

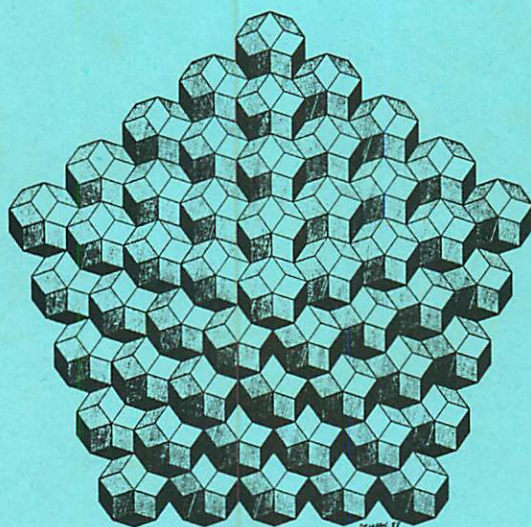
*Symposium*

# Symmetry of STRUCTURE

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Abstracts

I.



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ASYMMETRY OF MOVEMENT REACTIONS UNDER CONDITIONS OF VIBRATION  
AND IMPULSIVE FORCE INFLUENCES OF MAN-OPERATOR

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Industrial activity of man as a link of control of the most of Man-Machine Systems is constantly accompanied by the vibration, noise, impulsive forces and sign inversionable rectilinear accelerations. In practice, the movement reactions realization accuracy under such conditions decreases significantly. The urgency of the carried out researches is conditioned by the necessity of the rise of man-operator working capacity in many kinds of Man-Machine Systems.

In the research process the sign inversionable linear accelerations (the maximum amplitude of the deviation in frontal direction with the acceleration effect of about 0,1 g was 25 cm.), vibration ( $f=23$  Hz,  $n=0,3$  g) and the combination of the vibration and impulsive force (2,5 g during 20 msec.) were created.

15 healthy volunteers from 25 to 37 years old without special operator training were investigated. The program of force loads included the realization of prescribed muscular efforts left and right legs, left and right hands in turn under the consistent influence of the conditions we have already mentioned.

The value of the muscular effort separately for left and right leg and also for left and right hand in each of the problems was averaged not less than 30 realizations. Data array of  $15 \cdot 10^3$  realization parameters of muscular efforts of upper and lower extremities was analyzed.

As a result of our investigations was found a statistically reliable influence of above-mentioned factors on the examined movement reactions. The statistic analysis showed that linear or impulsive stimulation as well as their combination with vibration led to the intensification of the background values of muscular efforts of the operator. However the phenomenology of this intensification was different. At linear vestibular stimulation appeared an asymmetry between right and left lower extremities muscular efforts:

the homolateral leg efforts were reliably more intensive than those of contralateral. This phenomenon was observed in 11 cases from 15. Other cases showed no statistically reliable asymmetry. The degree of asymmetry was calculated by means of a special coefficient introduction:

$$AK = \frac{M_R - M_L}{M_R + M_L} \cdot 100\%$$

- $A$  - asymmetry coefficient of muscular efforts;  
 $M_R$  - mean value of right leg (or hand) muscular efforts;  
 $M_L$  - mean value of left leg (or hand) muscular efforts.

Individual and averaged values of  $AK$  for lower extremities are given in the Table 1.

Asymmetry coefficient values								Table 1
volont. No.	1	2	3	4	5	6	7	8
AK	2,13	2,34	-3,19	22,76	-1,69	1,35	3,63	0,33
AK <sub>L</sub>	6,82	9,54	4,85	1,16	3,64	1,82	16,3	9,76
AK <sub>L+V</sub>	7,91	2,0	-1,02	1,27	-1,021	7,86	5,89	8,16
volont. No.	9	10	11	12	13	14	15	Mean
AK	-0,29	-1,76	-3,16	2,42	-2,88	-1,65	0,87	-0,53
AK <sub>L</sub>	2,19	8,08	-1,11	6,51	5,79	12,19	4,59	6,06
AK <sub>L+V</sub>	6,02	7,22	5,58	8,36	11,21	6,39	7,41	5,55

AK - asymmetry coefficient control data, %;

AK<sub>L</sub> - asymmetry coefficient under conditions of rectilinear stimulation, %;

AK<sub>L+V</sub> - item, in combination with the superimposed vibration, %.

A statistically reliable increasing of muscular efforts of all volunteers was observed at impulsive stimulation. Simultaneously, a significant asymmetry of movement reactions has been found in all cases too. Still according to reaction time of each volunteer the direction of instantaneous acceleration, acting on him in the point of command realization, was different. That is why the sign

of AK, reflecting the direction of asymmetry between left and right extremities efforts, was also different.

As compared with the isolated rectilinear and impulsive stimulation a simultaneous vibration stimulation didn't provoke any significant difference in muscular efforts values. It was noted that the moderate decreasing of asymmetry coefficient value appeared in some cases of vibration superposition, particularly in the rectilinear stimulation experiments. (Table 1). The muscular efforts realization accuracy for upper extremities, just as it was expected, turned out to be considerably higher than for lower ones (average - 5,2 times higher, and for 6 volunteers from 15 - more than 10 times higher).

In conclusion it should be noted that stimulations with the frontal directed vector provoke a non-symmetric movement reactions alternation for the majority of the healthy volunteers: muscular efforts of homolateral extremity are usually more intensive than those of contralateral. Such biophenomenon must be taken into consideration when designing force elements control in Man-Machine Systems to neutralize its negative influences on accuracy and quality of man-operator's work.

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