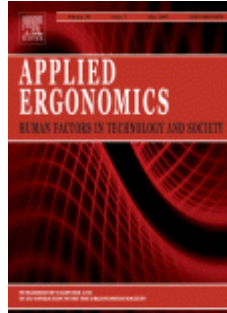


Applied Ergonomics - rok 2012, ročník 43

Číslo 2 (March 2012)



SPECIAL SECTION ON PRODUCT COMFORT

P. Vink, S. Hallbeck. *Editorial: Comfort and discomfort studies demonstrate the need for a new model.* Pages 271-276.

The term comfort is often seen relating to the marketing of products like chairs, cars, clothing, hand tools and even airplane tickets, while in the scientific literature, the term discomfort shows up often, since it is used in research. Few papers explain the concept of a localized comfort experience in relation to product use, although people use these products daily. Therefore, in this special issue, the concept of product comfort is studied further. In this editorial an overview of comfort models has been made, evaluated with the papers from the special issue and a new comfort/discomfort model is proposed to increase our understanding of the factors influencing comfort and discomfort experiences.

- Keywords: Product comfort; Comfort model; End users; Discomfort

Dohyung Kee, Inseok Lee. *Relationships between subjective and objective measures in assessing postural stresses.* Pages 277-282.

The purpose of this study is to investigate the relationships between subjective measures of discomfort and objective measures related to the assessment of postural stresses based on literature survey. Objective measures included posture holding time, maximum holding time (MHT), torque at joints, lifting index (LI) and compressive force (CF) at L5/S1. The major relationships identified in this literature survey were the following: 1) postural discomfort linearly increased with increasing holding time, and holding force, 2) whole body discomfort was inversely linearly proportional to the MHT, 3) body-part discomfort was related to objective measures such as torque at the relevant joint, 4) discomfort was strongly linearly related to LIs and CFs, and 5) the discomfort measured with the magnitude estimation was linearly related to that measured with Borg CR10. Thus, it is thought that discomfort might be used as a measure for quantifying postural stresses.

- **Keywords:** Discomfort; Musculoskeletal disorders; Physical loading; Postural stress

Yong-Ku Kong, Dae-Min Kim, Kyung-Sun Lee, Myung-Chul Jung. *Comparison of comfort, discomfort, and continuum ratings of force levels and hand regions during gripping exertions. Pages 283-289.*

The goal of this study was to compare three different evaluation systems of comfort, discomfort, and a continuum for the force levels and hand regions when gripping hand tools. Seventy-two participants were assigned to three groups, each group testing a different evaluation system. Each participant exerted ten levels of submaximal voluntary contractions on hand tools and used their assigned evaluation system to evaluate comfortable or uncomfortable feelings for the force levels and five different regions of the hand. The participants generally rated higher discomfort as required forces increased, but the discomfort and continuum evaluation systems were better than the comfort evaluation system because gripping exertion was related to the physical aspects of the hand tools and their users. Based on the results of the continuum evaluation system, the feeling changed from comfort to discomfort at 65% maximum voluntary contraction. The palm was the region of the hand with the most discomfort. Other design factors affecting comfort need to also be considered in order to better understand hand tool use.

- **Keywords:** Comfort; Discomfort; Continuum; Submaximal voluntary contraction; Hand regions

R. Zenk, M. Franz, H. Bubb, P. Vink. *Technical note : Spine loading in automotive seating. Pages 290-295.*

For car manufacturers, seat comfort is becoming more important in distinguishing themselves from their competitors. Therefore, many studies on participative seat comfort are carried out. In this paper, an objective assessment approach is reported which evaluates the concept of "optimal load distribution", based on the identification of a close relationship between the pressure on the seat and the discomfort felt by the person sitting. An in vivo measurement of the pressure in the spinal disc, which is an indicator of the load in the spine, was performed. For this research, a pressure sensor was implanted with a canula in the middle of the disc intervertebralis of a participant. The local pressure on the disc was established for the participant in an automobile seat set in various seat positions. The results indicate that in the seat position with the pressure distribution corresponding to the most comfortable posture the pressure in the intervertebral disc is lowest. The pressure in this position is 0.5 bar, while in the upright seated position the pressure is 1.6 bar.

