

R&D TRACTORS FROM ASPECTS OF ERGONOMY AND DESIGN

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INTRODUCTION

In the development of modern tractors, ergonomics quality is one of crucial criteria for upgrade of new developing products. Basic principal of ergonomic quality in tractor manufacturing can be described in multiple criteria, which the most important are:

- Driver safety
- Easy access to driver seat
- Conformity of driver seat
- Availability of tractor handling
- Visibility
- Tractor handling
- Working ambient of driver

All of these criteria have certain influence on tractor driver, on efficiency of tractor usage and productivity level which is essential from driver safety, his pleasure in working ambient, level of tractor efficiency and comfort. These criteria are issued in various standards, EU directives and legislations with obligatory purpose for every tractor manufacturers or industry. On various examples are given detail analysis of driver seat designs from aspect of design, ergonomic and new approach in tractor development. [1]

CONFORMITY OF TRACTOR SEAT

System for driver seat with static and dynamic characteristics is influenced on all kind conformity and compatibility of driver place in tractor. If we looked on driver seat basically we can conclude that on seat are influenced static and dynamic forces which are transferring from tractor to driver seat. Uncomfortable seat is cause of fatigue, back pain and generally speaking uneasy feeling during driving. Research in this field are showed that there are two scenarios: driver seating place is spot where driver body is in the contact with seat and feeling is soft, and opposite when driver seat is relatively firm; so conclusion is that the driver seat is contact surface where are tractor transferring forces in between seat and tractor driver. Dynamics pressure on contact surface had near sinus value with vibrations values between 1-10 Hz. Under this influential circumstances max values of dynamic pressure, under appearance of resonance, is on the contact surface is 4.5-5 Hz. The stress factor occurred upon driver during vibration is transferred on human body and the shock on organism is recognized as back pain.

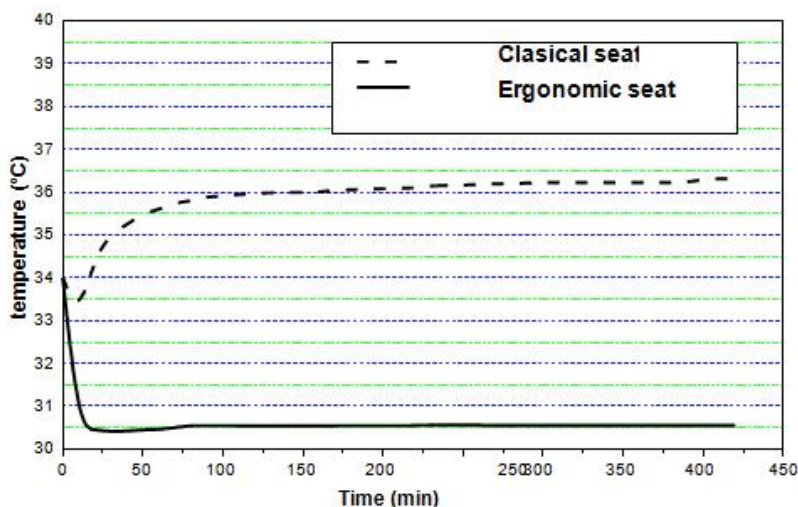
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For long time it was assumed that conformity is vehicle characteristics, with its value is in the range of max conformity to max disconformities. Old definition was "Feeling of easiness and joy during driving" which had only technical character. More scientific approach had next definition "balance of psychic, psycho-physical and psychological condition of men who is in harmony with its environments". This means that conformity is lack of disconformities. However lots of research showed that conformity is close to latest definition as "relationship between psychological and psycho-physical factors which could affect on driver".

Beside driver position, vibration, shape and feeling of seat firmness that could influenced on seat disconformities, also it could be important temperature of seat and its moisture. The class of conformity during seating could be determined by mechanical methods, and methods which include temperature and moisture measuring on contact surface between driver and seat; and additionally on following psycho-physical condition of driver and etc.[2]

Most familiar methods for determining discomfort are based on next standards:

