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Seat Technology of the Future

The work load and stress on people employed in the agricultural sector is very high. Suitable workplace design is a viable preventive measure. This paper shows how workplace design can be operator-friendly, as well as innovative, using a driver's seat in commercial vehicles as an example.



Maximo Evolution

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Literature

Literature references can be called up under LT 04304 via internet <http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm>.

The cabins of commercial vehicles, including agricultural machinery, serve as workplaces. As such, they must be designed above all to satisfy functional, anatomical, anthropometric and bio-mechanical criteria with the goal of preserving the user's, in other words the driver's health and ability to optimally perform.

The potential economic benefits of doing this are very large, because the costs incurred by worker disability are enormous [1]. Muscular and skeletal problems account for the largest single share of employee absenteeism, with a rising tendency [2].

Especially in the agricultural sector, the externally applied stresses, to which workers are subjected, are very great. Because of this, a higher-than-average proportion of agricultural workers complain of muscle pain in the arms, legs, or back (for a total of 70 % [3], compared to the average of 50 % for all other sectors of the economy [3]).

Agricultural workers spend many hours on tractors, in other words seated. This sitting is not problematic in and of itself except when vehicle operators take the brunt of vibrations that affect the entire body, which is the case when ploughing or even merely transporting loads. This can cause injuries to the spine ranging in severity all the way to chronic vocational disabilities (BK2100). Seat manufacturers have the obligation and responsibility to help prevent health problems by ergonomically designing driver seats to serve as workplaces.

Development of appropriate seats

The driver seat is the main interface between a vehicle's operator and the cabin, and as such greatly impacts working conditions. Here it is necessary to

distinguish between different types of machines. The job of a forklift operator differs significantly from that of a tractor or harvester operator.

However, it is always the same comfort and ergonomics factor that determine the overall comfort of a driver seat in the cabin (Fig. 1). Depending on the application, individual factors need to be prioritised differently, because each work situation places different demands on the driver. This comfort should not be confused with luxury, however; it is primarily intended to protect the operator's health by directly or indirectly enhancing their sense of well-being.

But these are not mutually independent parameters, but rather complexly interacting factors. This makes it especially important to optimise each product for its intended use. However, all of the factors and the associated physical parameters must always satisfy certain minimum requirements.

Biomechanics

As the statistics on lost working hours show, there is a considerable need for preventive action. To respond appropriately, it is necessary to possess in-depth knowledge of people and how they function. In connection with seating systems, this applies in especially great measure to human biomechanics. In recent years, Grammer has promoted know-how transfer through close ties between industry and research and supported basic spine research with the annual Grammer European Spine Journal Award [4], the distinction in this field that comes with the largest purse, 20000 €. In addition, in 2001



Fig. 1: A lot of parameters influence the seat comfort

Grammer organised the „Ergomechanics Congress“, an interdisciplinary international spine convention. Another such event is planned for 2005. In the process, we have learned that current biomechanics research findings can call into question and even refute received ergonomics wisdom. A case in point is the traditional assumption that sitting is more stressful than standing, and therefore a standing posture should be imitated as closely as possible by promoting an upright position. This assumption has been shown wrong by various measurements [5]. The latest findings indicate that it is best to shift among various sitting positions; no single position is beneficial if too long. Dynamic sitting helps nourish the intervertebral disks by varying the movements and loads involved.

Vibration absorption

In addition to static, forced postures, lateral inclination and torsion of the spine as well as strenuous work and abrupt lifting, another risk factor involved in causing back ailments are vibrations that affect the entire body.

The load-stress model (Fig. 2) of mechanically induced whole-body vibrations [6] shows how the seat itself can influence the stresses involved. The seat and its suspension determine which physical stresses are transmitted to the driver with a given vehicle and trajectory.

The principal factors that determine how well a seat mitigates vibrations are its inherent frequency and the available suspension travel. These parameters must be adapted to the vibration source.

This seat function ranks among the most important ones for keeping drivers healthy. Unfortunately, it is often counterintuitive to use, as a result of which it is often neglected or incorrectly set. For this reason, Grammer has equipped the Maximo Evolution with active weight adjustment. Appropriate sensors and electronics automatically adjust the seat to each driver's weight. The same seat has so-called a low-frequency suspension, which also absorbs lower-frequency vibrations to reduce further the stresses to which the driver is exposed. Besides good vertical suspension, it is naturally important to buffer horizontal jolts and vibrations. Especially when driving in difficult terrain or with trailers and rear attachments, these can be quite considerable. That is why the new Maximo Evolution is fitted with longitudinal and lateral horizontal suspension as a standard feature.