- **Keywords:** Comfort; Spine load measurement; Intelligent car seat; Automatic seat comfort adjustment

Rolf P. Ellegast, Kathrin Kraft, Liesbeth Groenesteijn, Frank Krause, Helmut Berger, Peter Vink. *Comparison of four specific dynamic office chairs with a conventional office chair: Impact upon muscle activation, physical activity and posture. Pages 296-307.*

Prolonged and static sitting postures provoke physical inactivity at VDU workplaces and are therefore discussed as risk factors for the musculoskeletal system. Manufacturers have designed specific dynamic office chairs featuring structural elements which promote dynamic sitting and therefore physical activity. The aim of the present study was to evaluate the effects of four specific dynamic chairs on erector spinae and trapezius EMG, postures/joint angles and physical activity intensity (PAI) compared to those of a conventional standard office chair. All chairs were fitted with sensors for measurement of the chair parameters (backrest inclination, forward and sideward seat pan inclination), and tested in the laboratory by 10 subjects performing 7 standardized office tasks and by another 12 subjects in the field during their normal office work. Muscle activation

revealed no significant differences between the specific dynamic chairs and the reference chair. Analysis of postures/joint angles and PAI revealed only a few differences between the chairs, whereas the tasks performed strongly affected the measured muscle activation, postures and kinematics. The characteristic dynamic elements of each specific chair yielded significant differences in the measured chair parameters, but these characteristics did not appear to affect the sitting dynamics of the subjects performing their office tasks.

- **Keywords:** Dynamic office chairs; EMG; Posture; Physical activity; VDU/computer workplace

Kageyu Noro, Tetsuya Naruse, Rani Lueder, Nobuhisa Nao-i, Maki Kozawa. *Application of Zen sitting principles to microscopic surgery seating.* Pages 308-319.

This paper describes the application of an alternative seating concept for surgeons that reflects the research of Zen sitting postures, which require Zazen meditators to maintain fixed postures for long durations. The aim of this alternative approach is to provide sitters with a seat pan with sacral support¹ that provides a more even distribution of seat pressures, induces forward pelvic rotation and improves lumbar, buttock and thigh support. This approach was applied to the development of a chair for microscopic surgery. The experimental chair is a seat pan that closely matches the three-dimensional contours of the user's buttocks. Seat comfort was evaluated by comparing both changes in pelvic tilt and seat pressure distributions using Regionally-Differentiated Pressure Maps (RDPM) with subjective ratings of surgeons while operating in prototype and conventional chairs. Findings include that the sacral support of the prototype chair prevents backward pelvic rotation, as seen in zazen (Zen sitting postures). Preliminary data suggests that the prototype provided greater sitting comfort and support for constrained operating postures than did the conventional chair. These findings support the selective application of concave-shaped seat pans that conform to users' buttocks and reflect Zen sitting principles.

- **Keywords:** Seating design; Surgical operations; Pelvic tilt; Sacral support; Seat pan; Concave chair; Seat comfort; Pelvis; Seat pressure distributions; Zen sitting; Zazen meditation

Liesbeth Groenesteijn, Rolf P. Ellegast, Kathrin Keller, Frank Krause, Helmut Berger, Michiel P. de Looze. *Office task effects on comfort and body dynamics in five dynamic office chairs.* Pages 320-328.

In the present study, we investigated the effect of office tasks on posture and movements in field settings, and the comfort rating for chair characteristics and correlation with type of task. The tasks studied were: computer work, telephoning, desk work and conversation. Postures, movements, chair part inclinations and comfort rating data were collected from 12 subjects. Computer work showed the lowest physical activity, together with upright trunk and head position and low backrest inclination. Conversation shows the highest activity of head legs and low back together with the highest cervical spine extension. In contrast, desk work provoked the most cervical spine flexion and showed the second lowest activity. The telephoning tasks showed medium activity and the highest kyphosis. Conversation showed the highest backrest inclination. Positive comfort relations were found for computer work and a "swing system" chair, for telephoning and an active longitudinal seat rotation, and for desk work and a chair with a three-dimensionally moveable seat.

- **Keywords:** Office seating and tasks; Physical effects; (Dis)comfort

Irene Kamp. *The influence of car-seat design on its character experience.* Pages 329-335.

Producing higher efficiency cars with less and lighter materials but without compromising safety, comfort and driving pleasure might give a competitive advantage. In this light, at BMW a new light weight car-seat concept was developed based on the human body contour. A possibility to increase the comfort is using a seat which elicits positive tactile experiences. However, limited information is available on seat characteristics and tactile experiences. Therefore, this study describes the contour of three different car-seat designs, including a light weight seat, and the recorded corresponding emotion and tactile experience of 21 persons sitting in the seats. Results show that the new light weight car-seat concept rated well on experienced relaxedness, even with the lack of a side support. The most important findings are that hard seats with rather high side supports are rated sporty and seats that are softer are rated more luxurious.

