometries of the Rocking Chair

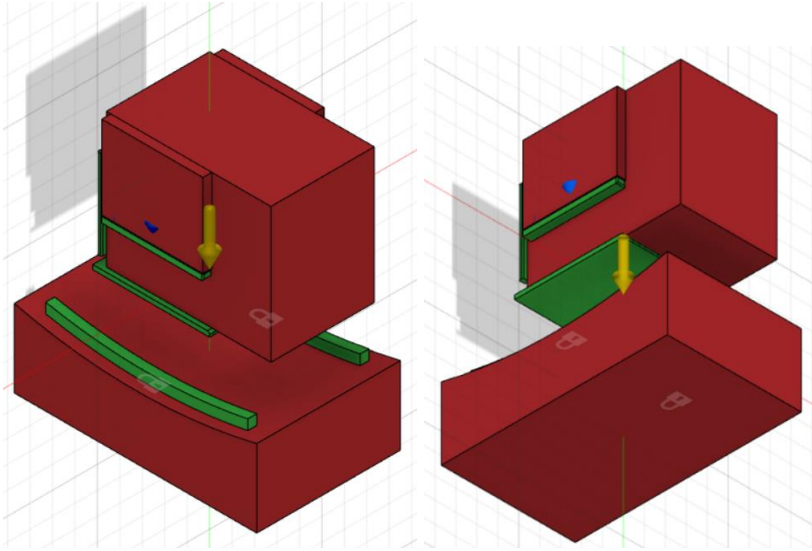

Figure 98. Dimensions of the Rocking Chair

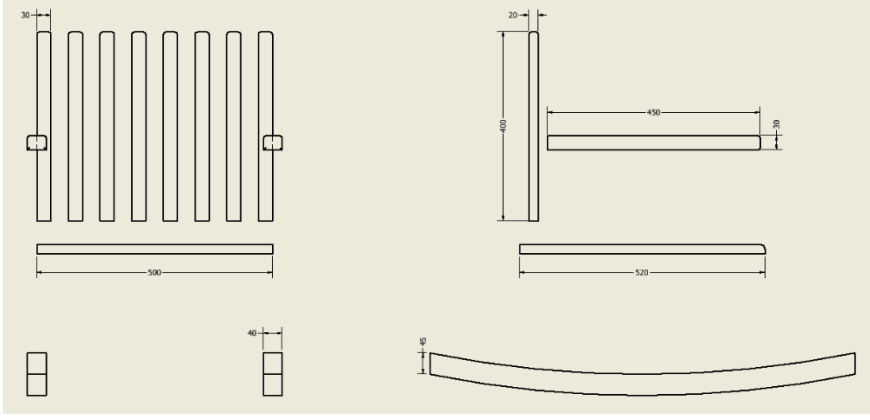

Figure 99. Rocking Chair Design, Unrestricted, -

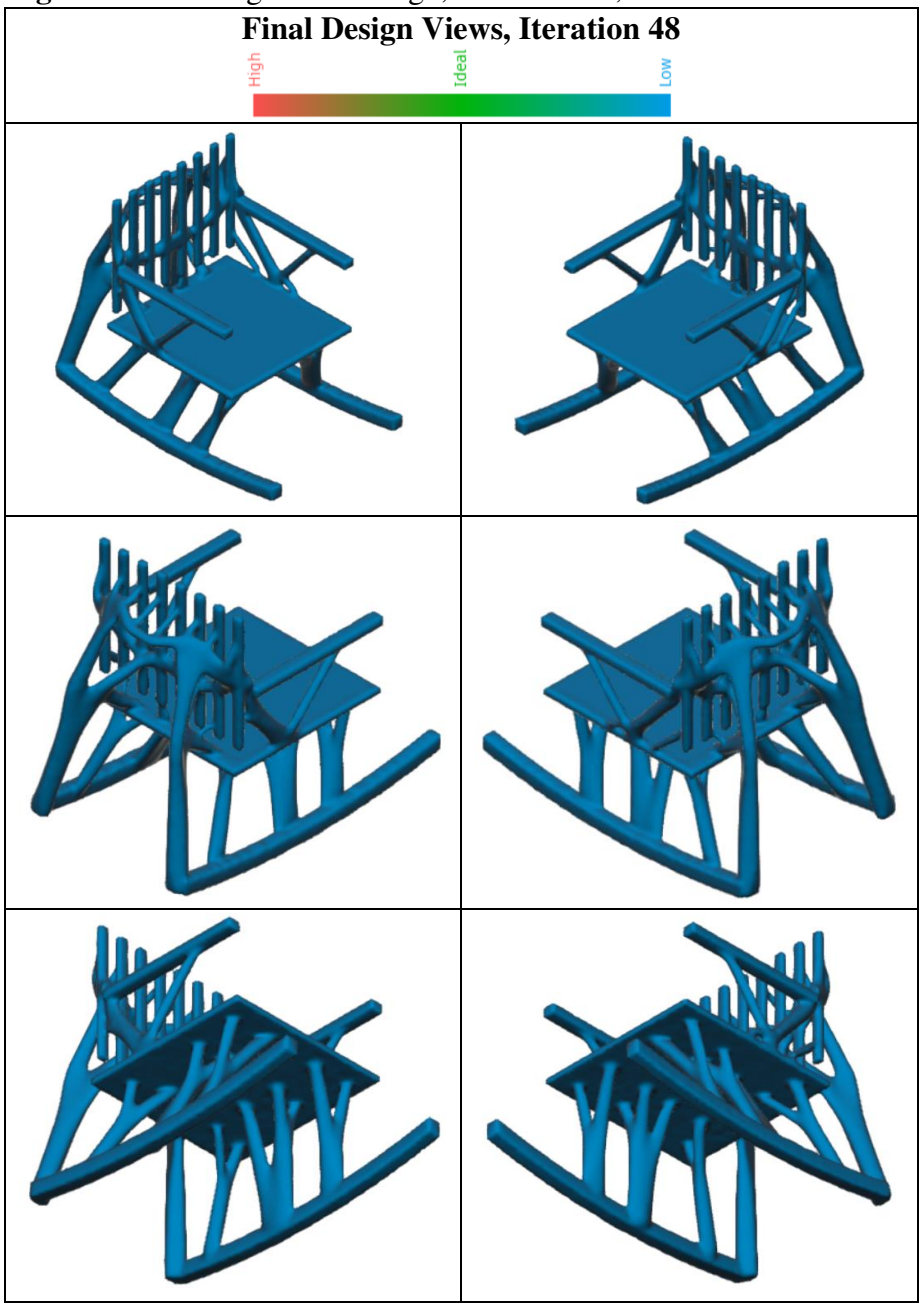

Figure 100. Rocking Chair Design, Additive, X+

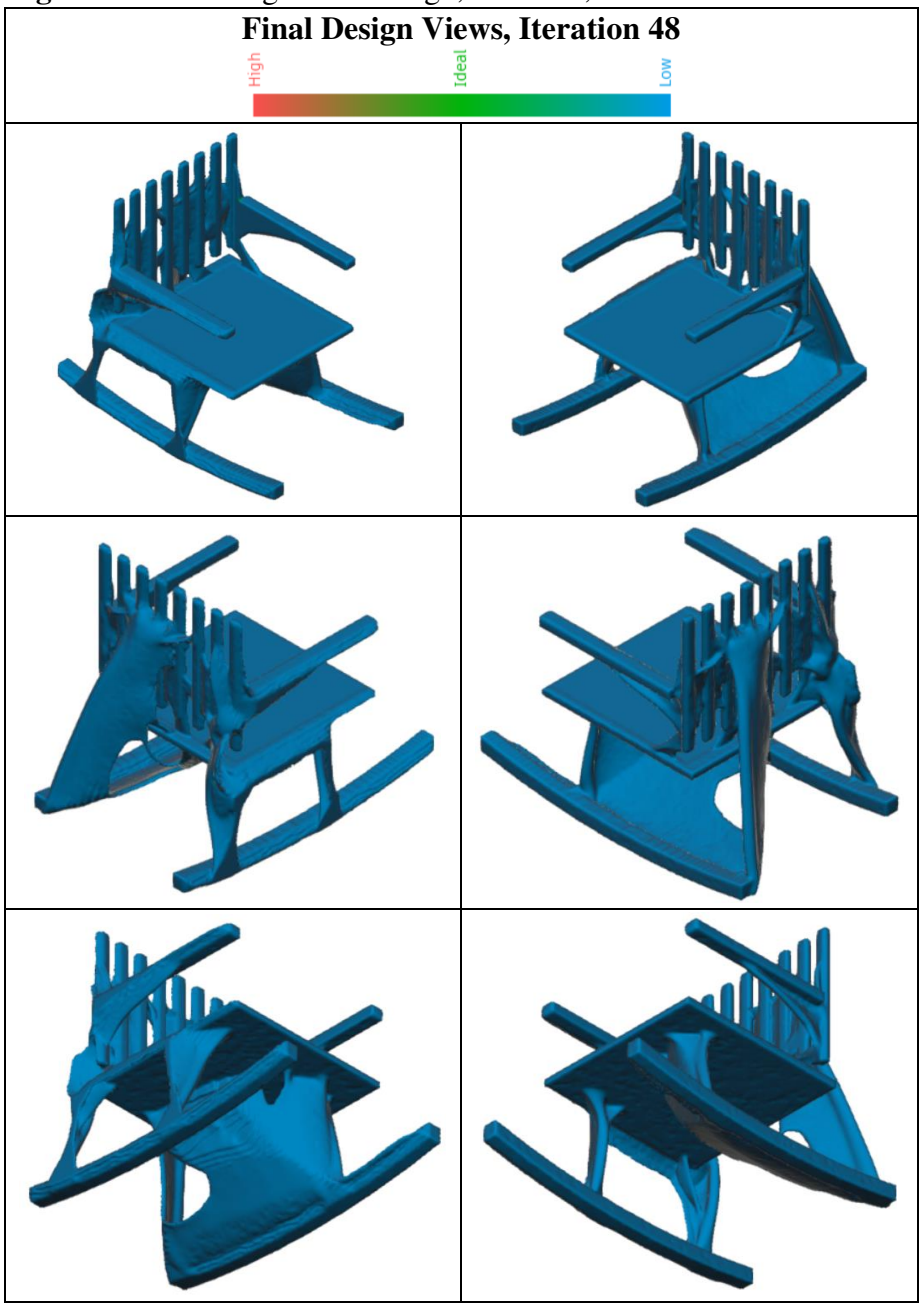

Figure 101. Rocking Chair Design, Additive, X-

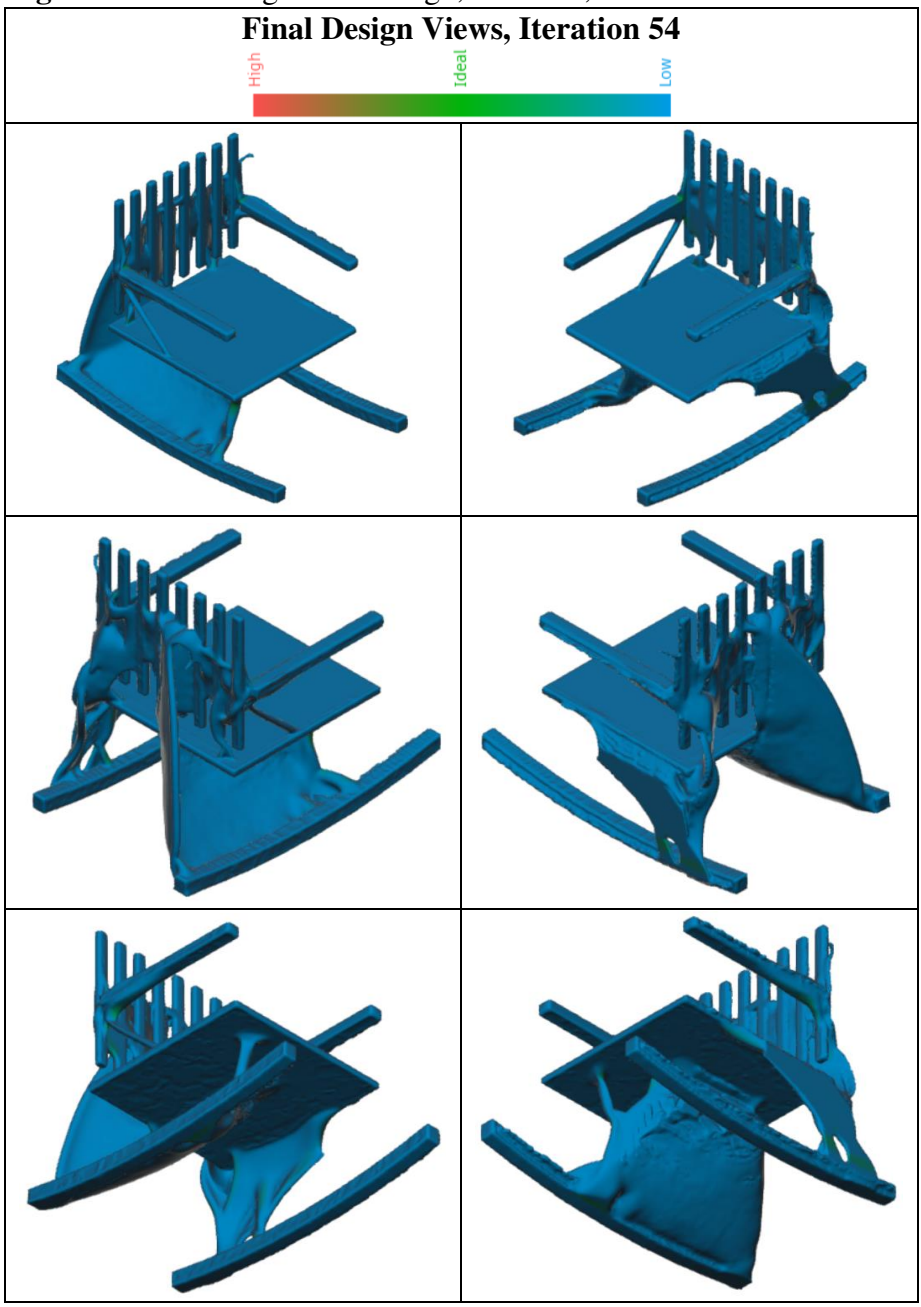

Figure 102. Rocking Chair Design, Additive, Y+

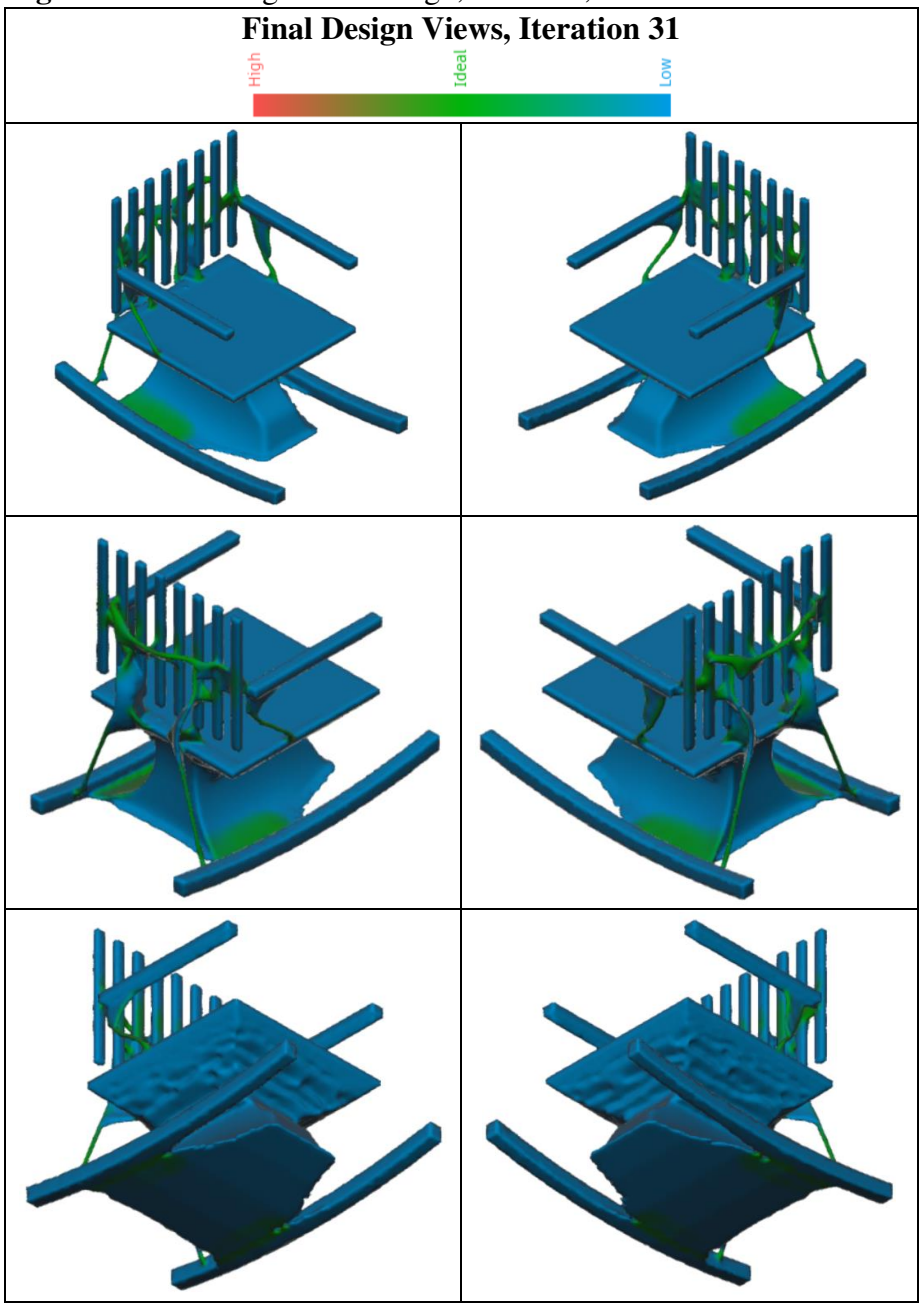

Figure 103. Rocking Chair Design, Additive, Y-

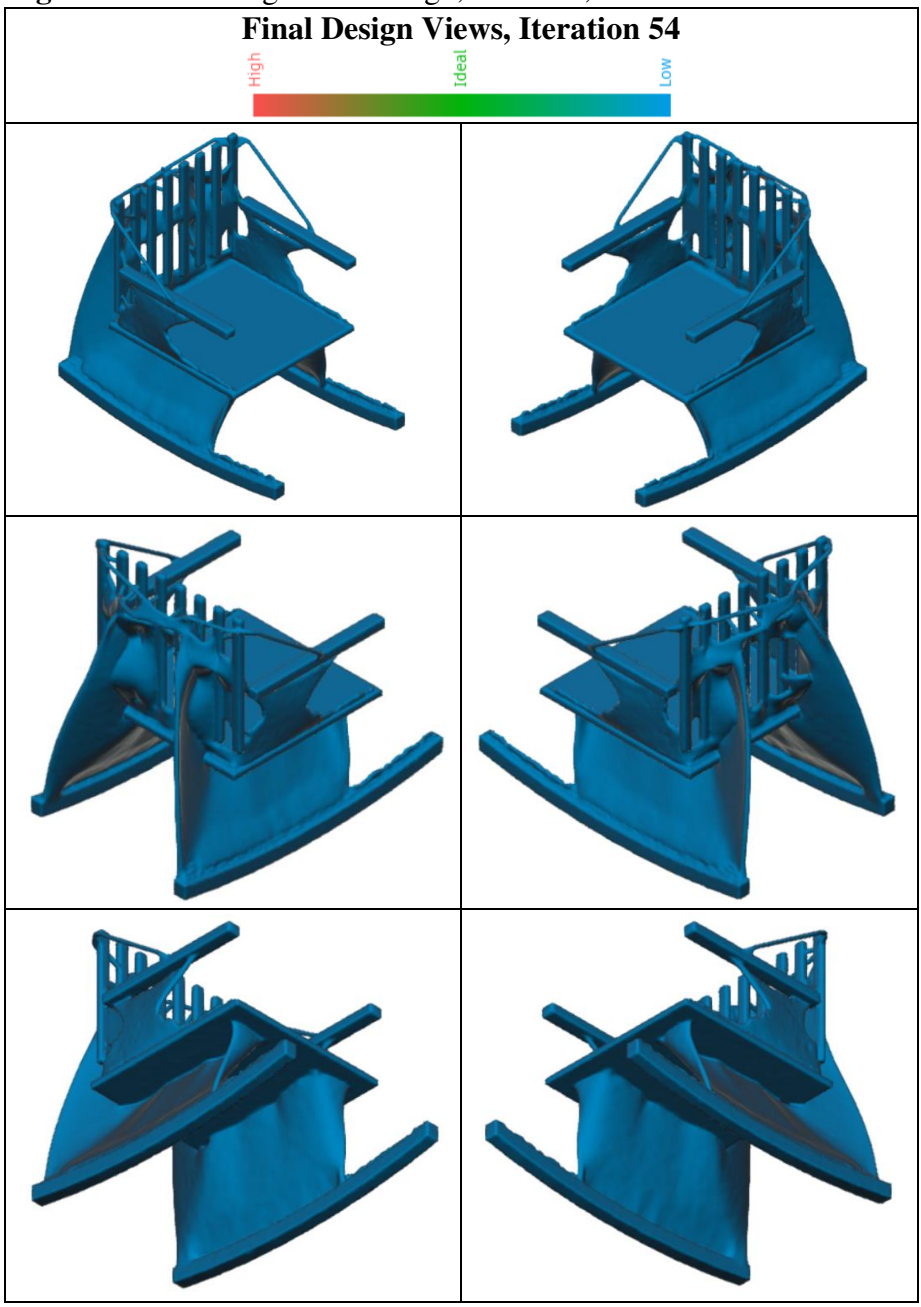

Figure 104. Rocking Chair Design, Additive, Z+

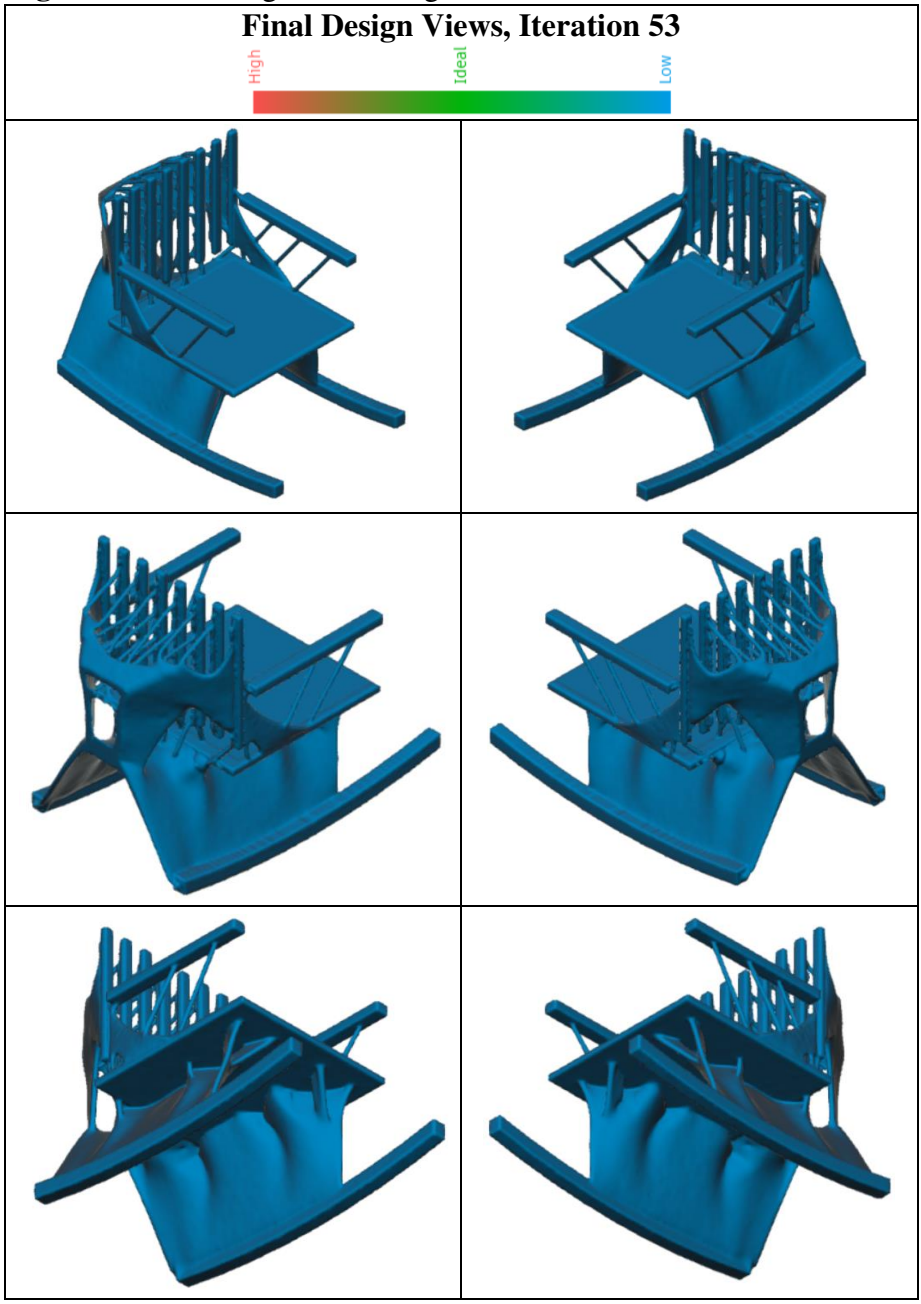

