UNITED STATES ERGONOMICS

Ergonomic Expert Review of the Haworth® Fern™ Chair

Prepared for:

HAWORTH®

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The Evolution of Ergonomics

Table of Contents

Executive Summary 2
1.0 OVERVIEW 4
2.0 EXPERT ERGONOMICS REVIEW 4
2.1 Controls 5
2.2 Seat Back 7
2.2.1 Seat Back Fit 7
2.2.2 Seat Back Support 9
2.3 Seat Cushion 11
2.3.1 Seat Cushion Fit 11
2.3.2 Seat Cushion Support 12
2.4 Armrests 14
3.0 CONCLUSIONS 16

Executive Summary

The Haworth Fern chair was evaluated by a Certified Professional Ergonomist at United States Ergonomics and is in the process of further laboratory and office based testing. The results of this evaluation and testing indicate that the Fern chair offers ample dynamic support, comfort features, and effective ranges of adjustability to meet the needs of diverse users. A summary of the ergonomics benefits are as follows:

Beneficial features

- The Fern seat back supports a comfortable and healthy upright torso angle of approximately 100° and allows for recline up to approximately 125°. A seat pan forward tilt feature offers an addition 7° of adjustability. Opening the hip angle minimizes pressure on the lower spine. The feature is also beneficial for users that may like to sit higher as it allows them to maintain their feet on the floor.

- Pressure mappings indicate a comfortable distribution of pressures and support in key areas. Pressure data indicates the chair will promote proper seated postures and should be comfortable for extended durations.

- The adjustable recline promotes healthy motion and accommodates users throughout the range of common working postures. The multi-position back stop also enables users to recline only to the point they prefer.

- The flexible frame on the seat back provides dynamic back support flexing with the user's movements providing support in upright, reclined and leaning postures. The mesh material provides comfortable support and ventilation.

- The height adjustable lumbar support provides effective fit for users of varying size including but not limited to the 5^{th} percentile female to 95^{th} percentile male.

- The adjustable armrests provide stable and comfortable support throughout a wide range of adjustment. They can be raised and lowered, pivoted in and out, or, moved forward or backward accommodating a wide range of users sizes and body types. They can also be positioned out of the way to prevent clashing with a user's work surface if desired.

- The adjustable seat pan depth accommodates a wide range of users, improving the support provided to larger users and preventing smaller users from experiencing compression in the back of their knees.

- The high seat back provides greater back support accommodating taller users.

- The chair's controls are well designed, clearly visible, intuitive, and easy to operate.

Based on the Fern chair's positive testing performance it has been awarded the United States Ergonomics Ergonomic Product Certification.

1.0 OVERVIEW

An expert ergonomics review has been completed on the Haworth Fern office chair. The purpose of the assessment was to examine the design and features offered by the chair to determine if it meets with best practices and applicable ergonomic seating standards. The evaluation included a qualitative assessment of the chair features in addition to pressure distribution measurement of the support offered by the seat.

The testing and evaluation was completed by United Stated Ergonomics, directed by a Certified Professional Ergonomist (CPE) with over 30 years of product testing experience.

2.0 EXPERT ERGONOMICS REVIEW

The Fern task chair evaluated had fully adjustable armrests, seat cushion depth and tilt adjustability, adjustable height lumbar support, height adjustability and a mesh seat back supported on a flexible frame (pictured below).

Front

Side

Back

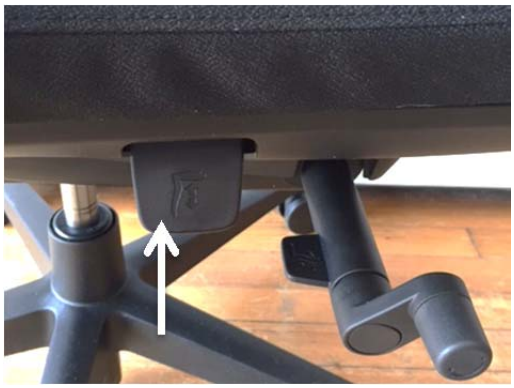
A description of the seat features and results of the ergonomics review are provided in the following sections.

