

# Children's Bent Wooden Chair Design Using High Frequency Heat Molding Technique

- Focused on Change of Kindergarten Environment -

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**Abstract:** Consumers' expenditure is getting larger on children due to their parents' compensation for increase of double-income family life and decrease of birth rate caused by high economic growth. Increase of demand on children items in the market leads the necessity of development of furniture for children. This study is aimed to design children chairs that meet the environment for children. In this study, the age of children is defined to be 5~7 years old. In order to investigate what causes environment change, this study covers roughly change of environment, change of learning program and use of environment-friendly material. In such scope, we drew out the factors that the chairs for children shall be equipped with. Case studies were done through such drawn factors. The scope of the furniture for children is limited to the chairs for children among the ones made in either Korea or overseas. As a result, we could draw out such keyword of the furniture as storage, mobility, environment-friendly, object style image, preferred color, functionality and safety, based on which we could plan the design and make the final result through high frequency round molding manufacturing process.

**Keywords:** bent wood, children chair, high frequency molding heating techniques, change of kindergarten environment

## 1. Introduction

### 1.1. Background and Objective

Consumers' expenditure is getting larger on children due to their parents' compensation for increase of double-income family life and decrease of birth rate caused by high economic growth. Increase of demand on children items in the market leads the necessity of development of furniture for children. This study is a children chair design that meet the environment for

children.

This study is aimed to design children's wooden chair using high frequency molding techniques. This Chair is designed according to the needs those are change of space, change of educational programs, needing to use environmental friendly materials. Children's Chair should be a mobility, storage, functionality and safety. Therefore, This chair has the advantages as follows:

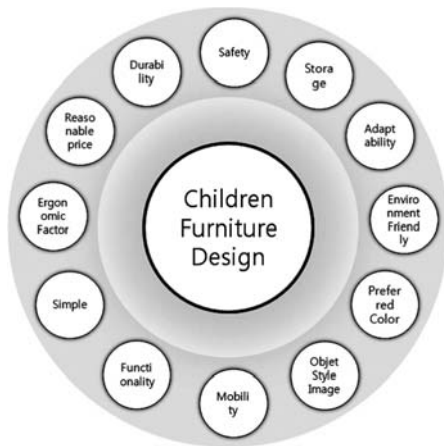
First, This is a stacking chair that can save space in the narrow education facilities is.

Second, high frequency heating system chair is useful to lighten weight of chair according to increase punching number.

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**Table 1.** Condition Factors for children furniture

Third, high frequency heating technique chair is reasonable to the children behaviors. Those are strong to contamination no joint and sanitary, Resistant to be heat and to be cold is excellent. Furniture is based on environment-friendly material high frequency heating system (Formaldehyde emissions less than 0.02).

### 1.2. Scope and Method

In this study, the age of children is defined to be 5~7 years old. In order to investigate what causes environment to change, this study covers roughly change of environment, change of learning program and use of environment-friendly material. In such scope, we drew out the factors that the children chairs shall be equipped with. Case studies were done through such drawn factors. The scope of the furniture for children is limited to the children chairs among the ones made in either Korea or overseas. In terms of the material, this study defines that the material used for children items shall be environment-friendly and warm-looking wood. In terms of wood process techniques, the products here in this study are manufactured focusing on bent-wood technique that shows good productivity and process efficiency.

## 2. Keyword for Children Chair Design

### 2.1. Children Chair Design Condition Factors

Our study is based investigation indicates that the conditional factors of children chair design are as follows:

1) Safety: It shall not be risky when children use it. For example, toxic paint, sharp edges or corners injury or thorn trees on the surface of things, what happens is static electricity, etc. those are not a poor factor for safety.

2) Durability: It shall be durable because children tend to use learning materials toughly.

3) Reasonable Price: It shall be good in structure and quality with reasonable price.

4) Ergonomic Factor: It shall consider children's body characters well.

5) Simple: Detailed depiction of things shall be avoided so that can express their imagination naturally when playing

6) Functionality: It should have a variety of functions since children's daily life as users are not clearly sorted into playing, learning and rest.

7) Mobility: It shall be small and light so that it can be carried by children.

8) Object Style Image: It shall be shaped to be friendly to children. It shall use natural things' images and soft curves.

9) Preferred Color: Children prefer warm colors, neutral colors and high chroma pure colors.

