Basics of Design Structure Matrices

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Contents

The design structure matrix DSM

	a	b	c	d	e
a	-		x		x
b		-		x	
c	x		-		x
d		x		-	
e	x		x		-

	q	r	s	t	u
q	-	x			
r		-			
s		x	-		x
t				-	x
u	x		x		-

- A DSM is an $N \times N$ matrix with identical row and column labels.
- A mark (x) at position (i, j) indicates: element i depends on element j.
- Directed and undirected DSMs may be distinguished.
- Different types and strengths of dependencies may be indicated.

Clustering a DSM

	a	*b*	*c*	*d*	*e*
a	-		x		x
b		-		x	
c	x		-		x
d		x		-	
e	x		x		-

	d	*b*	*e*	*a*	*c*
d	-	x			
b	x	-			
e			-	x	x
a			x	-	x
c			x	x	-

By permuting the rows and columns of the DSM, using a clustering algorithm, the underlying structure can be revealed.

Building a DSM

Questions:

- Which row and column elements should be used, e.g. components, activities, subsystems, people, etc.
- What type of dependencies should be modeled, e.g. spatial, energy, information, etc.

Methods to build a DSM:

- *Directly* from:
  - technical drawings,
  - technical documentation, and
  - expert interviews.
- *Indirectly* from a design matrix DM by:
  1. documents that specify the mapping, of e.g. functions to components, in a DM, and
  2. use the DM, to calculate the function DSM and the component DSM.

The design matrix DM

	k	l	m	n
a		x		x
b	x		x	
c		x	x	

- A design matrix is a $M \times N$ matrix that maps M elements of one domain to N elements of another domain, e.g. rows represent components and columns represent functions.
- Function l is fulfilled by components a and c.

DM to DSM conversion

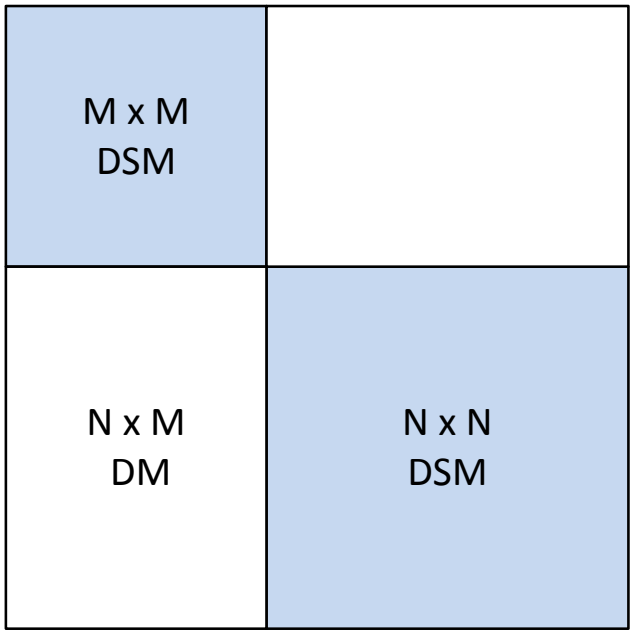
	k	l	m	n
a		x		x
b	x		x	
c		x	x	

	k	l	m	n
k	-		x	
l		-	x	x
m	x	x	-	
n		x		-

	a	b	c
a	-		x
b		-	x
c	x	x	-

- If two functions share a common component, then they are dependent, e.g. l and n share component a.
- If two components contribute to the same function, then they are dependent, e.g. a and c both contribute to l.