2.1 Controls

The chair provides a full range of adjustability without overwhelming the user. The chair's controls are clearly visible, intuitive and easily accessible while seated. The control levers present on the chair include:

- Seat height adjust
- Recline lock and multi-position back stop
- Recline tension adjustment crank
- Seat cushion depth adjustment
- Armrest height, width, and pivot adjustments
- Height adjustable lumbar support
- Forward tilt adjust of the seat pan

Seat Height Adjustment: The seat height control is a comfortably sized lever located under the right side of the seat pan (pictured below). This is a common location for seat height adjust levers making use intuitive. The lever is easily accessible and can be operated with one to three fingers.



Seat height lever

Seat Recline Adjustment: The seat recline lock knob (pictured below) is located under the right side of the seat pan and is adjusted by turning the lever forward or backward (5 adjustments, the forward-most adjustment locks the seat upright). When the lever is tilted back the recline is unlocked to allow weight activated recline. The multi-position back stop allows the user to select five different degrees of recline in approximately 7° increments. The 5th adjustment (lever turned back most) allows the user to recline up to 124°. The lever is easy to use and clicks into place making it clear when it is in a new position. The shape of the lever implies a forward/backward motion making use intuitive.

Recline Tension Adjustment: Adjacent to the recline adjustment is a recline tension crank (pictured below). Turning the handle forward increases the tension and turning it backwards decreases the tension. This accommodates users over a wide range of weights and sizes. Only a

few turns of the crank are necessary achieve a noticeable change in tension. The crank allows users to fine tune the recline tension to match their bodyweight and seating style.

1. Seat Recline Lock/Stopper 2. Recline Tension Crank

Seat Cushion Depth: The seat cushion depth adjustment is a lever located under the left side of the seat pan (pictured below). The minimum seat pan length is 15.5" to a maximum of 18.5" measured from the seat back. There are discrete notch settings in approximately 0.5" increments. The adjustment can also be made while seated in the chair or standing next to the chair. When seated the depth is adjusted by pulling the lever up and scooting forward or back on the seat pan.

Seat Depth Adjustment Lever

Maximum Seat Depth

Minimum Seat Depth

Forward Seat Pan Tilt: The optional adjustment of the seat pan angle provides another postural option for users. The forward tilt lever is located under the left side of the seat pan in front of the seat pan depth adjustment (pictured below). The forward tilt has 2 settings, tilted forward approximately 5° or flat. Opening the hip angle reduces the pressure on the lower spinal discs. The forward tilt can be used while the user is seated.

The tilt benefits users who prefer sitting more forward and upright while they work and users who may have lower back or thigh issues and prefer to sit with an open hip angle.

The feature is also beneficial for users that may like to sit higher as it allows them to maintain their feet on the floor.

Forward Tilt Adjustment Lever

Flat Seat Pan

Forward Tilted Seat Pan

2.2 Seat Back

The mesh and flexible seat back provides ventilation and support for the range of upright and reclined postures a user will be in throughout the day. The chair back features include an adjustable weight balanced recline mechanism, a mesh seat back, a flexible frame, and height adjustable lumbar support. The recline mechanism operates smoothly and provides options for a range of sitting styles. In the upright position, the chair supports a comfortable hip angle of approximately 100° and allows a recline of up to approximately 125°.

A review of the seat back fit and performance are summarized in the following sections:

2.2.1 Seat Back Fit

The size of the seat back is appropriate to accommodate the 5th percentile female to 95th percentile male. The seat back has an 18” width at the top and a 20” width towards the bottom. The chair back is 25” height tall (measured from the seat cushion). The seat frame provides a built-in lumbar curvature (illustrated in picture below) for lower back support that is adjustable in height. The seat back frame flexes with the user’s movements providing dynamic lumbar support in upright, reclined and leaning postures. The seat back width allows free movement of the elbows beyond the back of the chair.