Figure 105. Rocking Chair Design, Additive, Z-

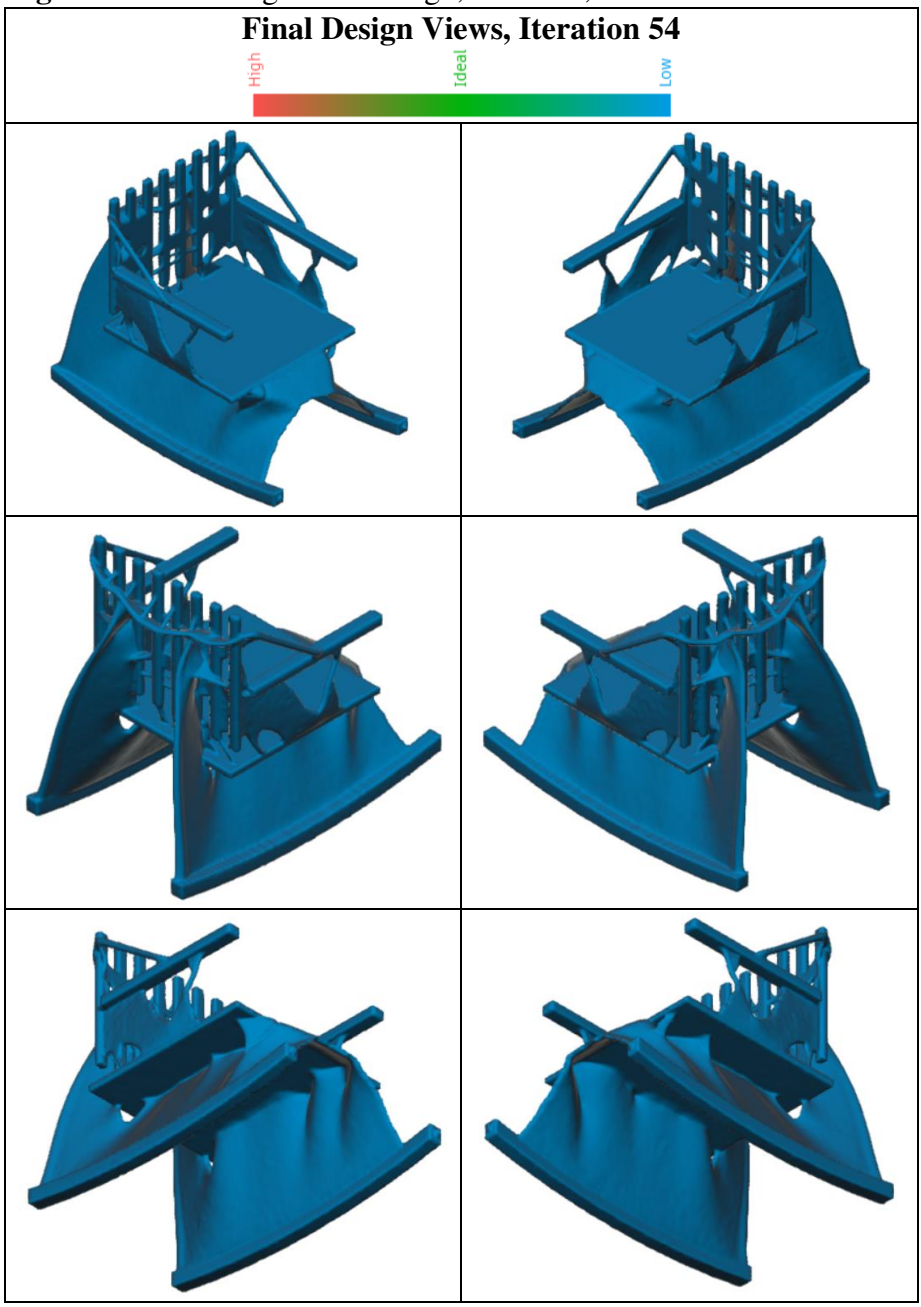

Figure 106. Rocking Chair Design, 3 Axis Milling, X+, Y+, X-, Y-

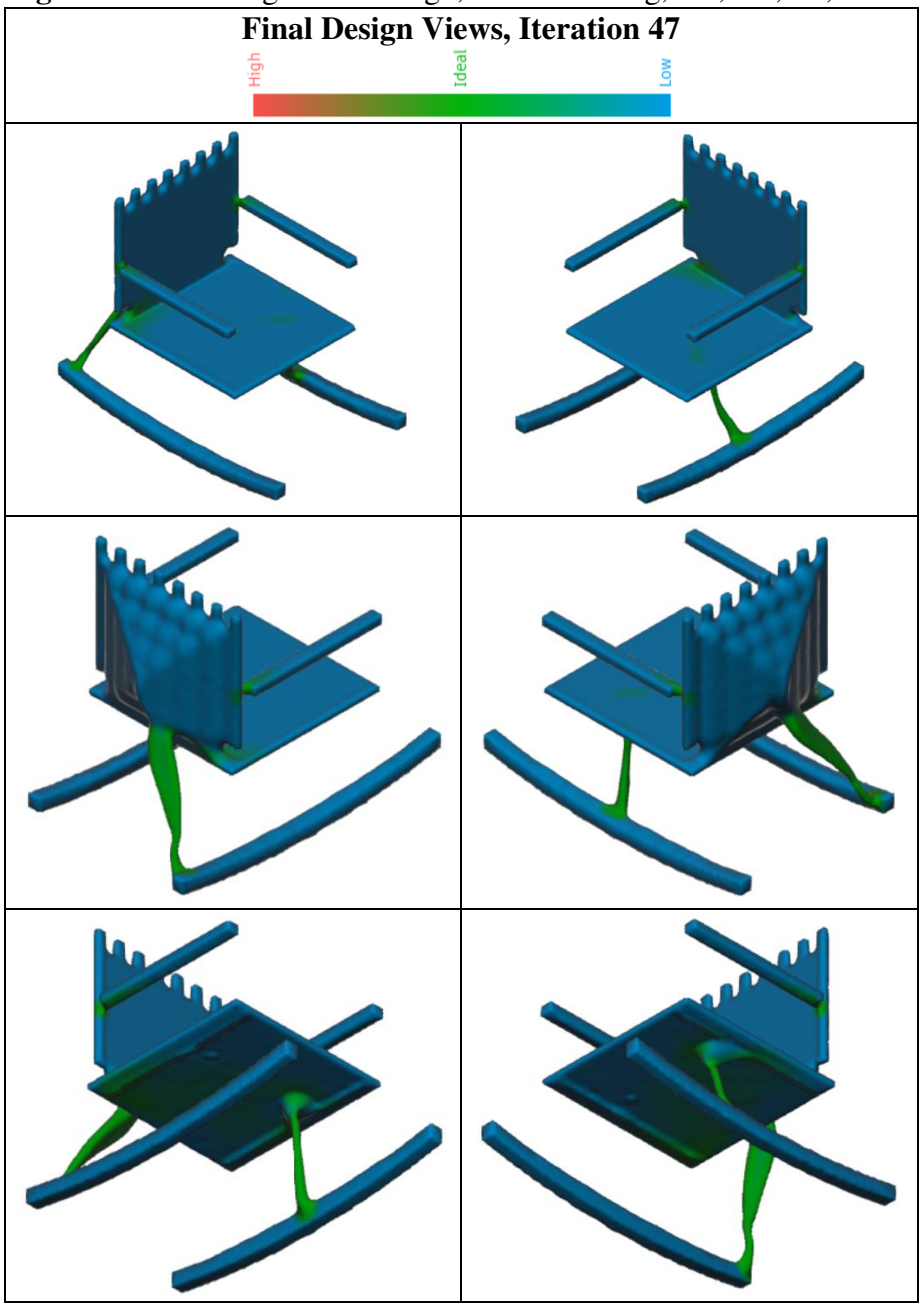

Figure 107. Rocking Chair Design, 3 Axis Milling, X+, Z+, X-, Z-

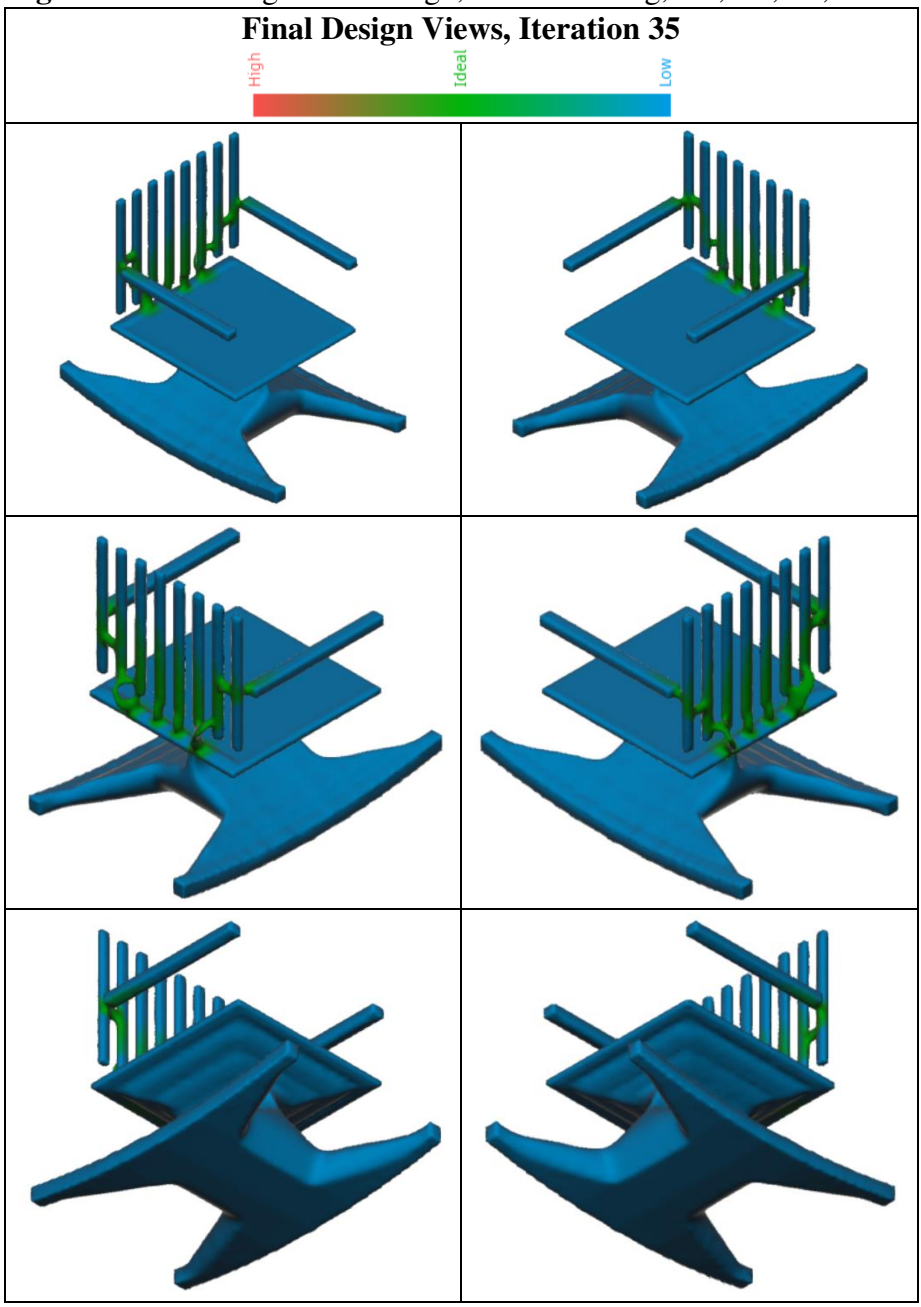

Figure 108. Rocking Chair Design, 3 Axis Milling, Y+, Z+, Y-, Z-

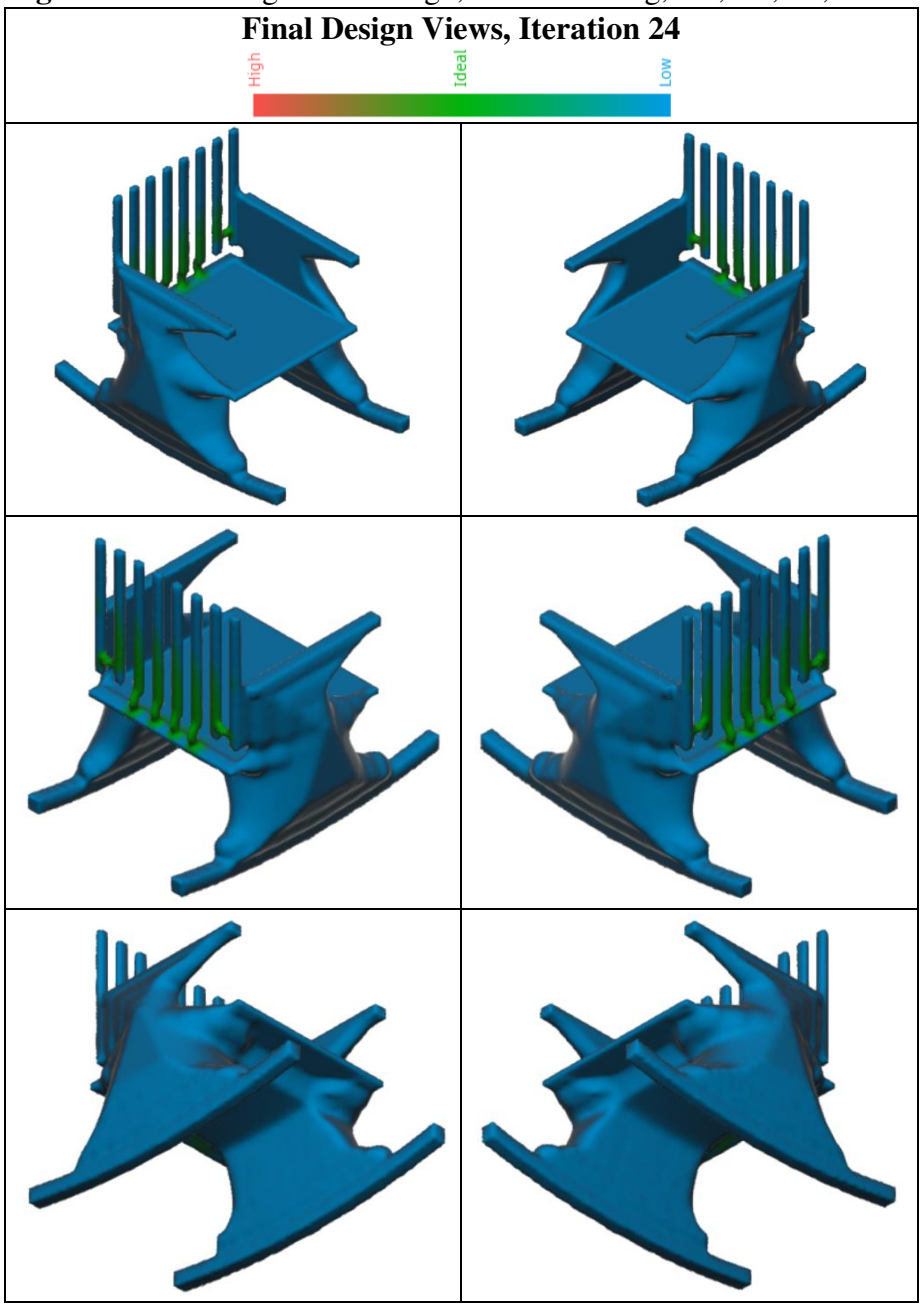

Figure 109. Rocking Chair Design, 3 Axis Milling, X+, Y+, Z+, X-, Y-, Z-

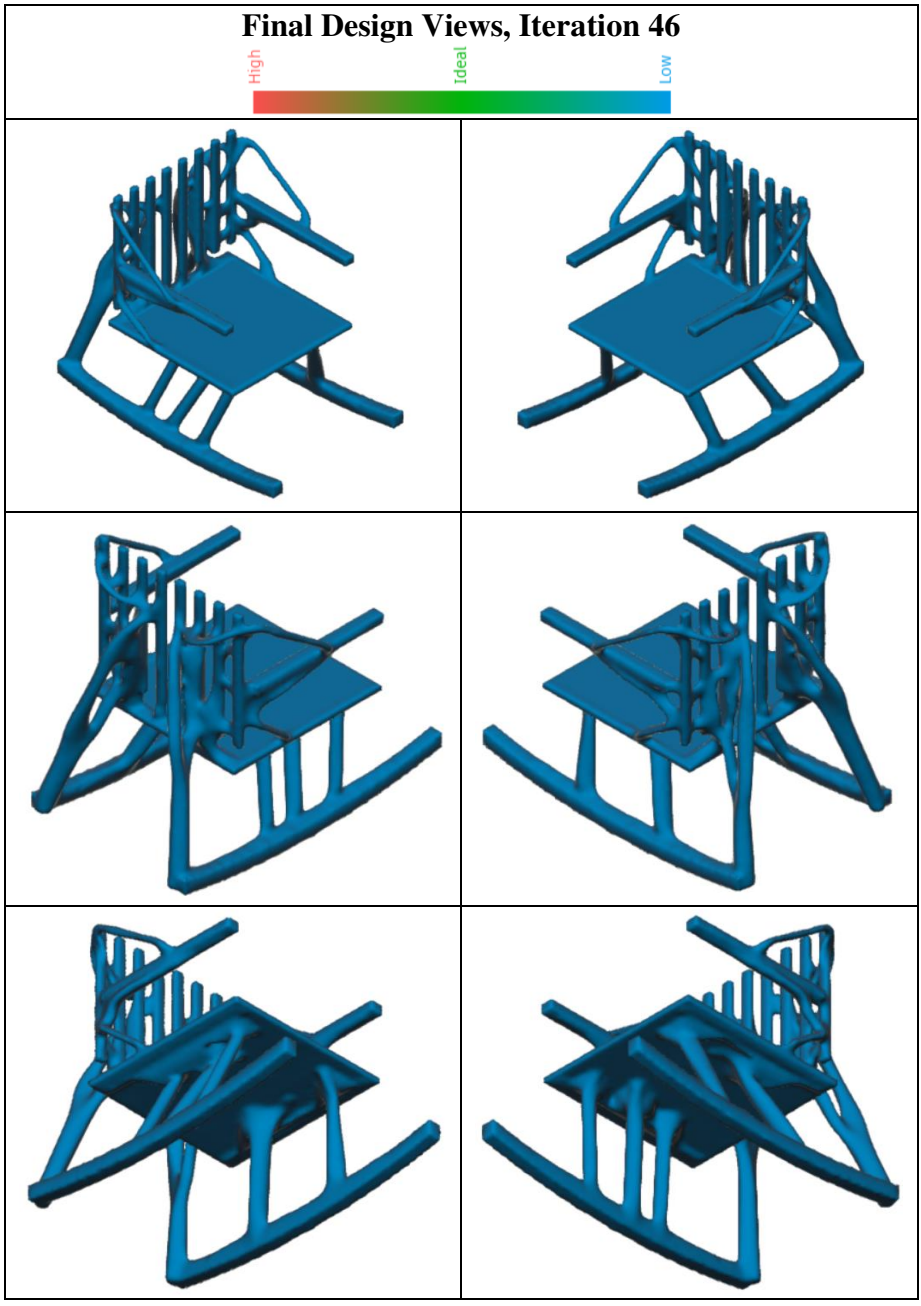

Figure 110. Rocking Chair Design, 5 Axis Milling, Unrestricted

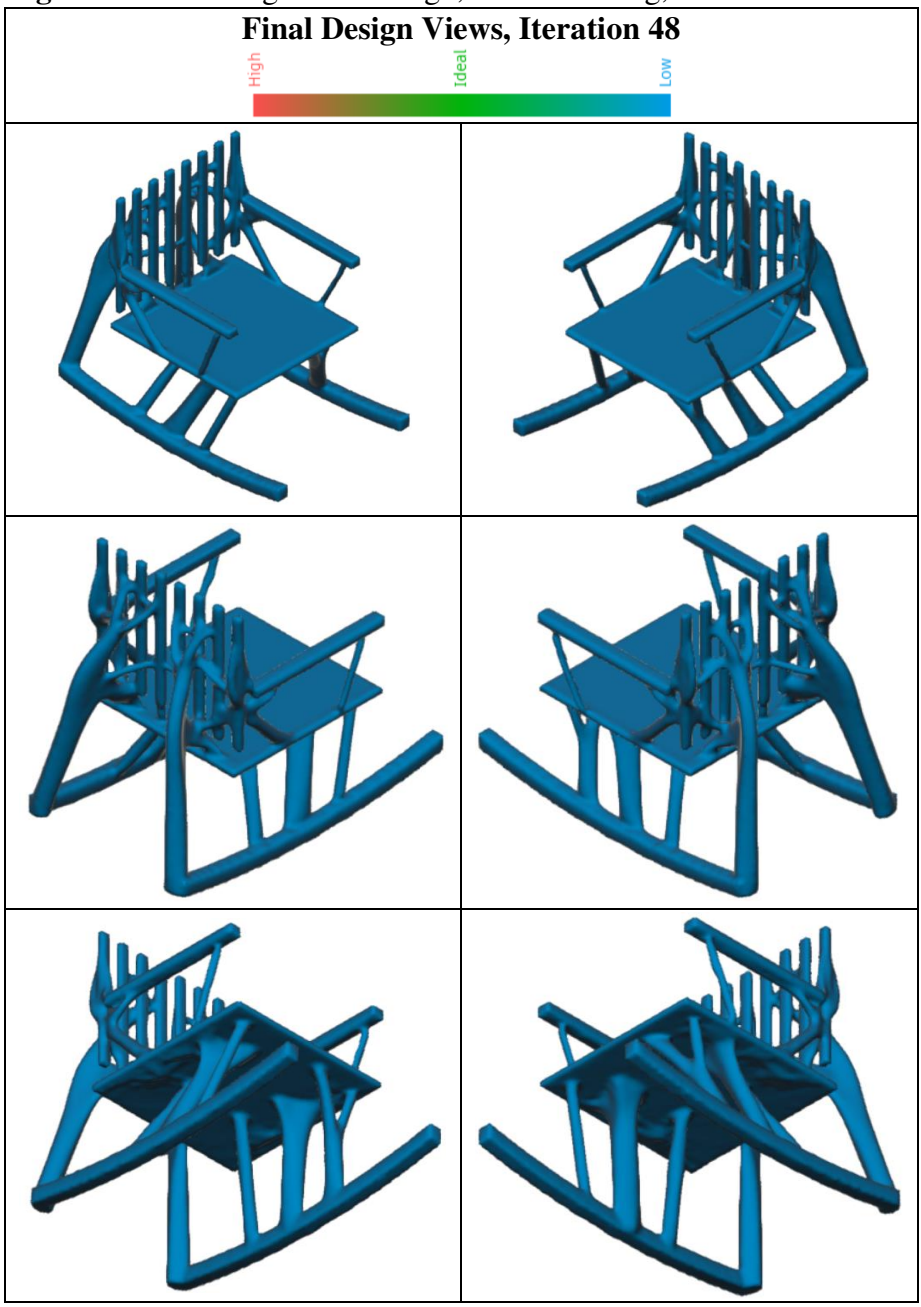

Figure 111. Rocking Chair Design, 2 Axis Cutting, Z