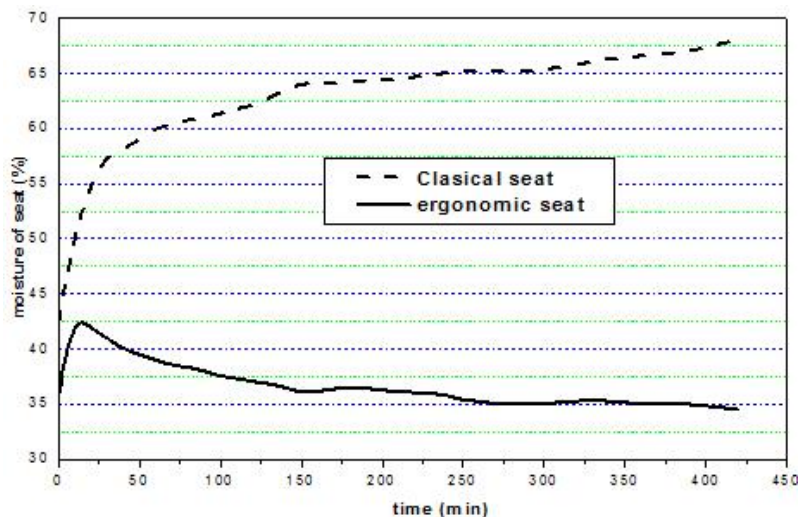
- ISO 2631 and BS 6841 which are defining magnitude of discomfort by value of vibration level,
- ISO 3386/1 method for determine level of pressure on seat by pressing plate ring,
- ISO SD 5982 method with determining mechanical influence on driver seat until the driver head and transferring vibration through all body,
- ISO 4253 which define optimal dimensions based on body column position.



1.a

Results of research are evaluated by developing research on ergonomic aspects and design, and that are new methods for research the ratio of demands based on conformity. As example it could be derived method for some ergonomics researching for testing influence

changes of temperature and moisture human body changes by German manufacturer GRAMMER AG Seating Systems as DLG Test. On the figure 1., are presented influences of temperature and moisture in seat of tractor driver.



1.b

Figure 1: Graph of changes in temperature and moisture of driver body in dependence of length of working time [2]

In the figure 2., is presented classical seat and seat designed by considering new ergonomic characteristic. It has to said that Standards, Legislations and EU Directives that are issued by approval type procedure project both seats.

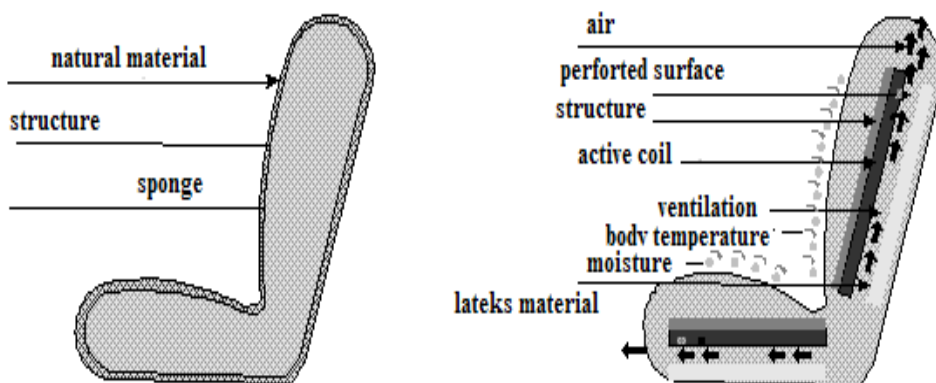


Figure 2: Schematic of classical seat and seat were are included ergonomic characteristics as body temperature and moisture [2]

New approach in designing product from aspect of ergonomics, and by developed new technologies which where used to reduce discomfort. As example is given figure 3 where is presented ``intelligent seat`` with its functions.