Lumbar curvature

To adjust the height of the lumbar support a handle located at the back center of the chair can be raised or lowered to the users preferred position. The handle is easily accessible while seated by either the right or left hand and slides smoothly up and down. There are incremental lumbar height settings providing 4” of adjustability. The minimum height is 4.5” and the maximum height is 8.5” as measured from the bottom of the pan.

Lumbar Adjustment Control

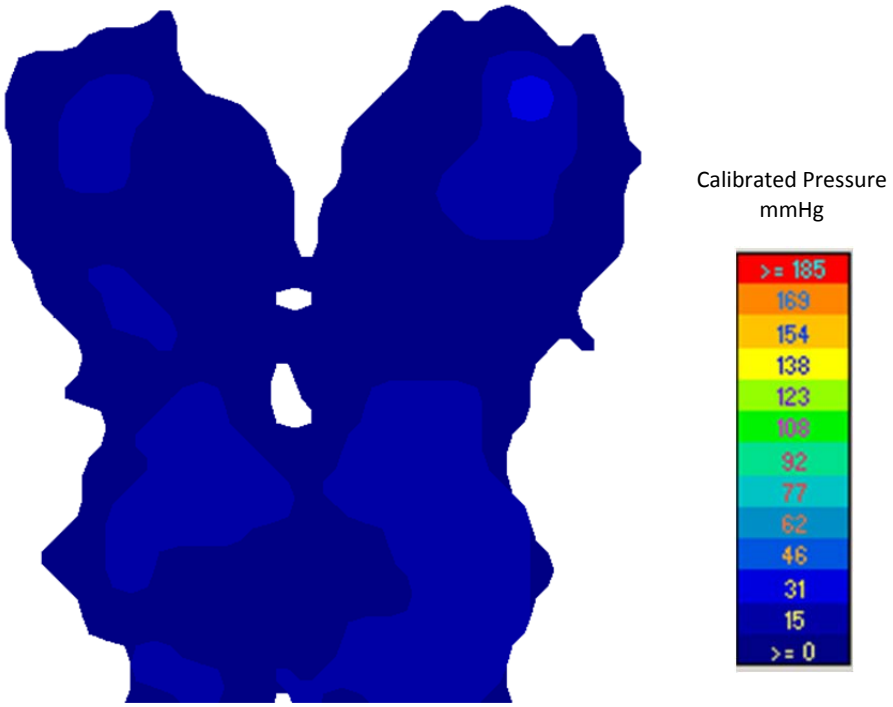
2.2.2 Seat Back Support

The seat back pressure mapping revealed considerable contact area and comfortable pressure levels (see pressure plots below), a desirable characteristic indicating good seat back support. The flexibility provided by the mesh backing and lumbar curvature contributes to this by keeping the backrest in contact with the user during postural variations. The mesh backrest had provided comfortable pressure levels in both upright and reclining postures.

