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DSM METHOD – DESIGN STRUCTURE MATRIX

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ABSTRACT
In this paper is presented the design structure matrix method for project management relations. This method differs from traditional methods of project management because it focuses on the presentation of information flow, and the effects that these flows have on the flow performance of the overall project. This method is used for solving problem in wind tunnel "Armfield C15-10", where is presented the experiment of fluid flow over the airprofiles. After selecting the parameters and determining their mutual dependence, and using software PSM 32 agrees DSM structural parameters, which can then rearrange in lower triangular form in order to minimize feedback within the design process. The final DSM matrix gives desired results and based on this results we optimize used parameters.
Keywords: *DSM Method, Design Structure Matrix, PSM 32, wind tunnel, fluid flow over the airprofiles*

1. INTRODUCTION
In the DSM methodology, the relationship between the elements of a system can be represented with respect to the execution flow. There are three basic types of connections between the elements of the system: parallel (or concurrent), sequential (or dependent) and steam (or dependent).
For dependent tasks, it is difficult to determine their order of execution, often it will be within a few iterative cycles. A set of interdependent tasks should be performed simultaneously. Iterativnost itself is explained by the simultaneous performance of the set of dependent tasks, information whose values are not yet known, have to be assumed. Later, these assumptions are corrected in a few cycles or iterations.
The matrix contains a list of all the related activities and related patterns of information exchange - that is, what parts (parameters) of information are required to run certain activities and where go the information produced by the given activity (which other tasks within the matrix using the output information). With the help of a matrix connectivity information between the parts of the product can be displayed, among the teams that are working on the project, including activities and the parameters in this project. Table 3 shows just such a division of DSM matrix. In addition, the purpose of each type is given, and the methods to be applied to such a matrix[1,3].

2. PARTITIONING AND REARRANGING DSM MATRIX
Partitioning is the process of manipulating rows and columns of DSM (ie, redistribution thereof) so that the new arrangement of DSM does not contain any feedback loops (feedback or return information), thus DSM is transformed into the **lower triangular form**[2].
It is almost impossible that the simple manipulation of rows and columns can result in the shape of a triangle in complex mechanical tasks.
In DSM partitioning, several approaches are used, with similar processing of information. All partitioning algorithms can be written in several steps as follows:

- **Identify the elements of the system** (or tasks - or make) without affecting other elements in the matrix, and watching the empty row in the DSM.
- **Identify the elements of the system** (or tasks) **that do not supply the other elements** in the matrix of information, and so to find empty columns in the DSM, and put them on the bottom of the DSM.
- If, after **steps 1 and 2**, **there are no remaining elements** in the DSM , it is necessary for matrix to be fully partitioned, if not, it means that the remaining elements contain backup information (at least one).

3. EXPERIMENT ANALYSIS OF PARAMETERS IN THE WIND TUNNEL „ARMFIELD C15-10“

The problem that is used in this example is tied for wind tunnel "Armfield C15-10", which is used to test fluid flow through the airprofiles. Also, using these results we get feedback on the resistance forces in the models, the boundary layers, as well as the buoyancy force. The software used to create the matrix, determine dependencies and partitioning is PSM32.

Selected parameters are associated with mathematical relations, and they are important for this experiment. The parameters that were selected for testing are marked with the letter *p* and they are as follows:

p1 – User requirements, p2 – Work section, p3 – Fan power

p4 – Fluid flow

$$R_e = \frac{v \cdot l}{\upsilon} = \frac{\rho \cdot v \cdot l}{\mu} \qquad ...(1)$$

p5 – The law of conservation of mass

$$\frac{\partial \rho}{\partial t} + div\left(\rho \vec{v}\right) = 0 \qquad ...(2)$$

p6 – Flow regime, p7 – Calibration of the measuring box, p8 – Airprofile models, p9 – Type of pressure gauge, p10 – Measurement of dynamic pressure, p11 – Setting the wind tunnel balance to measure lift and drag , p12 – Dimensions of rakes for tracking vortex flow, p13 – Fluid velocity in the working section

$$v = \sqrt{\frac{2\rho_m \cdot g \cdot \Delta h}{\rho_Z}} \qquad ...(3)$$

p14 – Aerodynamic drag force

$$F_D = C_D \cdot \rho \cdot \frac{v^2}{2} \cdot A$$

$$F_D = C_{D0} \cdot \rho \cdot \frac{v^2}{2} \cdot A + (kC_L^2) \cdot \rho \cdot \frac{v^2}{2} \cdot A \qquad ...(4)$$

p15 – Aerodynamic lift force

$$C_L = \frac{F_L}{\rho \cdot \frac{v^2}{2} \cdot A} \qquad ...(5)$$

p16 – Resistance model (body), p17 – The emergence of the boundary layer, p18 – Type and number of sensors, p19 – External conditions, p20 - Visualization of measurement data.