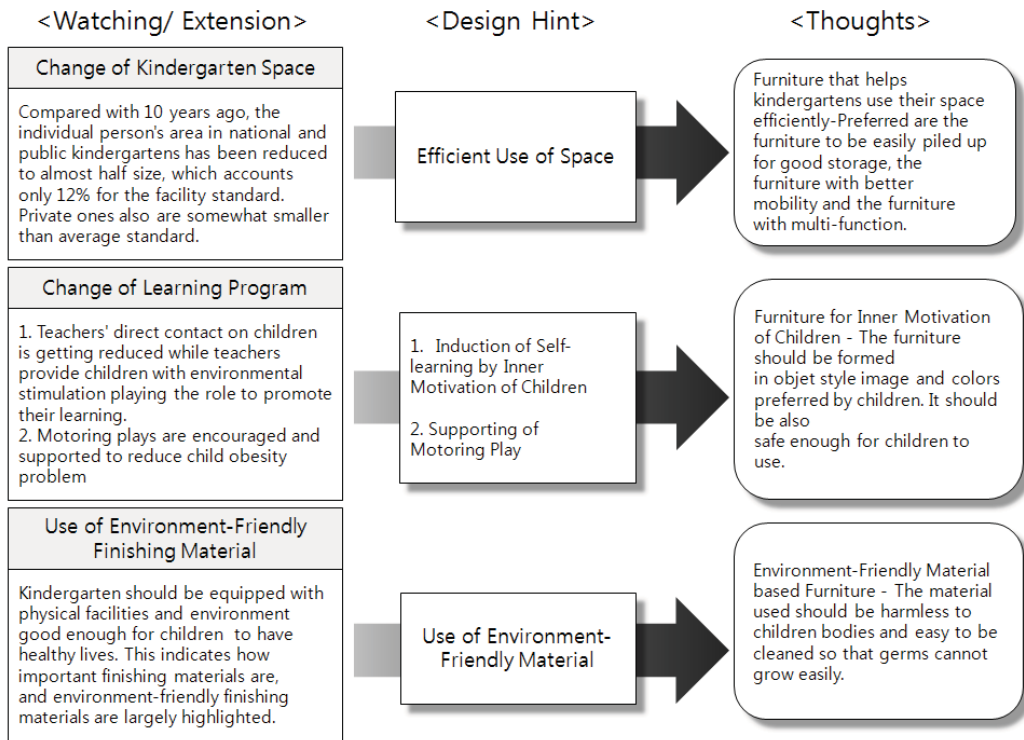
They prefer especially such colors as yellow, orange, pink, red, etc while disliking such dark and thick colors as black, gray, royal blue, brown, khaki, etc. (Lee 1985)

10) Environment-Friendly: It shall be made of and finished by the materials that are chemically stable enough not to affect human body.

11) Adaptability: It shall be adaptable with diversity for children's growth.

12) Storage: Its structure shall be good enough

**Table 2.** Environment Change Factors of Kindergarten



to be stored since children are interested in things only for short term and their preference easily changes.

2.2. Design Factors for Change of Children Environment

2.2.1. Change of Kindergarten Space

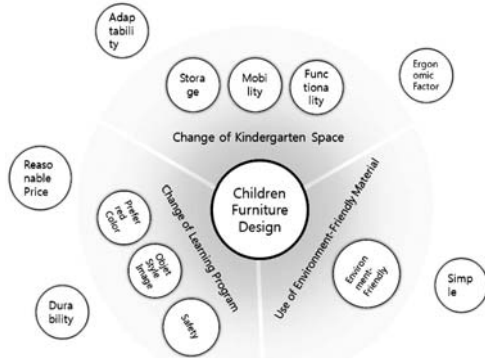
Compared with 10 years ago, the individual person's area in national and public kindergartens has been reduced to almost half size, which accounts only 12% for the facility standard. Private ones also are somewhat smaller than average standard. Furniture that helps kindergartens use their space efficiently - Preferred are the furniture to be easily piled up for good storage, the furniture with better mobility and the furniture with multi-function. The motor space of

public kindergartens, which is the area including indoor gym, assembly space and outdoor athletic ground, has finally decreased to 0.69 m<sup>2</sup>/person, which is 0.6 times, almost half of, that of the 10 years ago time. It accounts only 12% for the motor space standard for the kindergartens of 40 children or less, which is 5.65 m<sup>2</sup>/person. It accounts about 15% for the average of that of private kindergartens, which is 4.5 m<sup>2</sup>/person. This shows how small it is. We have gotten the result that even private kindergartens give only 3.62 m<sup>2</sup> per person for athletic activity that is also somewhat smaller than the standards if calculated only with pure outdoor athletic ground area excluding their indoor motor space (Kang 2010).