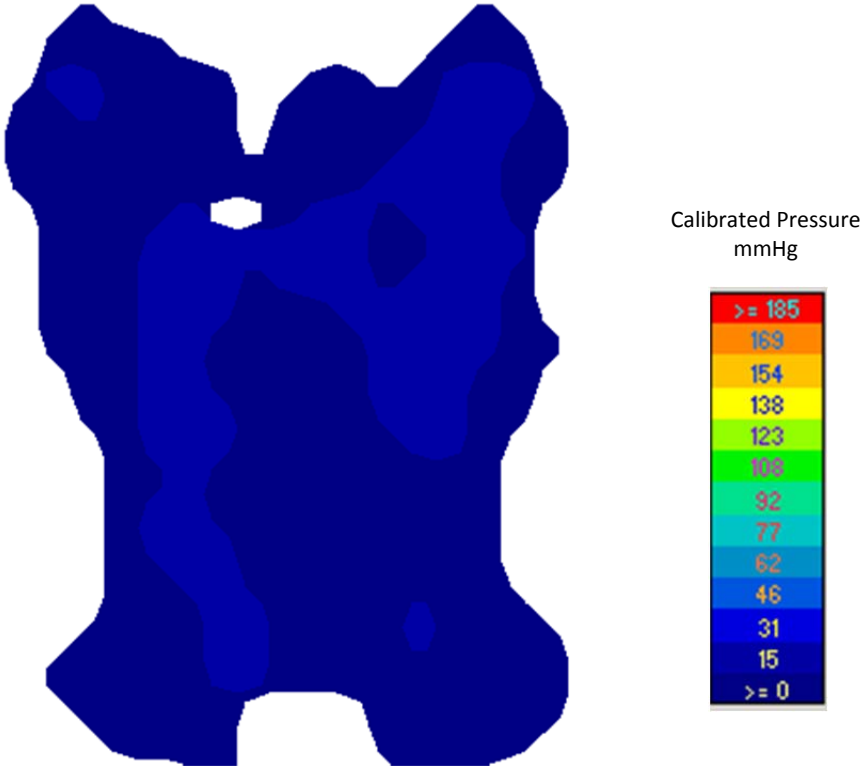
Pressure measurements were obtained from a male of approximately 72th percentile stature (height=71.0" weight=208 lbs) and a female approximately 60th percentile stature (height=65" weight=135 lbs).

Upright, the average pressure was 14 mmHg for both the 60th percentile female and 72nd percentile male. Peak pressures also indicated comfortable support and ranged between 29 mmHg for the small female and 34 mmHg for the large male.

Seat back contact area ranged from 635.9 cm^2 for the female and 1206.7 cm^2 for the large male in the upright position. The contact area increased an average of 5% in the reclined position with more support added at the upper back.