Table 1 shows the dependence of the parameters matrix of structure, reduced to a list with three columns. The first column contains a parameter marker and number. The second column of the matrix contains the addresses of the parameters that shows witch other parameter depends on it, and the third column contains the record of semantic dependencies: $P_j = f$ (p_i, i I (1....n}, $i\ ^{1}\ j$), where n is the number of parameters defined in a parameter base. In total, twenty parameters are included in the matrix representation of the experiment. Interdependent traits of the parameters are displayed and matrix shown in Table 2 is formed.

Table 1. The relations between wind tunnel parameters

Ordinal number	Depends on:	Record of functional dependencies
p1	p2, p8	p1=*f*(p2) p3=f(p8)
p2	p12, p19	p2=*f*(p12,p19)
p3		
p4	p3, p13	p4=*f*(p3,p13)
p5		
p6	p3, p4, p8, p12	p6=*f*(p3,p4,p8,p12)
p7		
p8	p1	p8=*f*(p1)
p9	p13, p10	p9=*f*(p13,p10)
p10	p19	p10=*f*(p19)
p11	p14, p15	p11=*f*(p14,p15)
p12	p2	p12=*f*(p2)
p13	p1, p3, p4	p13=*f*(p1,p3,p4)
p14	p4, p8, p11, p12	p14=*f*(p4,p8,p11,p12)
p15	p4, p13, p8	p15=*f*(p4,p13,p8)
p16	p8	p16=*f*(p8)
p17	p6, p8	p17=*f*(p6,p8)
p18	p4, p13, p14, p15	p18=*f*(p4,p13,p14,p15)
p19	p1	p19=*f*(p1)
p20		

Table 2. Formed matrix of wind tunnel parameters

	1!	2!	3!	4!	5!	6!	7!	8!	9!	10!	11!	12!	13!	14!	15!	16!	17!	18!	19!	20!
1! User requirements								0					0						0	
2! Work section	0											0								
3! Fan power				0		0							0							
4! Fluid flow						0							0	0	0			0		
5! The law of conservation of mass																				
6! Flow regime																	0			
7! Calibration of the measuring box																				
8! Airprofile models	0					0								0	0	0	0			
9! Type of pressure gauge																				
10! Measurement of dynamic pressure									0											
11! Setting the wind tunnel balance to measure lift and drag														0						
12! Dimensions of rakes for tracking vortex flow		0				0								0						
13! Fluid velocity in the working section				0					0						0			0		
14! Aerodynamic drag force											0							0		
15! Aerodynamic lift force											0							0		
16! Resistance model (body)																				
17! The emergence of the boundary layer																				
18! Type and number of sensors																				
19! External conditions		0								0										
20! Visualization of measurement data																				

In Table 3 are the results obtained after partitioning. It was created a group of interdependent tasks (pictured is pink). It is shown which are those parameters. The resulting group of parameters should be first in the calculation, because whole calculation depends on it.

Table 3. A partitioned matrix of wind tunnel parameters

	5!	7!	9!	16!	17!	18!	20!	6!	10!	11!	14!	15!	4!	13!	1!	2!	8!	12!	19!	3!
5! The law of conservation of mass																				
7! Calibration of the measuring box																				
9! Type of pressure gauge																				
16! Resistance model (body)																				
17! The emergence of the boundary layer																				
18! Type and number of sensors																				
20! Visualization of measurement data																				
6! Flow regime					0															
10! Measurement of dynamic pressure			0																	
11! Setting the wind tunnel balance to measure lift and drag											0									
14! Aerodynamic drag force						0				0										
15! Aerodynamic lift force						0				0										
4! Fluid flow						0		0			0	0		0						
13! Fluid velocity in the working section			0			0						0	0							
1! User requirements														0			0		0	
2! Work section															0			0		
8! Airprofile models				0	0			0			0	0			0					
12! Dimensions of rakes for tracking vortex flow								0			0					0				
19! External conditions									0							0				
3! Fan power								0					0	0						

5. CONCLUSION

DSM method proved to be a useful method for the analysis of the process of conducting experiments in the wind tunnel. This method explains how to determine the optimal allocation of parameters with the identification of iterative parts of testing process on airfoil models. This type of experiment takes into consideration the large number of equations and relations of fluid mechanics, and no other, traditional method of dependency relations, could not be, in such way, successful to connect their common parameters.

The method is applicable to a specific project because the need for analysis of the parameters, that appear in the equations, is necessary.

The method seems to be useful for the construction of the DSM matrix and make insight into it, and even without further analysis, the creation of DSM model experiment gives the improved ability to read and display the complexity of the experiment[4,5]. With the help of DSM we were able to easily visualize the process of preparation of the tunnel, as well as the flow through the profiles, using only a single image.

Maybe saving time and speed of performing matrix of relations is not great in this case, because we did not take into consideration the specific numerical values of the experiment, but an experiment that could be carried out further, which could have up to a few thousand parameters, this method is irreplaceable.

6. REFERENCES

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