User-friendly operation

Modern technology makes it feasible to integrate more and more functions into seats, yet

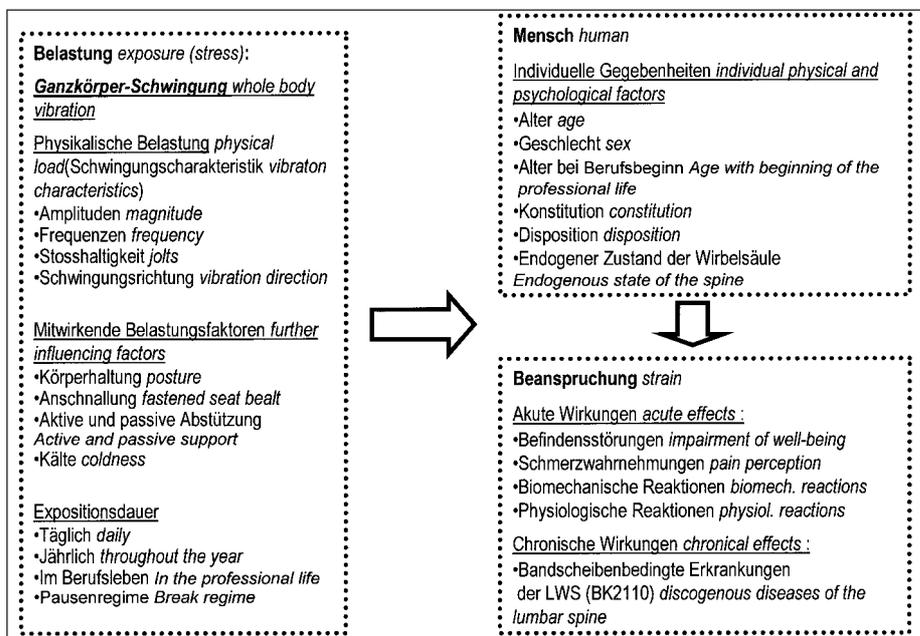


Fig. 2: Load-strain model for mechanical whole body vibrations (acc. to [6])

users hardly ever read the instructions, as studies commissioned by Grammer have shown. Even very important seat functions are commonly ignored or incorrectly used. Considering the work that seat users do, however, this should not come as a surprise. Sitting is not the actual goal in and of itself. Consequently, drivers will tend to only use those seat functions that are indispensable for allowing them to do their jobs (e.g., fore/aft adjustment so they can reach the pedals with their feet).

When beginning to develop a seat, it is therefore important to ask which functions will actually be used by drivers, and especially how they can be designed to permit their use without consulting the manual. Grammer therefore begins each product development project with an in-depth user input study, the findings of which are incorporated into the development processes and then continually monitored by appropriate evaluations. This is what gave rise to the Grammer „Design for Use“ operating concept. The basic principle is that seat functions must be self-explanatory and easy to learn. This is achieved by a hierarchical logic, a placement logic, and a shape logic. In addition, feedback from the system as a whole is just as important as feedback from the individual controls.

User studies have also shown that hard-to-understand but vital functions ought to be automatically controlled. As already mentioned, this principle has been put into practice in the Maximo Evolution.

Active seat climate control

Seat climate plays a major role in determining comfort, because the driver constantly notices it. People continuously generate heat as a result of metabolic processes. On the other hand, we are homoiothermic, or warm-

blooded, organisms and must maintain our core body temperature at fairly exactly 37°C. To accomplish this, excess heat has to be given off. 90% of this heat is removed via the skin through heat radiation, heat conduction, and evaporation. To offer drivers a pleasant seat climate (thus permitting relaxed working), Grammer has developed an active seat climate control system. Consisting of a fan, a storage layer, and a ventilation layer, this system removes moisture and heat from the area between the driver and the seat. Dummy and human physiological measurements were applied to create an active climate module that, in contrast to existing climate systems, even improves the seat climate in passive mode (compared to conventional seats), and in active mode prevents health hazards by circulating air. This system is included in the Maximo Evolution as a standard feature.

Outlook

The goal of efforts to develop vehicle cabins and seats has consistently been to reduce the stresses to which drivers are subjected.

Looking ahead, we see potential for improving matters by more closely harmonizing the seat with the vehicle in which it is used. The user studies cited here should be extended to illuminate the overall vehicle cabin so that the needs of people using it as a workplace can be met better.

Also in order to comply with future regulations for mitigating vibrations, like the 2002/44/EC directive, it is indispensable to closely coordinate the relevant endeavours. This EC directive establishes ceilings for the vibrations that workers may be exposed to. They are defined by the interplay of the vehicle and the seat. A seat with excellent suspension characteristics, such as our Maximo Evolution, can make a substantial contribution in protecting vehicle operators.