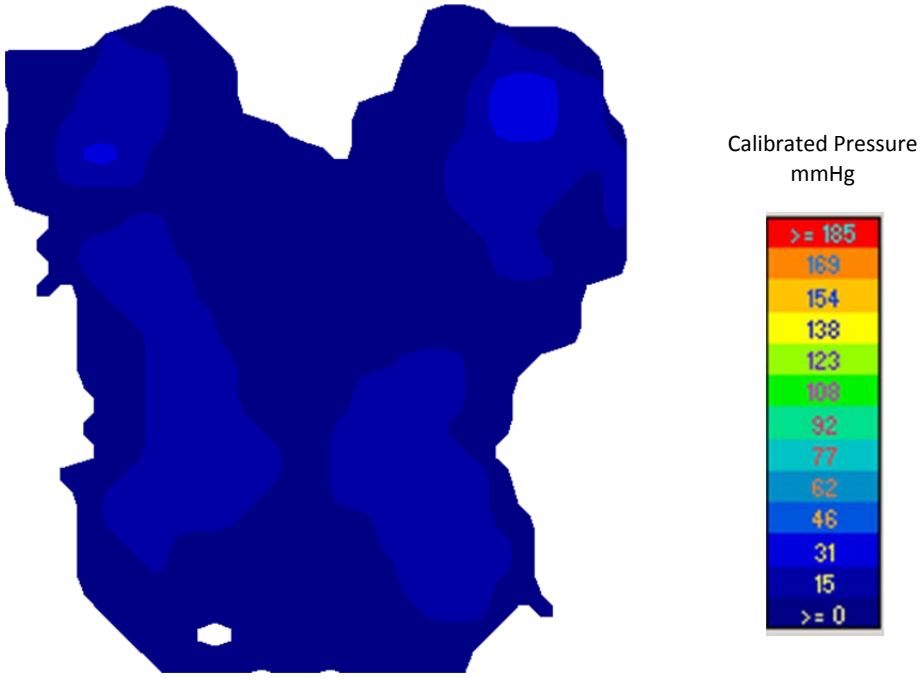


Male: Seat back pressure in upright seated posture

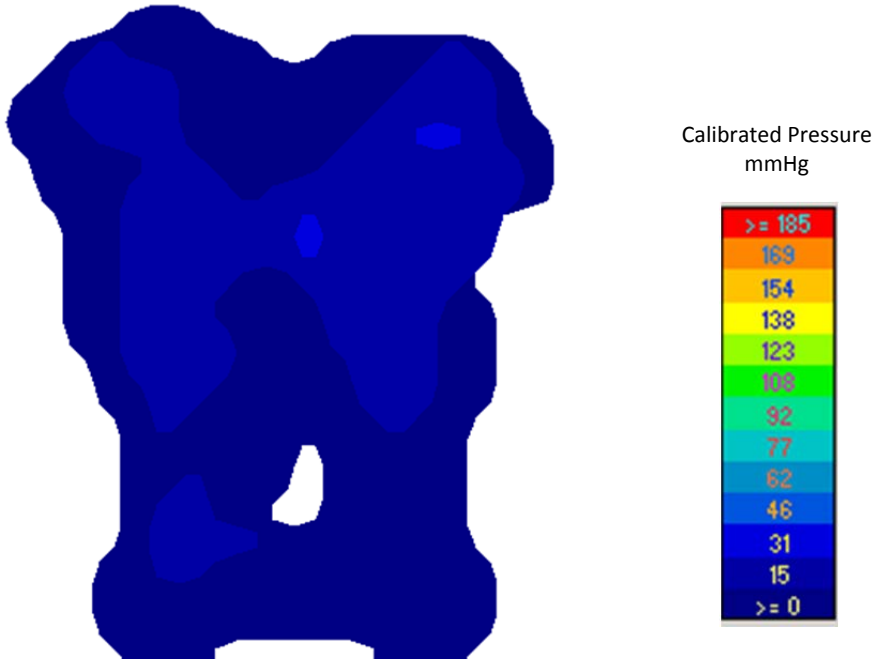


Female: Seat back pressure in upright seated posture

When reclining, the pressure mapping indicated good support and comfortable pressure levels. The average pressures ranged from 14 mmHg to 15 mmHg and peak pressures ranged from 31 mmHg to 39 mmHg to for the female and male, respectively.



Male: Seat back pressure in reclined posture



Female: Seat back pressure in reclined posture

With the recline resistance setting set to the lowest resistance, the seat transitions smoothly from upright to reclined. The mechanism can be locked allowing the seat back to remain in the upright position. The spring tension may also be adjusted to the users preference.

2.3 Seat Cushion

The Fern seat pan is adequately sized and possesses depth adjustability and tilt adjustability. A summary of the fit and support of the seat cushion is presented in the following sections.

2.3.1 Seat Cushion Fit

The physical dimensions of the seat cushion are 19.9” wide by 18.5” deep. The 19.9” width will accommodate larger individuals (up to 95th percentile male) effectively. The free space beyond the seat cushion extends from a minimum of 18” to a maximum of 21” prior to being limited by the adjustable armrest stanchions (includes space beyond cushion). This will provide additional accommodation for individuals beyond the 95th percentile size range.

The depth of the seat cushion is adjustable from a minimum effective length of 15.0” to a maximum of 18”, measured from the apex of the lumbar curve on the seat back to the edge of the seat pan. There are incremental depth adjustments made in approximately 0.5” increments. The seat pan audibly “clicks” into place letting the user know when the seat pan has reached a new depth. The range of depth adjustment will fit the 5th percentile female to the 95th percentile male.