- **Keywords:** Car seats; Emocard; Tactile experience; Comfort; Seat contour

M. Franz, A. Durt, R. Zenk, P.M.A. Desmet. *Comfort effects of a new car headrest with neck support.* Pages 336-343.

This paper describes the design of a neck-/headrest to increase car comfort. Two studies were undertaken to create a new comfortable headrest with neck support. In experiment one, neck- and headrest data were gathered using 35 test subjects. The pressure distribution, stiffness of the foam material and position of the head and neck support were determined. In experiment two a full adjustable final headrest with adjustable neck support was constructed and tested with 12 subjects using a new adjustable headrest under virtual reality driving conditions. Experiment two showed that the headrest with the new/adjustable neck support was favoured by the majority of the subjects. 83% were satisfied with the stiffness of the material. 92% were satisfied with the size of the neck- and headrest. All subjects mentioned that the neck support is a comfort benefit in calm traffic conditions or on the motorway.

- **Keywords:** Comfort; Headrest; Car seat; Pressure distribution

Elsbeth M. de Korte, Maaike A. Huysmans, Annelise M. de Jong, Josine G.M. van de Ven, Mark Ruijsendaal. *Effects of four types of non-obtrusive feedback on computer behaviour, task performance and comfort.* Pages 344-353.

This study investigated the effects of non-obtrusive feedback on continuous lifted hand/finger behaviour, task performance and comfort. In an experiment with 24 participants the effects of two visual and two tactile feedback signals were compared to a no-feedback condition in a computer task. Results from the objective measures showed that all types of feedback were equally effective to reduce lifted hand/finger behaviour (effectiveness) compared to absence of feedback, while task performance was not affected (efficiency). In contrast to objective measures, subjective user experience was significantly different for the four types of feedback signals. Continuous tactile feedback appeared to be the best signal; not only the effectiveness and efficiency were rated reasonable, it also scored best on perceived match between signal and required action. This study shows the importance of including user experiences when investigating usability of feedback signals. Non-obtrusive feedback embedded in products and environments may successfully be used to support office workers to adopt healthy, productive and comfortable working behaviour.

- **Keywords:** Human computer interaction; Feedback; Behaviour; Comfort; Task performance; Usability

P. Vink, C. Bazley, I. Kamp, M. Blok. *Possibilities to improve the aircraft interior comfort experience. Pages 354-359.*

Comfort plays an increasingly important role in the interior design of airplanes. Although ample research has been conducted on airplane design technology, only a small amount of public scientific information is available addressing the passenger's opinion. In this study, more than 10,000 internet trip reports and 153 passenger interviews were used to gather opinions about aspects which need to be improved in order to design a more comfortable aircraft interior. The results show clear relationships between comfort and legroom, hygiene, crew attention and seat/personal space. Passengers rate the newer planes significantly better than older ones, indicating that attention to design for comfort has proven effective. The study also shows that rude flight attendants and bad hygiene reduce the comfort experience drastically and that a high comfort rating is related to higher "fly again" values.

- **Keywords:** Cabin comfort; Legroom; Passengers' opinion; Aircraft interiors

REGULAR PAPERS

Hajime Oi, Koji Tabata, Yasuhito Naka, Akira Takeda, Yutaka Tochiyama. *Effects of heated seats in vehicles on thermal comfort during the initial warm-up period. Pages 360-367.*

Eight subjects participated in a subjective experiment of eight conditions to investigate the effects of heated seats in vehicles on skin temperature, thermal sensation and thermal comfort during the initial warm-up period. The experimental conditions were designed as a combination of air temperature in the test room (5, 10, 15, or 20 °C) and heated seat (on/off). The heated seat was effective for improving thermal comfort during the initial warm-up period when air temperature was lower than 15 °C. Use of heated seats prevented decreases in or increased toe skin temperature. Heated seats also increased foot thermal sensation at 15 and 20 °C. Optimal thermal sensation in contact with the seat was higher when air temperature was lower. Optimal skin temperature in contact with the seat back was higher than that with the seat cushion. Moreover, these optimal skin temperatures were higher when air temperature was lower.