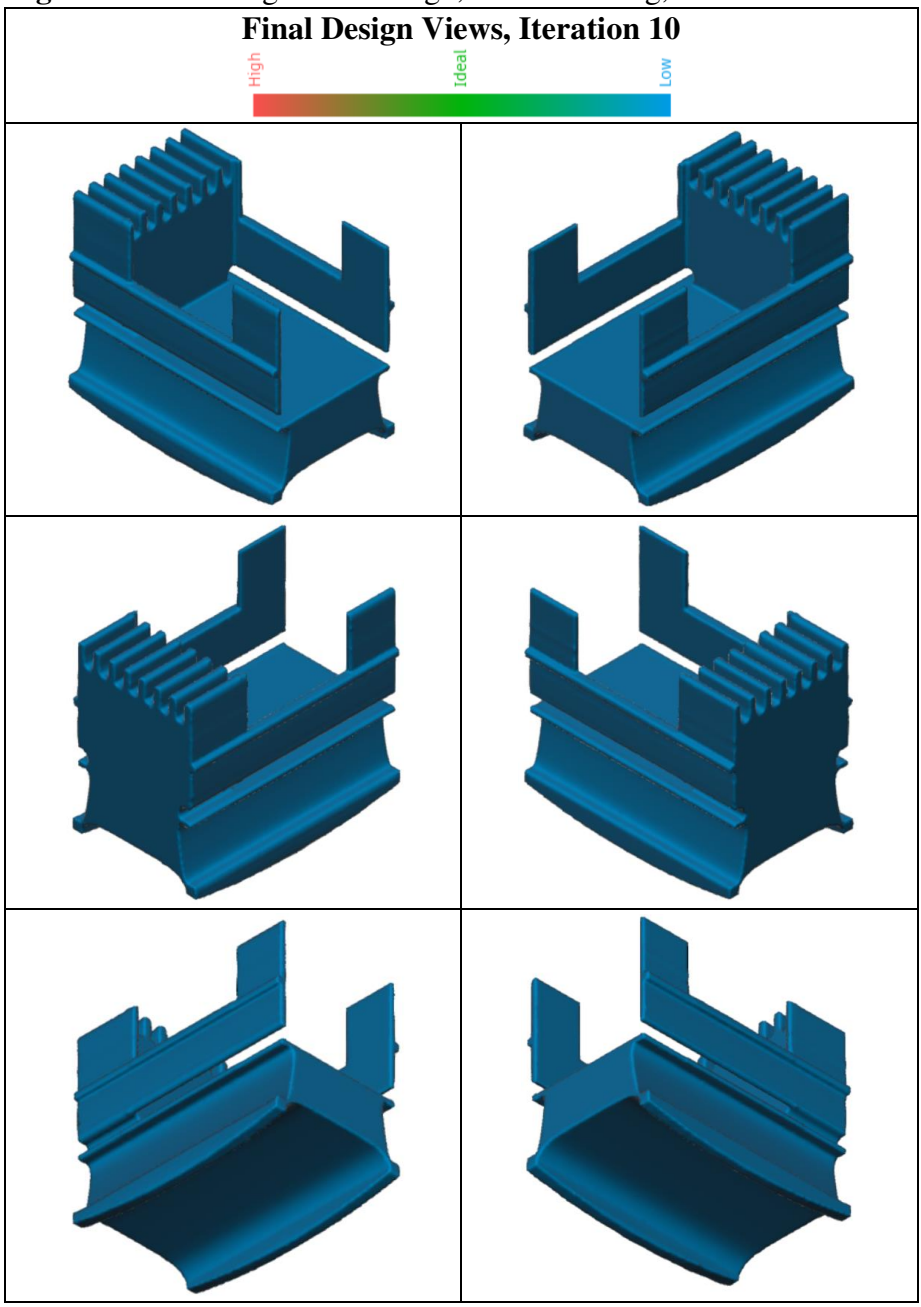

Figure 112. Rocking Chair Design, Die Casting, X+, X-

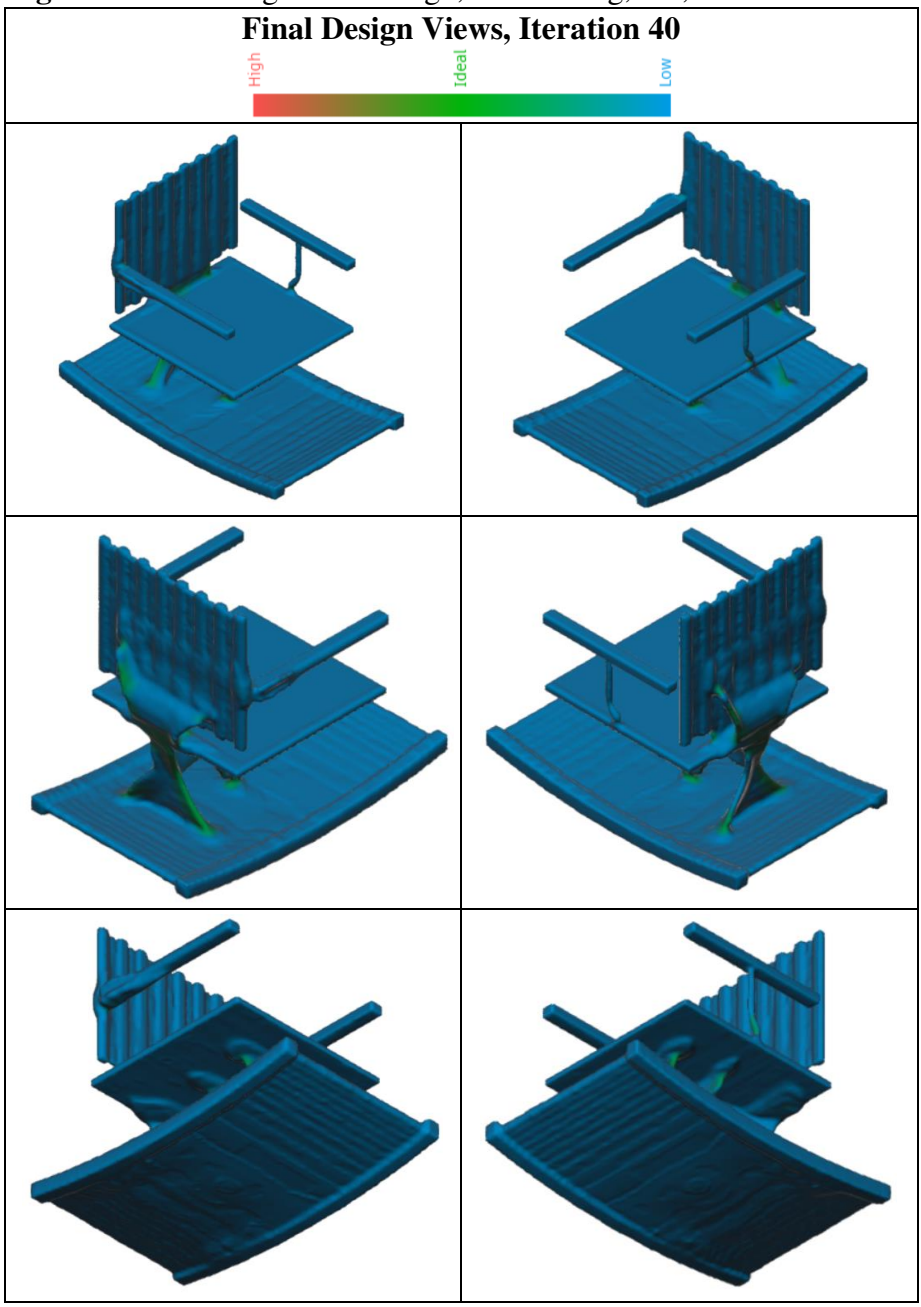

Figure 113. Rocking Chair Design, Die Casting, Y+, Y-

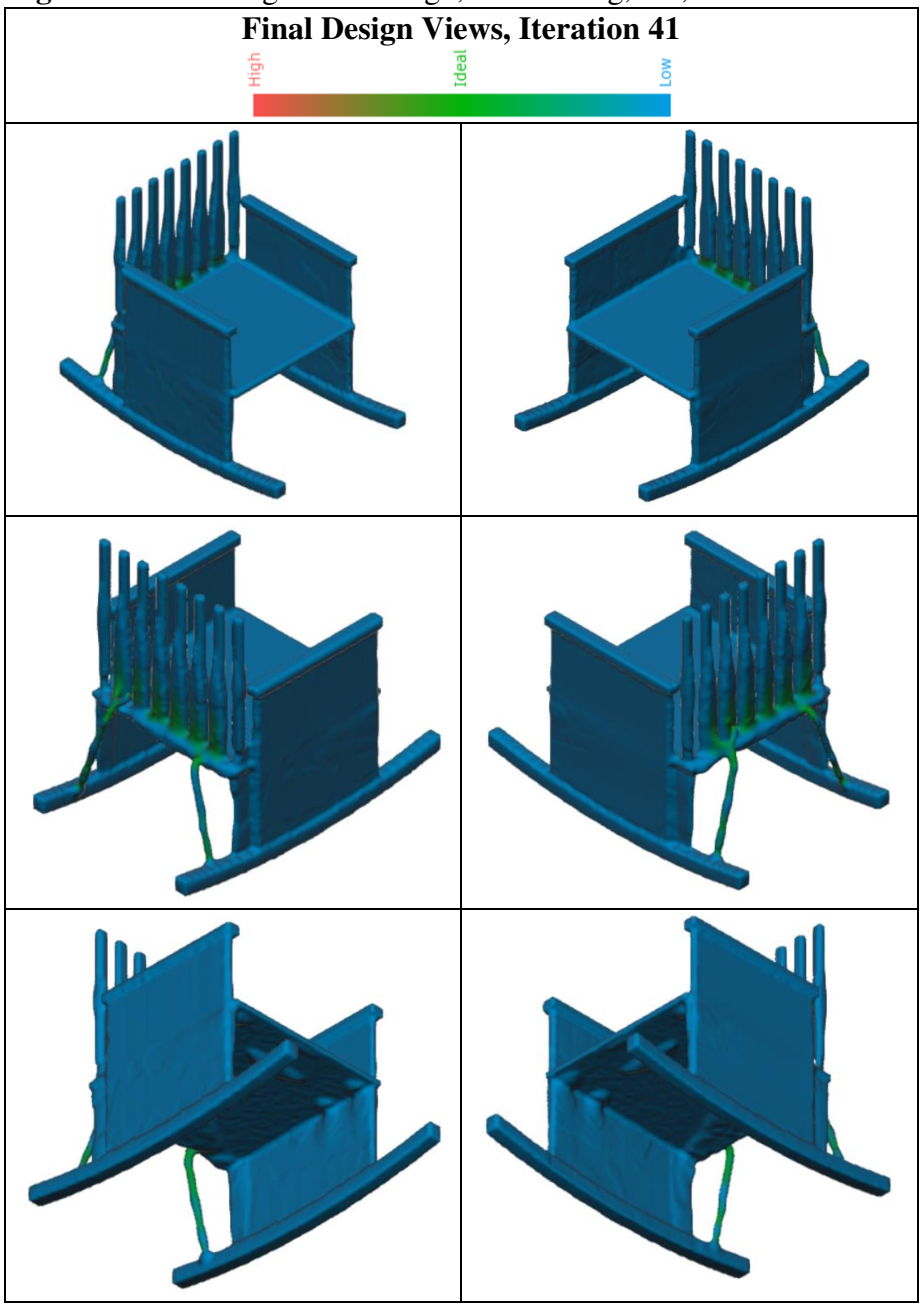

Figure 114. Rocking Chair Design, Die Casting, Z+, Z-

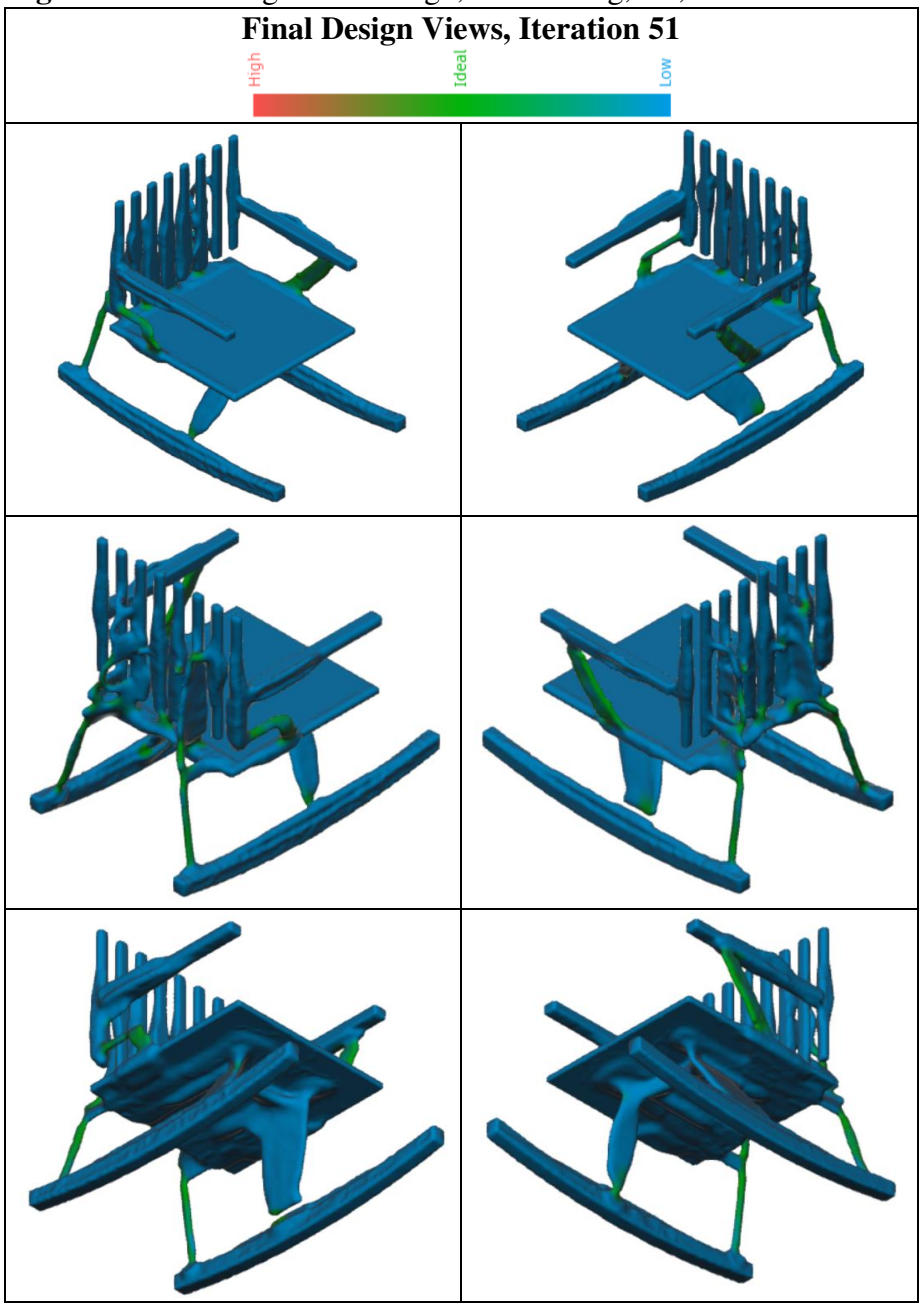

Table 6: The Values Calculated for The Rocking Chair Design

Manufacturing Method	Orientation	Volume (mm^3)	Mass (kg)	Max von Mises stress (MPa)	Max displacement global (mm)
Unrestricted	-	2.029e+7	16.234	0.3	0.1
Additive	X+	2.05e+7	16.401	1.3	0.6
	X-	2.101e+7	16.805	2	1.83
	Y+	4.537e+7	36.293	3.9	4.81
	Y-	2.088e+7	16.706	1.3	0.19