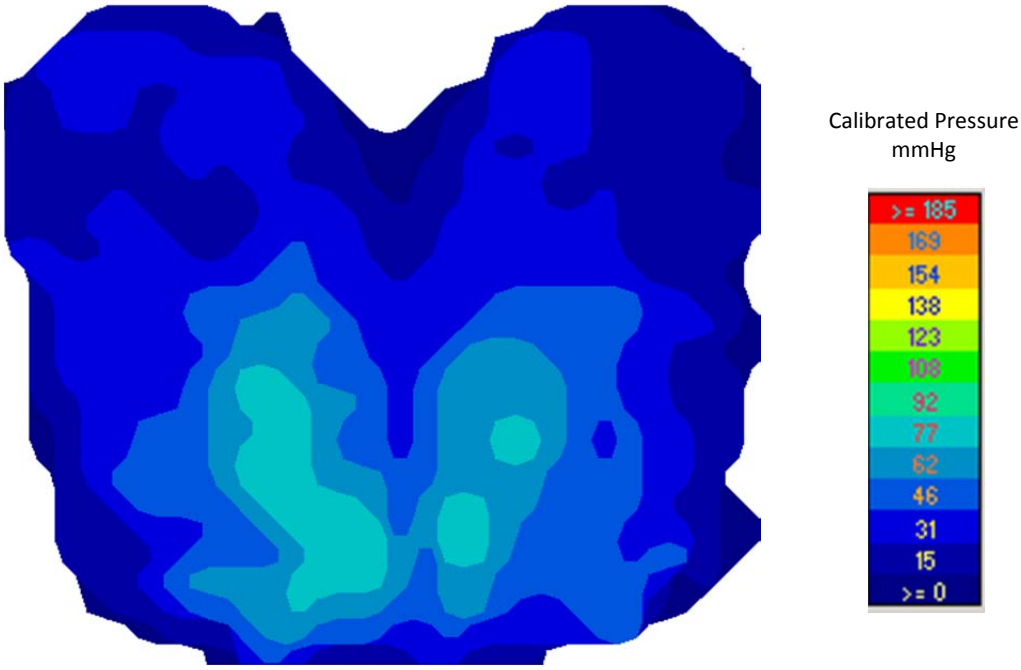
The seat cushion height was adjustable between 16.5” and 21.5”, measured from the center of the seat cushion. Based on current practice, users typically adjust the seat height to a point approximately 2” above popliteal height (the height of the point behind the knee). The high setting will accommodate the 95th percentile male. The forward edge of the seat cushion compresses to a height of approximately 15” in the low setting accommodating the 5th percentile female. The seat cushion also has a waterfall edge, which will prevent compression on the back of the leg. For smaller users (<5th percentile female) the forward seat pan tilt can be utilized to lower the edge of the seat further. The seat pan height at the lowest setting with the forward tilt is 14.5”.

2.3.2 Seat Cushion Support

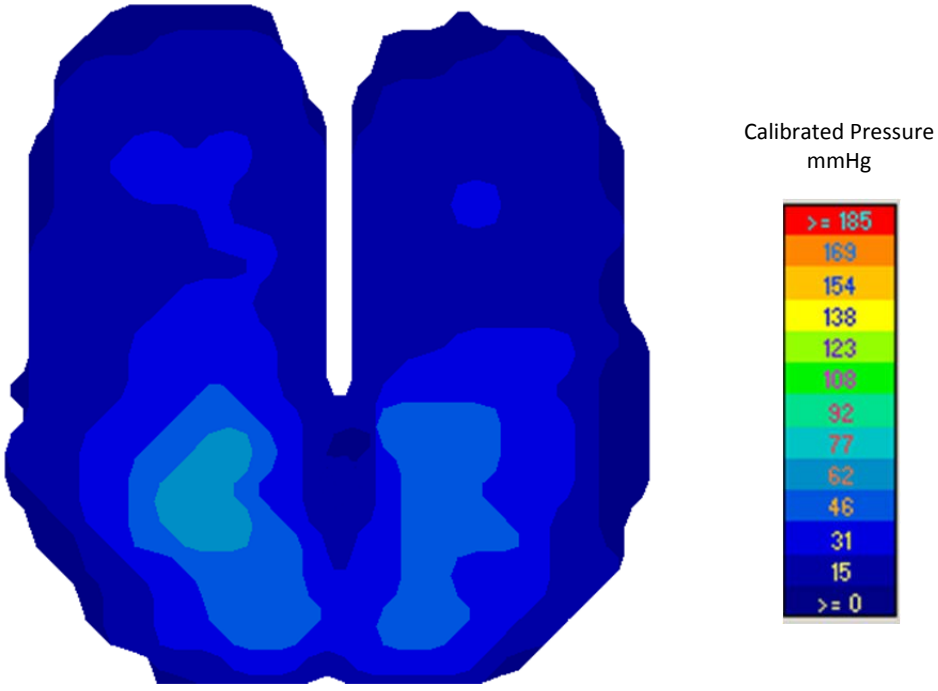
The seated contact pressure was measured in the upright seated posture. The pressure profiles revealed effective seat cushion support (see pressure profiles below). The average pressures in a standard ergonomic position (person sitting fully back on seat pan in contact with the seat back) ranged between 31 mmHg and 42 mmHg for the female and male, respectively. When reclined, seat pan pressure decreased to 30 mmHg for the female and 36 mmHg for the male. The peak pressures with a flat seat pan ranged between 74 mmHg and 90 mmHg for the female and male, respectively. For the forward tilt, peak pressure ranged from 121 mmHg and 96 mmHg for the female and male respectively.