- **Keywords:** Heated seat; Thermal comfort; Skin temperature

Ali Sheikhzadeh, Jangwhon Yoon, Dan Formosa, Barbara Domanska, Darrell Morgan, Michael Schiff. *The effect of a new syringe design on the ability of rheumatoid arthritis patients to inject a biological medication. Pages 368-375.*

Self-administration of new biological medications can be difficult for Rheumatoid Arthritis patients with functional impairment and hand and dexterity limitation. Twenty-three Rheumatoid Arthritis (RA) patients participated in this study to compare preferences and injection forces using a conventional syringe and a new ergonomically designed syringe. Injection force measurements were collected in two ways: a) isometric forces, with the syringes' plungers in fixed positions (depressed halfway and fully depressed), and b) forces exerted during injection of the medication. Subjects' grip and pinch strengths were measured. A perception questionnaire gauged subjects' impressions and preferences. Subjects were capable of exerting significantly higher isometric forces using the new syringe with the plunger fixed both halfway and fully depressed. During injection of the medication, peak and mean injection forces were significantly higher, and duration was shorter, when using the new syringe. Subjects rated the new syringe higher on all twenty attributes on preference and performance. Therefore, it is expected that the new syringe will benefit self-administration of medication injection for RA patients.

- **Keywords:** Syringe; Usability; Rheumatoid arthritis

Meirav Taieb-Maimon, Julie Cwikel, Bracha Shapira, Ido Orenstein. *The effectiveness of a training method using self-modeling webcam photos for reducing musculoskeletal risk among office workers using computers.* Pages 376-385.

An intervention study was conducted to examine the effectiveness of an innovative self-modeling photo-training method for reducing musculoskeletal risk among office workers using computers. Sixty workers were randomly assigned to either: 1) a control group; 2) an office training group that received personal, ergonomic training and workstation adjustments or 3) a photo-training group that received both office training and an automatic frequent-feedback system that displayed on the computer screen a photo of the worker's current sitting posture together with the correct posture photo taken earlier during office training. Musculoskeletal risk was evaluated using the Rapid Upper Limb Assessment (RULA) method before, during and after the six weeks intervention. Both training methods provided effective short-term posture improvement; however, sustained improvement was only attained with the photo-training method. Both interventions had a greater effect on older workers and on workers suffering more musculoskeletal pain. The photo-training method had a greater positive effect on women than on men.

- **Keywords:** Occupational exposure; Ergonomics; Telemedicine; Feedback; Task performance and analysis; Algorithm; Posture

W. Vaughn McCall, Niki Boggs, Alan Letton. *Changes in sleep and wake in response to different sleeping surfaces : a pilot study.* Pages 386-391.

Six married couples (12 adults, mean age 34.8 years) were randomized as couples in a cross-over design to sleep on a queen-size conventional mattress for 2 weeks and a specially-designed pressure-relief mattress for 2 weeks. The pressure-relief mattress was designed to reduce the number of contact points exceeding 30 mm Hg. Actigraphic measurements of sleep and self-reports of sleep and daytime symptoms were collected at baseline for 2 weeks on each couple's home mattress and box springs at home, followed by 2 weeks of data collection on each randomized mattress for a total of 6 weeks of data collection. Pressure maps were created for each participant on each sleeping surface. There were no significant differences between the randomized sleeping surfaces for any measure of actigraphic sleep or self-reported sleep and daytime symptoms. However, poor pressure relief performance of the home mattress was associated with better actigraphic sleep on the randomized pressure-relief mattress. We conclude that while pressure-relief mattresses may not be universally preferred, baseline characteristics of the sleeper and/or their mattress may explain performance and sleeper preferences on future mattress selection.

- **Keywords:** Mattress; Sleep; Pressure mapping

J.E. Gold, J.B. Driban, V.R. Yingling, E. Komaroff. *Characterization of posture and comfort in laptop users in non-desk settings.* Pages 392-399.

Laptop computers may be used in a variety of postures not coupled to the office workstation. Using passive motion analysis, this study examined mean joint angles during a short typing/editing task in college students (n = 20), in up to seven positions. Comfort was assessed after task execution through a body map. For three required postures, joint angles in a prone posture were different than those while seated at a couch with feet either on floor or on ottoman. Specifically, the prone posture was

characterized by comparatively non-neutral shoulders, elbows and wrists, and pronounced neck extension. Significantly greater intensity and more regions of discomfort were marked for the prone posture than for the seated postures. It is recommended that the prone posture only be assumed briefly during laptop use. Exposure to laptops outside of the office setting should be assessed in future epidemiologic studies of musculoskeletal complaints and computer use.

