

**Homework 2**  
**Task-based Design Structure Matrix**

**Out:** September 16, 2003  
**Due:** September 25, 2003, 3pm

**Learning objectives**

In this homework you will apply the Design Structure Matrix (DSM) method to a hypothetical design project. You will first learn how to translate the project graph from the previous assignment to a DSM representation. Next you will add design iterations to the project and analyze their effect on the previous task sequence. You will consider partitioning and tearing the DSM to improve speed. Finally you will estimate the effect of these changes on the critical path.

**Resources**

- [1] Steven D. Eppinger, Daniel E. Whitney, Robert P. Smith, and David A. Gebala. "A Model-Based Method for Organizing Tasks in Product Development", Research in Engineering Design. vol. 6, no. 1, pp. 1-13, 1994.
- [2] Steven D. Eppinger, Murthy V. Nukala, and Daniel E. Whitney. "Generalized Models of Design Iteration Using Signal Flow Graphs", Research in Engineering Design. vol. 9, no. 2, pp. 112-123, 1997.
- [3] DSM website: <http://www.dsmweb.org/>
- [4] DSM software: <http://www.problematics.com> (PSM32)
- [5] Excel DSM Macro – ESD.36 handout section

*This homework can be solved without the assistance of software. However, this might be a good opportunity to familiarize yourself with DSM tools that are applicable to larger scale projects.*

**Situation**

You are still Project Manager for the UAV development project described in HW1. You have successfully completed the *requirements definition* (b,10) step, effectively the first task in the process. You realize that your previous PERT/CPM plan was useful, but did not capture a number of important design iterations.

**Assignment**

1. Construct a Design Structure Matrix (DSM), with dimensions 13x13, including all UAV tasks *b* through *n* (all tasks except “start” and “finish”). This DSM should capture the same task dependencies as the project graph from HW1.2. (see Appendix I for an initial DSM template). Comment briefly on the structure of the completed matrix.
2. During the requirements review (*b*) you discussed the upcoming design project with your functional team managers and your suppliers. You realize that your previous PERT/CPM plan is useful, but does not capture some important task interdependencies: After a first

pass through *fuselage, wing and empennage design* (*f,g,i*), the *vehicle layout* (*d*) has to be refined. While *avionics design* (*h*) may be started without being constrained by initial *fuselage design* (*f*), it must be assured that the avionics suite will actually fit into the fuselage, requiring iteration between (*h*) and (*f*). The ground testing (*m*) is conducted primarily for two purposes. First, a mechanical ground test will reveal the wings modes of vibration. If the wings turn out to be too flexible, a stiffening of the wing structure (*g*) has to be considered. Secondly, electronically enabled functions provided by the avionics suite (*h*) such as actuation of the flight control surfaces will be verified. Some adjustments to the avionics suite (*h*) are usually required to fine tune the system before first flight as a result of these tests. Rather than test flight worthiness, the main objective of flight testing (*n*) is to verify that both the engine and payload perform according to their respective specifications (*c,e*) in a realistic flight regime. Some non-compliances discovered during flight test must result in revisions of *engine specification* (*c*) and *GFE payload interfaces* (*e*), respectively, with subsequent delivery of revised engines and payloads. Modify the DSM to reflect these interactions and briefly comment on the changes.

3. Convert the DSM to a binary matrix {using 1,0} and multiply the matrix with itself a number of times. Describe the result of each sequential multiplication and draw conclusions for your UAV project.
4. Apply the partitioning algorithm we discussed in class (Lecture 3) by swapping columns and rows of the DSM in a deliberate fashion. Attempt to improve the task sequence of the project such that feedback loops are minimized and appropriate meta-tasks emerge. Discuss briefly how this might change your original project plan in HW1.

### Challenge Question

5. Recompute a new finish date for the project (in 2008) with your new, reordered DSM by assuming that: (i) each iteration loop is exercised exactly once and that (ii) individual task durations are cut in half each time the task is executed.

➤ **Turn in your answers with the rubric attached as the cover sheet.**

dWo, 9/16/03

b												
	c											
		d										
			e									
				f								
					g							
						h						
							i					
								j				
									k			
										l		
											m	
												n