	Z+	2.146e+7	17.172	0.7	0.2
	Z-	2.172e+7	17.375	1	0.14
3 axis milling	X+, Y+, X-, Y-	2.305e+7	18.436	3.9	11.9
	X+, Z+, X-, Z-	3.961e+7	31.69	3.9	16.7
	Y+, Z+, Y-, Z-	5.462e+7	43.696	3.9	11.42
	X+, Y+, Z+, X-, Y-, Z-	2.051e+7	16.405	0.6	0.4
5 axis milling	Unrestricted	2.061e+7	16.489	0.3	0.15
2 axis cutting	Z	1.405e+8	112.372	0.4	0.27
Die casting	X+, X-	2.768e+7	22.147	1.8	2
	Y+, Y-	2.49e+7	19.923	3.8	2.6
	Z+, Z-	1.95e+7	15.598	3.6	5.73

4. RESULTS

"Generative design", which is a design process that simulates forms in nature; During the process, it can offer numerous design suggestions in line with the design goals determined by the designer. For this research, generative design software created many design outputs examples for 6 different products. While doing this, it has been observed that it provides partially successful solutions in minimizing the use of resources in the material and providing structural strength.

As in all areas of our daily life, the effects of artificial intelligence are increasing day by day in the field of design. Nowadays, the role of the designer; can be redefined as the authority that determines goals, parameters and constraints and reviews and approves designs created by artificial intelligence. Learning the programming language, the designer is one step ahead in his familiarity with computers and therefore computational logic. This