- **Keywords:** Office ergonomics; Computer workstations; Joint angle

Krishna Asundi, Dan Odell, Adam Luce, Jack T. Dennerlein. *Changes in posture through the use of simple inclines with notebook computers placed on a standard desk. Pages 400-407.*

This study evaluated the use of simple inclines as a portable peripheral for improving head and neck postures during notebook computer use on tables in portable environments such as hotel rooms, cafés, and airport lounges. A 3D motion analysis system measured head, neck and right upper extremity postures of 15 participants as they completed a 10 min computer task in six different configurations, all on a fixed height desk: no-incline, 12° incline, 25° incline, no-incline with external mouse, 25° incline with an external mouse, and a commercially available riser with external mouse and keyboard. After completion of the task, subjects rated the configuration for comfort and ease of use and indicated perceived discomfort in several body segments. Compared to the no-incline configuration, use of the 12° incline reduced forward head tilt and neck flexion while increasing wrist extension. The 25° incline further reduced head tilt and neck flexion while further increasing wrist extension. The 25° incline received the lowest comfort and ease of use ratings and the highest perceived discomfort score. For portable, temporary computing environments where internal input devices are used, users may find improved head and neck postures with acceptable wrist extension postures with the utilization of a 12° incline.

- **Keywords:** Portable computing; Notebook peripherals; Biomechanics

J.E. Gold, J.B. Driban, N. Thomas, T. Chakravarty, V. Channell, E. Komaroff. *Postures, typing strategies, and gender differences in mobile device usage : an observational study. Pages 408-412.*

Mobile device text messaging and other typing is rapidly increasing worldwide. A checklist was utilized to characterize joint postures and typing styles in individuals appearing to be of college age (n = 859) while typing on their mobile devices in public. Gender differences were also ascertained. Almost universally, observed subjects had a flexed neck (91.0%, n = 782), and a non-neutral typing-side wrist (90.3%, n = 776). A greater proportion of males had protracted shoulders (p < 0.01, χ^2 test), while a greater proportion of females had a typing-side inner elbow angle of <90°, particularly while standing (p = 0.03, χ^2 test). 46.1% of subjects typed with both thumbs (two hands holding the mobile device). Just over one-third typed with their right thumb (right hand holding the mobile device). No difference in typing styles between genders was found. Future research should determine whether the non-neutral postures identified may be associated with musculoskeletal disorders.

- **Keywords:** Text messaging; Musculoskeletal disorder

Iman Dianat, Christine M. Haslegrave, Alex W. Stedmon. *Using pliers in assembly work : short and long task duration effects of gloves on hand performance capabilities and subjective assessments of discomfort and ease of tool manipulation. Pages 413-423.*

The present study investigated the effects of wearing typical industrial gloves on hand performance capabilities (muscle activity, wrist posture, touch sensitivity, hand grip and forearm torque strength) and subjective assessments for an extended duration of performing a common assembly task, wire tying with pliers, which requires a combination of manipulation and force exertion. Three commercially available gloves (cotton, nylon and nitrile gloves) were tested and compared with a bare hand condition while participants performed the simulated assembly task for 2 h. The results showed that wearing gloves significantly increased the muscle activity, wrist deviation, and discomfort whilst reducing hand grip strength, forearm torque strength and touch sensitivity. The combined results showed that the length of time for which gloves are worn does affect hand performance capability and that gloves need to be evaluated in a realistic working context. The results are discussed in terms of selection of gloves for industrial assembly tasks involving pliers.

- **Keywords:** Muscle activity; EMG; Wrist posture; Strength; Touch sensitivity

Andreas Liebl, Jörg Haller, Bernd Jödicke, Herwig Baumgartner, Sabine Schlittmeier, Jürgen Hellbrück. *Combined effects of acoustic and visual distraction on cognitive performance and well-being.* Pages 424-434.

Information work is usually performed in offices and influenced by the combined effects of acoustics, room climate, lighting and air quality. However, the principal part of literature solely focuses on the individual effects of physical parameters. This study (n = 32) investigates the combined effects of acoustic and visual distraction with regard to cognitive performance and well-being. Therefore low level background speech (40 dB(A)) of good or poor intelligibility was combined with either static or dynamic lighting. Experimental testing lasted for approx. 7 h for each participant and was conducted in mock-up offices. No interaction effects of background speech and lighting conditions with regard to cognitive performance were found. However, the results prove that even low level background speech of high intelligibility significantly impairs short-term memory, reasoning ability and well-being. But no effect of background speech on text comprehension and sustained attention was found. Visual distraction due to dynamic lighting caused significant complaints but did not impair performance. An interaction effect of background speech and lighting conditions was found with regard to perceived performance during task processing. Test persons only felt to perform better, if background speech of low intelligibility was combined with static lighting. It is shown that the effects on cognitive performance and well-being must be considered separately since these effects are rarely consistent.