The average contact area in a standard ergonomic posture was 1267.5 cm2 for the female and 1404.2 cm2 for the male. When reclined the contact area increased to 1284.83 cm2 for the female and 1428.1 cm2 for the male.

The front edge of the seat cushion is contoured, providing effective thigh support. Pressure levels were even across the edge of the seat indicating no contact stress.



Male: Seat cushion pressure mapping in standard ergonomic position



Female: Seat cushion pressure mapping in standard ergonomic position

2.4 Armrests

The armrests are cushioned and are highly adjustable. The adjustment range will accommodate beyond the 5th percentile female to the 95th percentile male and support the user effectively through a range of sitting and working postures. Adjustment controls are low force and intuitive to operate. The tension for the adjustments is at an adequate level to prevent inadvertent movement of the armrests, while still being easily moved. The pivot adjustment is achieved by simply gripping the armrests and pulling them inward or pushing them outward. Similarly, the armrests may be moved forward or backward. This adjustment improves the chairs fit when used at a 90° cornered workstation by preventing armrest clash with the edges of the desk.

Armrest

Button for Height Adjust

Armrest in forward (left) and backward (right) positions

Pivot Out

Pivot In

Width Adjust

A summary of the adjustable armrest range are provided below:

Armrest Adjustability Range (Optional 4D armrests as assessed)	
Adjustment	**Range**
Height adjustment range	4.8”
Side-to-side arm cap adjustment range	15” total (7.5” each arm cap)
Fore/aft adjustment range	3.5”
Max Internal pivot/External pivot	40° inward/ 40° outward

The benefits of the adjustable armrests include:

- The adjustability and padding of the armrests minimize the potential for ulnar nerve contact stress at the forearm or elbow.

- The armrest vertical height adjusts low enough to allow the arms to hang freely and can be raised high enough to accommodate the 5^{th} to 95^{th} percentile range comfortably. Height is adjusted in approximately 0.5” increments using an easy to access button underside the armrest.

- The width adjustment feature of the armrests allows for a closer placement of the armrest which can be useful for smaller users. This feature allows users to keep their upper arms relaxed at their sides providing effective low stress support.

- The fore/aft adjustability allow the user to get closer to the desk without clashing with the desk.

- The pivot and width adjustments are continuous allowing users to easily fine tune arm rest adjustments.

3.0 CONCLUSIONS

The Fern chair provides dynamic support and provides an effective range of adjustability to meet the needs of diverse users and work activities. The geometry and range of adjustability of the chair will accommodate individuals beyond the 5th percentile female through the 95th percentile male effectively. The Fern chair incorporates the current best practices in ergonomic chair design and abides by ergonomic standards related to fit and function.

While the chair is simple to use, users should still be educated on the adjustment features and the principles of healthy seated postures.

Based on the Fern chair's positive testing performance it has been awarded the United States Ergonomics Ergonomic Product Certification.