step allows the designer to make comparisons, inspired by methods and processes in different fields; It fosters creativity by establishing connections between areas that seem unrelated and enables it to develop innovative strategies.

Some advantages of artificial intelligence-aided design methods are (1);

- The biggest advantage of artificial intelligence for designers; It is the removal of repetitive, time-consuming and challenging tasks in creative processes from the designer's work flow, and by automating some of these processes, designers gain significant time. In the design process that starts with the determination of the needs and objectives of the product; In some stages, it is predicted that artificial intelligence-aided software will provide advantages: processes such as meeting functionality and ergonomics criteria, suitability for production, meeting the cost target of the project, prototyping.

- With the data obtained from the findings, it can be said that generative design tools will provide support in the production

of design alternatives that provide cost and manufacturability parameters together; It will also reduce the number of prototypes and create a time advantage in the prototyping process, as it provides visual representations of design alternatives through an interface.

- Another advantage of AI-aided design tool is to increase the creativity capacity of human intelligence. Generative design tools can support design processes that belong to human with their capacity to offer solutions in areas that people cannot imagine. It is predicted that these processes, whose rules are determined with algorithms, can support human designers in developing new forms and solutions by coincidental coalescence.

Today; Artificial intelligence, which began to be used as a new production technology in the design process, may become a design reality in the following years, and it is likely to bring a new design-production revolution that will be effective worldwide.

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