- **Keywords:** Acoustic distraction; Visual distraction; Office noise; Performance; Well-being

Matthew Phillips, Warren Payne, Cara Lord, Kevin Netto, David Nichols, Brad Aisbett. *Identification of physically demanding tasks performed during bushfire suppression by Australian rural firefighters.* Pages 435-441.

Purpose: To identify and characterize the physically demanding tasks undertaken during multi-day wildfire (known as bushfire in Australia) suppression by Australian rural firefighters. Methods: During semi-structured group interviews, thirty-one experienced male firefighters reviewed 53 firefighting tasks that could be performed during tanker-based bushfire suppression. Participants were asked to nominate the most physically demanding tasks and then define their typical frequencies, durations, operational importance and the dominant actions and activity types in each task. Results: Seven tasks were identified as physically demanding. They were further categorized into three hose and four handtool (e.g., rakehoe) related activities. These tasks were assessed as

moderately important to critical and were thought to occur less than one up to 700 times in a four-month bushfire 'season'. Each task's duration was estimated to last approximately 2–30 min depending on the task. Dominant actions were carry, drag, dig/rake actions in seven, three and four of the demanding tasks, respectively. 'Strength-endurance' was the dominant activity type for five of the seven tasks. Conclusion: Seven fireground tasks, three using a hose and four using handtools were classified as physically demanding by incumbent firefighters. The combination of hose and handtool work indicates that the tanker-based bushfire suppression tactics used by Australian rural firefighters appears to be a hybrid of structural and wildfire firefighting techniques and may require a dedicated physiological analyses before the job demands for these firefighters can be quantified.

- **Keywords:** Firefighting; Job task analysis; Task demands; Occupational physiology

David Darwent, Greg Roach, Drew Dawson. *How well do truck drivers sleep in cabin sleeper berths?* Pages 442-446.

The aim of this study was to evaluate the sleep obtained by livestock transport truck drivers while resting in truck sleeper berths during long-haul commercial operations. Operations were carried out in the very remote regions of Australia. The sample comprised of 32 drivers who wore wrist activity monitors and reported bed-times for a two-week period. Drivers had a mean (\pm standard deviation) age of 35.41 (\pm 9.78) years and had worked as truck drivers for 13.83 (\pm 9.11) years. On average, they obtained 6.07 (\pm 1.18) hours of sleep/24-h period. The majority of sleep occurred at night, but drivers occasionally supplemented their main sleep with a daytime nap. Consistent with operational demands, drivers were most likely to sleep in cabin sleeper berths ($n = 394$, 77%). Only a small proportion of sleeps were sampled at home ($n = 63$, 12%) or at truck depots ($n = 56$, 11%). Mixed-model ANOVA revealed that while earlier bed-times at home yielded more sleep, there were only marginal differences in sleep quality across location. No intrinsic safety concerns associated with the use of sleeper berths were identified across consecutive days of long-haul transport operations.

- **Keywords:** Sleep; Sleeper berths; Truck drivers

Valérie Le Bris, Béatrice Barthe, Jean-Claude Marquié, Alain Kerguelen, Sophie Aubert, Bernadette Bernadou. *Advantages of shift changeovers with meetings : ergonomic analysis of shift supervisors' activity in aircraft building.* Pages 447-454.

Good shift changeovers contribute to ensuring continuity and reliability in shift work. In situations where production is not maintained 24 h a day, changeovers with meetings (SCM) between the two work teams (written plus oral face-to-face handovers) alternate with changeovers without meetings (SCnM; written handovers only). An ergonomic work analysis on an aircraft assembly line showed that (1) incoming and outgoing operators met during the overlap time allotted by the company, and (2) the content of the exchanges was richer for SCMs than for SCnMs. SCMs enabled the operators to pass on and process more aspects of their work than SCnMs did. SCMs also allowed incoming operators to validate their predictions, and enabled both outgoing and incoming operators to update their mental models and work together on peripheral aspects of the technical process over a greater time span. The findings highlight the importance of allowing overlap time in shift work.

- **Keywords:** Shift work; Mental model updating; Work activity