2.2.2. Change of Learning Program

Modern children educational programs are dif-

**Table 3.** Condition Factors of children chair suitable for Environmental change of kindergarten



ferent from conventional ones because they appreciate children's independency. Children are learning and growing by themselves making experiences through the plays they do themselves under given environment. Therefore, the teachers' direct contact on children is getting reduced while teachers provide children with environmental stimulation playing the role to promote their leaning.

### 2.2.3. Use of Environment-Friendly Material

In the modern society, rapid growth of industry is followed by intensive urban population and buildings that neglect natural environment factors. In terms of the finishing materials, such buildings are constructed of low priced finishing materials harmful to human for cost reduction, resulting in sick building syndrome and sick house syndrome. The indoor spaces of kindergartens should be equipped with environment-friendly facilities for infants to have healthy lives because such spaces are the field of learning where children are working toward their physical, emotional and social progress. The environment change factors are as follows;

The condition factors of children chair are storage, mobility and functionality in terms of the factor to meet the change of children environ-

ment and efficient use of space; preferred colors, object image and safety in terms of the role of promoting inner motivation; and environment-friendly factor in terms of use of environment-friendly material.

This chair design is appropriate to variability of space for play and education time because a caring for children is changing to education in kindergarten environment.

Following elements are required in terms of three kinds of chair design elements.

First, it needs the factor of efficient use of space in change of kindergarten space. Second, it needs the factor of motivation of autonomous learning for inner motivation of children in change of learning program. Third, it needs eco-friendly finishing materials good enough for children to have healthy lives.

For these factors, this chair design are required the following conditions.

First, Furniture that helps kindergartens use their space efficiently - Preferred are the furniture to be easily piled up for good storage, the furniture with better mobility and the furniture with multi-function. High frequency heating system is useful to lighten weight of chair increasing punching number and multi-function can increase the usefulness of the space.

Second, Furniture for Inner Motivation of Children - The furniture should be formed in object style image and colors preferred by children. It should be also safe enough for children to use.

Third, Furniture is based on environment-friendly material high frequency heating system (Korea Conformity Laboratories test).

### 2.3. Keyword based Case Studies

Followings are the application scope of domestic and overseas children chairs focusing on the storage, functionality, mobility, safety, preferred

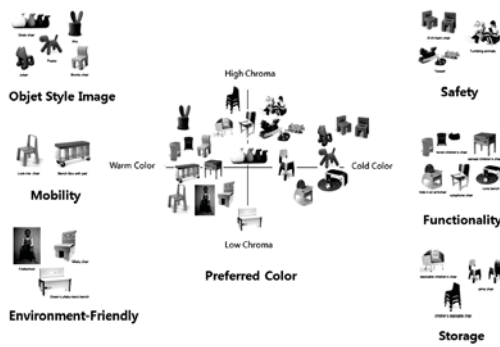


Fig. 1.2. Keyword based Case Studies.

Table 4. Design Concept

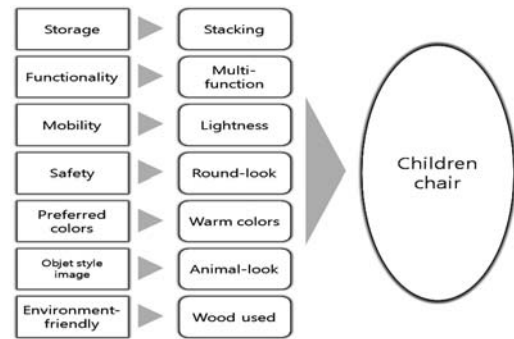


Table 5. Average body size of Korean Children for 5~7 years Years Old (<http://sizekorea.kats.go.kr>)

	Height	Sitting Height	Sitting Popliteal height	Sitting knee height	Sitting hip width	Sitting hip horizontal length of Popliteal	Sitting hip horizontal length of the knee
Man	1183.22	654.84	290.95	351.37	228.94	326.73	380.68
Woman	1170.13	646.8	293.15	352.81	227.95	331.28	382.47
Average	1176.66	650.81	292.06	352.09	228.45	329.03	381.58

Table 6. Details should be considered when designing the children chair

The basic dimensions planning	Note to plan
Chair height	Floor beneath the femoral - 1 cm
Chair width	Minimum (Sitting hip width + 5 cm)
Chair depth	(Hip-Popliteal height) × 0.85
Back height	(Sitting height) × 1/3
Back oblique line	90° suitable

color, objet style image and environment-friendly factors among the factors for children chair induced above.