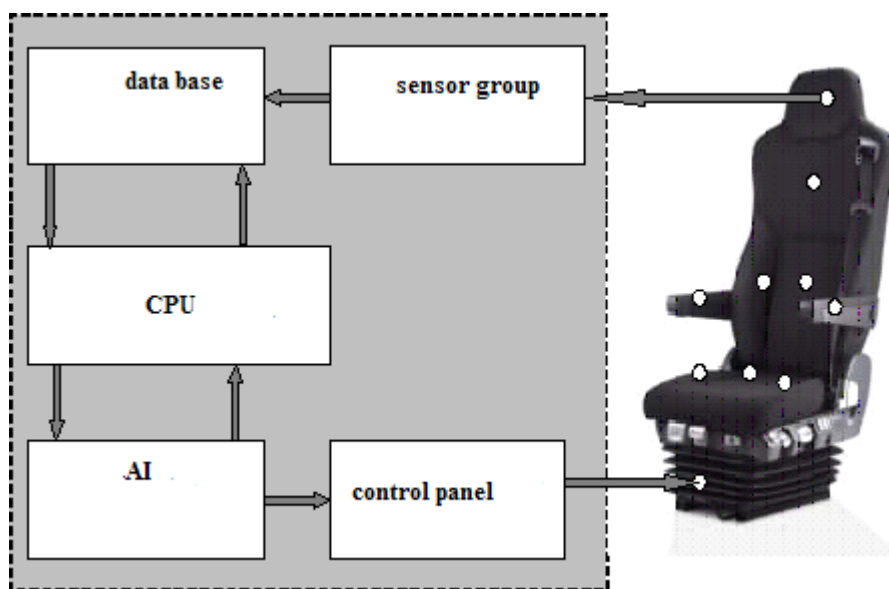


Figure 3: Intelligent seat[2]

Intelligent system is introduced by upgrading comfort of driver seat. Seat is equipped with numerous sensors, and with detection of body position. Sensors data is loaded in data base which are transferred in CPU for data processing. When the data is processed they are transferred in artificial intelligence for further data processing. Then, data which were processed are sent in control panel followed by most appropriate position of seat for driver.

AN EXAMPLE OF DEVELOPING NEW METHODS OF TESTING WHICH INCLUDE COMPLEX APPROACH IN DESINGING NEW TRACTORS

Leading tractor manufactures, as John Deere has developing methods which accomplish ergonomic conditions of seat. Following that conditions manufacturer has developed method for analysis and testing conformity of tractor cabin. Method is based on software model named ERGONAUT, which can simulate multiple driver virtual environments by combining data from driver real and virtual environment. For purposes of testing and research it is possible to:

- Adjusting position of virtual tractor driver by Virtual-Anthropos which is designed for this method and which has unlimited possibilities of adjusting the position of driver body position.
- following real driver in simulation (virtual) cabin of tractor by simulator of tractor drivability

- following virtual driver in virtual tractor cabin
- following real driver in real tractor cabin[2]

This kind in approach of analysis and testing allowed detecting remarks of ergonomics in early phase designing of tractor cabin. The tractor design in this kind modeling has increasing impact of designing in all; for example designing Studios are not modeling one part of chassis but it has been stilled vehicle chassis as whole tractor. Designing of tractor by new principles include aspect of ergonomic and new design, thus has specific approach and must answer to different specific demands. By that it is considered whole shape of tractor must follow harmony accomplish in design, by following technical demands in basic tractor usage. Designers approach must implement ergonomic demands by improving imaginary tractor line and not to disturb functionality and safety demands which are standard for tractor as a product. Such importance in following ergonomics demands can be seen in LANDINT'S studies which are obvious in Figure 5.



Figure 4: First Tractor



Figure 5: New Design Tractor Generations[3]



Figure 6: Studio's concept of tractor design in new direction of ergonomics concepts with aerodynamic shape of vehicle [3]

In field of agriculture machines and mostly tractors new approach in design and ergonomics, is mostly present and it could be saw in few latest years. Interesting futuristic design, it can be Landini design, which studio is crucial in car design, with aerodynamic shape chassis.

DEVELOPING LEVEL OF TRACTORS IN WORLD AND IN OUR COUNTRY FROM ASPECTS IN IMPLEMENTATION OF NEW PRICIPLES IN ERGONOMICS AND DESIGN

Almost all tractor manufacturers in word had accepted principles of ergonomics approach in tractor production. As right illustration could be used example in Table 1. For this purpose are given ergonomics demands as main characteristics in tractor industry.

Table 1. Over look of main ergonomic characteristics [5]

Ergonomics characteristics Level of implementation of ergonomics demands in small and medium tractors: ●- full accomplished ◐- semi accomplished ○- accomplished in small amount ⊗- not accomplished	Manufacturer														
	John Deere	LANDINI	SAME	New Holland	Mercedes-Benz	Massey Ferguson	LOMBORGHINI	Renault	CASE	HORSH	DEUTZ	URSUS	Zetor	Belarus	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Safety of tractors driver															
- protected structure with one frame	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- protected structure with two frames	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- cabin	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	
Easy access to drivers seat															
- seat between back seats	◐	◐	●	●	◐	●	●	●	●	●	●	●	●	●	
- seat between shafts	○	○	⊗	○	○	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
- ergonomics rise	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- ergonomics handlers	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- size of entry doors-optimal	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Comfort of driver seat															
- seat of depreciation;	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- moving backward -forward	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- adjusting of stop lug	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- anti allergic and anti static material	●	●	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	
- automatic adjusting of seat micro air condition	○	○	⊗	○	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	

