Summary

A new approach to ergonomics in the office

An analysis of the biomechanical impact

of a new office chair system

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Introduction

With pragmatic office environments and ergonomics in mind, developers have long endeavoured to design the places where people work so that more physical activity is encouraged.

Thanks to innovative kinematics, the potential range of motion has been significantly expanded (in comparison with previous models) in the new design of a Wilkhahn office chair examined in this study.

The purpose of the multi-jointed structure is to enable a more natural and satisfactory pattern of movement which is created by a sliding joint at knee joint level and two ball and socket joints at hip level and opens up new three-dimensional ranges of motion for the seat and back. A freely-adjustable spring system allows customised change of the counterpressure.

The goal of this new, three-dimensional supporting kinematics is to foster more natural and more physically acceptable ranges of motion and to lead to a new sense of well-being and comfort.

Methods

To assess the biomechanical impact of the chair, 19 clinically healthy test persons with good anamneses were selected.

Various tests were carried out on the new motion options that will be discussed in more depth below:

- Range of motion
- Simulation
- Pressure analysis
- Subjective survey

Circular movements/range of motion

ON's new design feature (Trimension©) offers a new range of motion due to the three-dimensional mechanics. As a result, it also offers more variable options for motion. In addition to traditional synchro-mechanics that permit leaning forwards and backwards, ON can tilt sideways and rotate the back and seat. These new movements are included in the range of motion and described in the angles between shoulder, back and head axes to the horizontal (see figure 1). As regards the prescribed motion, the individual segments display smooth three-dimensional motion with one another which is enabled by ON's kinematics. At the same time, the flexible mechanics activate more muscles in an entirely new way; when seated people move about considerably more. This means that the different

groups of muscles (back muscles – diagonal stomach muscles - leg muscles) with all their different functions can operate jointly in muscle loops.

Muscular co-ordination via the lumbar region of the spine and the hip right to the leg muscles is shown. An extremely positive aspect is the interaction and therefore also the communication and co-ordination of the segments mentioned in a natural and physiologically integrated framework. A fully—operating functional unit of pelvis, shoulder and head in motion with the chair is displayed.

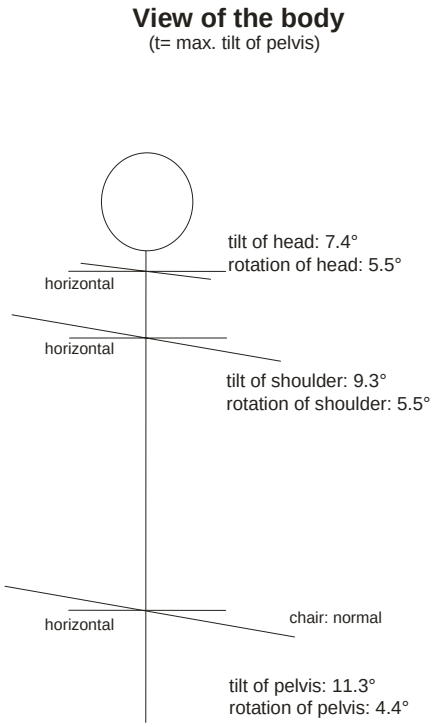

Figure 1: view of the body with the angles (in degrees) for rotation and inclination established for the right hand side

ON encourages and stimulates well-balanced freedom of motion in all directions. It is ON's physiological rotational movement of the torso, combined with the muscle loops described, that activates the muscles deep in the back which are the most important element in the spine's stabilisation system. The person sitting on the chair no longer has to rotate against it, but move in conjunction with the seat and backrest.

Simulation

These new opportunities for motion are used by the test persons intuitively during the study.

In two simulations (picking up and putting down an object from the front and rear back) with different levels of movement, the angle between the backrest and shoulder was examined in particular. This angle will determine the rotation of the shoulder/backrest system. An angle of zero between the shoulder and

backrest means that the shoulder and backrest are parallel and therefore the top part of the body is in contact with the chair during motion.

The angles measured prove the theory that better support is achieved by the seat and backrest during rotational movements while sitting on ON. At the point where the objects are put down during the simulations, small angles are measured in ON (< 19°) between shoulders and backrest – backrest and seat rotate with the top of the body. This means that motion carried out on ON is not isolated from the body, but takes place as part of a complex interaction with ON's new kinematics.

Pressure analysis

In order to examine the quality of ON's synchro-mechanics, the differences in the maximum distribution of pressure between the right and left hand side were measured. It becomes clear that ON is only very slightly short (19%) of the optimum figure (1). This means that in addition to the new scope of motion generated, the old patterns of movement (extension of the torso towards the back) function while sitting on ON and users gradually discover the new possibilities ON offers intuitively.

Survey

A questionnaire, filled in during the analysis, looks at the subjective perception of the test persons as regards ON. The test persons' subjective assessments indicate that ON is a chair that responds to the test persons'/office workers' expectations although these have not yet even been formulated. The Trimension© kinematics are directly experienced by the test persons and assessed as being good and consequently a desirable feature for offices.

Key messages

Pressure analysis

- Despite the three-dimensional kinematics, ON still allows linear patterns of movement typical of conventional office chairs. Therefore, adapting to ON as a chair should be easy.

Rotational movements/range of motion

- Because of ON's limits in terms of kinematics, test persons did not achieve patterns of movement that are unhealthy in the long term, such as for example tilting the pelvis to more than 20° (biggest individual tilt for all test persons: 16.8%).
- At the same time, motion is neither restricted nor prescribed, but within the physiological range with free patterns of movement. Circular and very harmonious movements can also be carried out.
- ON allows interaction and therefore communication and co-ordination of the entire back hip/pelvis (lumbar region of the spine), torso/shoulder (thoracic spine) and neck/head (cervical spine).

Simulation

- The sideways inclination and rotary feature of the backrest in conjunction with the seat form a new kinematic system of sitting.
- The small angle between the shoulder and backrest shows that the test persons make use of ON's kinematics when performing rotational movements. This creates a functional unit between ON and the person sitting on it during motion.
- The fusion of physical motion and motion in the chair creates a functional system between the body and ON.

Assessment questionnaire

- In particular, ON produced very good results on aspects such as range of motion, comfort of motion and fostering variety in posture and motion.
- 90% of the test persons thought that sitting on ON generates more movement which 100% of the test persons state is innovative.
- To the question "Would you like an office chair like ON at work?" 95% of the test persons answered yes.
- All in all, we can say that as regards new scope for motion, the first impression gained by the test persons in terms of ON's movements was positive.

Summary

ON embraces a new approach to ergonomics: towards people and their individuality. Postures and motion should be allowed and not prevented. The aim is to encourage physiological skills instead of establishing rules and regulations.