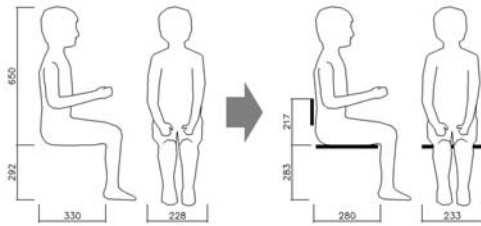
Based on the case study results, we have selected the stacking structure for higher efficiency of storage; added the function of closet, musical instrument and motoring as well as the function of rocking chair for functionality; made it lighter and attached wheels to it to be easily carried for mobility; used shock-absorption material for safety; added the animal image preferred by children for objet style image; and used the materials that are harmless to human body and can be recycled for environment-friendly characteristics.

For the preferred colors, we have used various colors not limited only to warm colors.

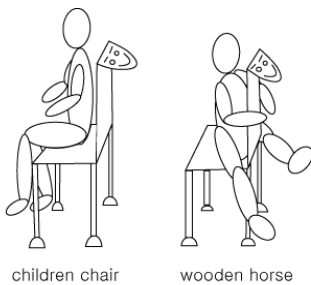
### 3. Suggestion on Children Chair Design using High Frequency Bent-Wood Molding Technique

#### 3.1. Design Concept

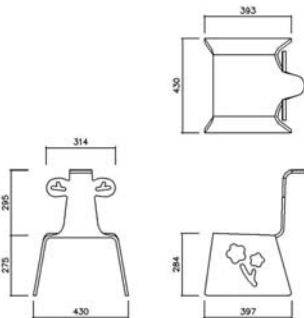
The factors drawn out for the change of children environment are storage, mobility, functionality, safety, preferred color, objet style image and environment-friendly factor. For better mobility, it should be lighter. For safety, it should be rounded on edges without risky factors. For pre-



**Fig. 4.** Dimensions Designed for Children Chair: Average Body Size of Korean Children of 5~7 Years Old.



**Fig. 5-1.** Idea sketch.

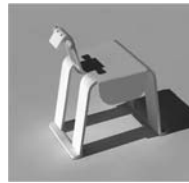


**Fig. 5.2.** Dimension Plan.

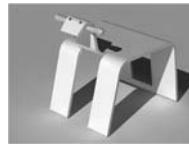
ferred color, it should be made in warm colors preferred by children. For objet style image, it should be formed in animal look. To be environment-friendly, it should be made of environment-friendly materials harmless to children's bodies.

### 3.2. Dimension Planning

The following dimensions have been gained from the factors that must be considered in de-



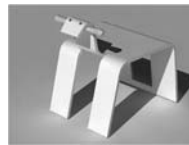
First. The first rendering was planned to have curve face look bending one-side to use plywood efficiently. The handle was made of different material for diversity of material.



Second. For the next rendering plan, we considered of how to minimize the curve face part. For this, we removed the bending part around legs and sides of seat. This made the front legs' supporting part detached, resulting in being weakened and shaken.



This was planned to enhance the supporting power of the legs and for infant to move her/his legs freely while sitting on.



Third. To enhance productivity, we planned also about how to process the handle at once.



Fourth. We planned again the handle on the back support in a simple look to express ears and horn.



Last. For stability, we made the contacting face of the back support a little bit wider. Also to enhance productive efficiency in NC processing of side punched-holes, we finally planned more simplified punched-hole look.

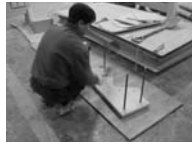
**Fig. 5.3.** 3D Rendering Process.

signing children chair that meets average body size of Korean Children (Park 1987).