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	John Deere	LANDINI	SAME	New Holland	Mercedes-Benz	Massey Ferguson	LOMBORGHINI	Renault	CASE	HORSH	DEUTZ	URSUS	Zetor	Belarus	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Tractor drivability															
- mechanical steering	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	○	○	○	
- electro- hydraulic steering	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- clearance	●	●	●	●	●	●	●	◐	●	◐	●	◐	◐	◐	
Visibility															
- glass surface	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- nose down	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- working space	●	●	●	●	●	◐	●	●	●	◐	◐	◐	◐	◐	
- instruments and commands	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- exhaust muffler position	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- adjusting of steering	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- night lights	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- cabin lights	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
- visibility of instrument table	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
Tractor handling															
- automatic blockade of front differential	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- automatic blockade of gear differential	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- semi Powershift	●	●	○	●	●	○	○	○	○	○	○	⊗	⊗	⊗	
- fully Power shift	○	○	○	○	○	○	⊗	⊗	⊗	○	⊗	⊗	⊗	⊗	
- semiautomatic gear	◐	◐	◐	◐	◐	○	○	○	○	○	○	○	○	○	
- automatically continual gear	◐	◐	○	◐	◐	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	
Working ambient															
- cabin noise optimal	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	○	○	○	
- natural condition of air	●	●	●	●	●	●	●	●	●	●	●	◐	◐	◐	
- air condition	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	○	○	○	
- radio	◐	◐	○	◐	◐	○	○	○	○	○	○	⊗	⊗	⊗	

Conditions in our industry are transferring to our domestic tractor manufactures and developing tempo of new products. In implementations of new approach in developing it can be noticed continual obsolete and decreasing in implementation of new ergonomic issues in products.

Table 2. Implementation of ergonomic demands in domestic tractors [5]

Ergonomic Characteristic	Manufacturers	
	IMR	IMT
Level of implementation of ergonomics demands in small and medium tractors: ●- full accomplished ◐- semi accomplished ○- accomplished in small amount ⊗- not accomplished		
1	2	3
Safety of tractors driver		
- protected structure with one frame	◐	◐
- protected structure with two frames	◐	◐
- cabin	◐	◐
Easy access to drivers seat		
- seat between back seats	●	●
- seat between shafts in the middle	⊗	⊗
- ergonomics rise	●	●
- ergonomics handlers	◐	◐
- size of entry doors-optimal	●	○
Comfort of driver seat		
- seat of depreciation	◐	◐
- moving backward -forward	●	●
- adjusting of stop lug	○	○
- anti allergic and anti static material	⊗	⊗
- automatic adjusting of seat micro air condition		
Tractor drivability	⊗	⊗
- mechanical steering	⊗	⊗
- electro- hydraulic steering	●	●
- clearance	●	●
Visibility	●	●
- glass surface	●	●
- nose down	◐	◐
- working space	●	⊗

Ergonomic Characteristic Level of implementation of ergonomics demands in small and medium tractors: ●- full accomplished ◐- semi accomplished ○- accomplished in small amount - ⊗- not accomplished	Manufacturers	
	IMR	IMT
1	2	3
- instruments and commands	●	⊗
- exhaust muffler position	●	●
- adjusting of steering	◐	◐
- night lights	◐	◐
- cabin lights	●	●
- visibility of instrument table	◐	◐
Tractor handling		
- automatic blockade of front differential	⊗	⊗
- automatic blockade of gear differential	⊗	⊗
- semi Powershift	⊗	⊗
- fully Power shift	⊗	⊗
- semiautomatic gear	⊗	⊗
- automatically continual gear	⊗	⊗
Working ambient		
- cabin noise optimal	⊗	⊗
- natural condition of flow air	●	●
- air condition	◐	◐

CONCLUSION

World manufacturers in tractor industry are intensively working in upgrading its products by implementing ergonomic designs that was result of intensively meeting standards in tractor industry. Beside various safety category and ergonomic criteria, they also had to meet new design in modeling tractors chassis. However, having in mind, they were used experiences from car industry also. In our industry, we have very large space in upgrading tractor ergonomics and chassis design and keep our knowledge with latest in research and developing in tractor manufacturing.

AKNOGLOWMENTS

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