Ideas sketching is processed focused on the design concept as mentioned the previous study. In addition, we drew out the multi- functions for the functional purposes and they were planned to support children's physical play for the children (Fig. 5.1). idea sketch. We drew out a final design as shown in the figure above and it is based on



1. NC Cutting: Cut the plywood for dimension by NC device.



2. Wood Shaping Assembled: Assemble the cut plywoods by joint metal.



3. Wood Shaping Ground: Grind the assembled wood shaping sections to be even on surface.



4. Wood Shaping Putty Work: Put putty on the ground sections.



5. Joint Wood Installed for Wood Shaping: Install joint wood to fix the wood shaping to the high frequency press.



6. Metal Sheet Installed: Fix the wood shaping to the high frequency press and then finish its edges.



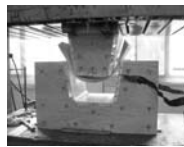
7. High Frequency Line Connected: Connect the positive and negative lines to the wood shaping metal sheet.



8. Laminating Materials Prepared for Molding: Put adhesive to veneer and compile in grid look.



9. Material for Molding on Press: Put the veneer sheet on high frequency press.



10. Compressed by Press: Compress the veneer by high frequency press.

Fig. 5.4.1. Manufacturing Process: Wood Shaping.

the projected dimensions (Fig. 5.2).

### 3.3. 3D Rendering Process

Followings are the developing process of rendering for the final design.

Through the rendering, mock-up and dimension planning set forth above, we determined the following forms and dimensions. The following forms were planned to enhance the productive efficiency during bent-wood molding. In addition, we considered the human body size that most met children while sitting on and planned also animal-look streamline form.

## 4. Manufacturing Process and Application Cases

### 4.1. Manufacturing Process (Fig. 5.4.1)

### 4.2. Photos of Manufacturing and Application

Fig. 5.4.2. Manufacturing Process: Compress and molding.

### Cases

After processed, it has been completed with coating as follows; Fig. 6.1.1 is the final outcome of the children chair. It is a warm color product as discussed in the previous study. Fig. 6.2 shows that the child is reading a book sitting on the chair. Fig. 6.3 shows the child sitting behind the chair, and it supports the child's physical play. Fig. 6.4 shows a chair and sat in the front and back. Fig. 6.5. shows how the final outcome of



11. Processing: 3D NC processing and band-saw-in process can be used considering work efficiency and the optimized processing point of 3D NC.



12. Processed Product: Processed White Bone Product  
**Fig. 5.4.3.** Manufacturing Process: molding product.



**Fig. 6.1.** Final Result.

the other advantage.

Fig. 6.6 shows a stacking of the final product. This facilitates the storage availability.

First, this bent wooden chair is sitting backward and forward in playing and education (Fig. 6.5 Reading). When the children are looking at the teacher, they can sit on the chair 2-type without moving (Fig. 6.2 Sitting Forward, Fig. 6.3 Sitting Backward). When the children are looking at the teacher, they can sit on the chair 2-type without moving (Fig. 6.2 Sitting Forward, Fig. 6.3 Sitting Backward).

Second, high frequency heating system chair is useful to lighten weight of chair according to increase punching number.

Third, high frequency heating system chair is reasonable to the children behaviors. Those are



**Fig. 6.2.** Sitting Forward.



**Fig. 6.3.** Sitting Backward.



**Fig. 6.4.** Sitting Together.



**Fig. 6.5.** Reading.



**Fig. 6.6.** Stacked Look.

strong to contamination no joint and sanitary, Resistant to be heat and to be cold is excellent. Furniture is based on environment-friendly material high frequency heating system (Formaldehyde emissions less than 0.02 : A Green Certification reference, Korea Conformity Laboratories test). Fourth, this bent wood chair are required to the frequent spatial variability in the kindergarten. It can improve children's ability to organize themselves as well as it is useful to store and easily to be stacking (Fig. 6.6).

#### 4.3. Product Application Cases

In general, Koreans' living is based on floor. However, floor-based children chair has not been yet developed enough for children. A floor-based children chair helps an children to sit on the floor





Fig. 7.1. Floor-Based children (Chair 1).



Fig. 7.2. Floor-Based children (Chair 2).

with good posture in the room and keeps her/him comfortably positioned for playing or learning.

## 5. Conclusion

High frequency molding technique does not only use environment-friendly material but also less waste materials and has simpler manufacturing process than the other existing furniture, so that it is highly efficient in manufacturing.

To plan children chair design, we selected kindergarten among children' areas and approached children environment. We implemented this study by defining the scope of cause of environment change of kindergarten mainly into change of space, change of learning program and use of environment-friendly material. As a result, we could draw out such keywords of the furniture as storage, mobility, environment-friendly, object

style image, preferred color, functionality and safety, based on which we could plan the design and make the final result through high frequency round molding manufacturing process.

## Acknowledgement

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