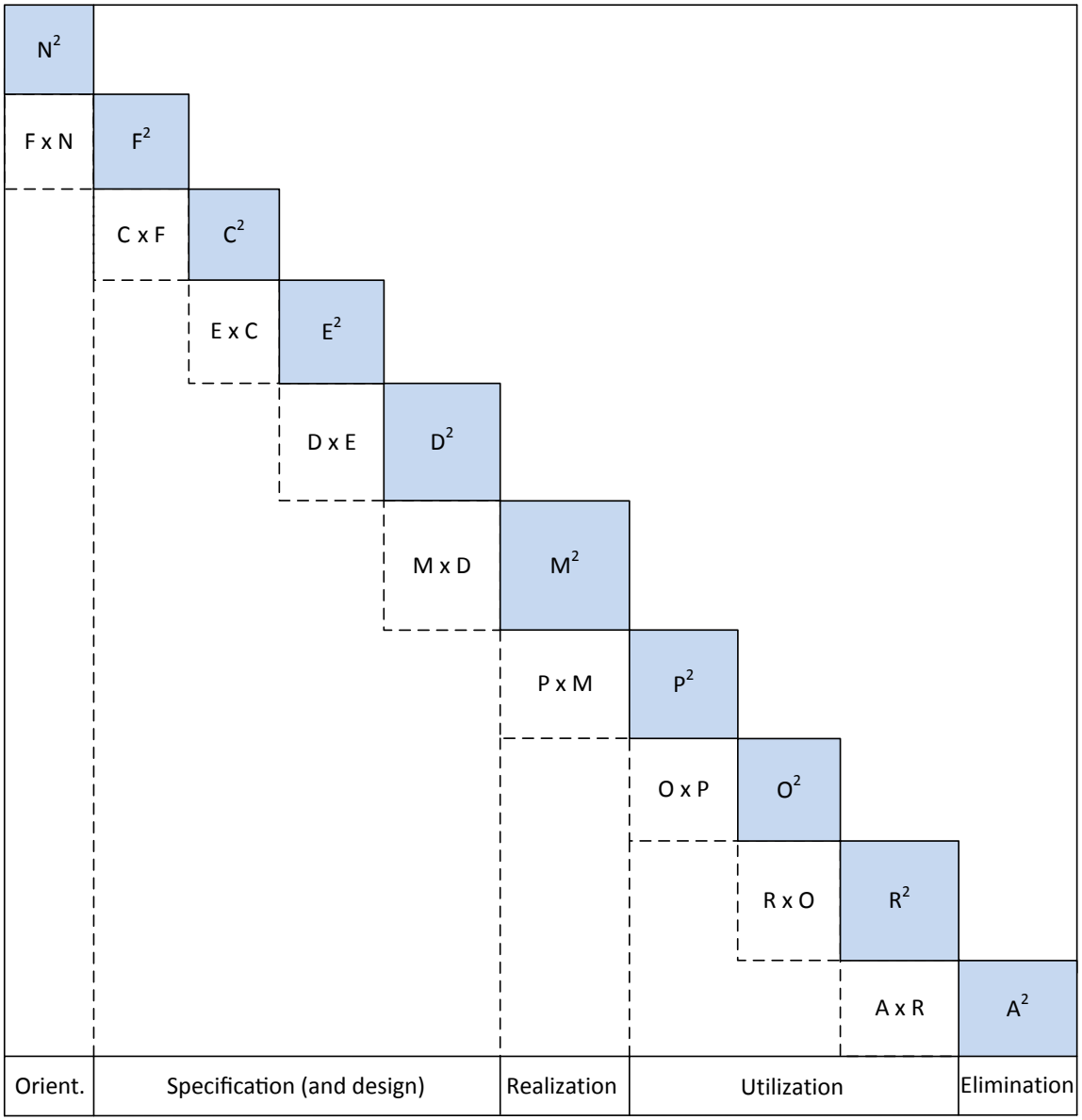
The multi-domain matrix MDM



	k	*l*	*m*	*n*	*a*	*b*	*c*
k	-		x				
l		-	x	x			
m	x	x	-				
n		x		-			
a		x		x	-		x
b	x		x			-	x
c		x	x		x	x	-

- Multiple DSMs and DMs are combined in one matrix.
- Matrices on the diagonal are single domain DSMs, e.g. function DSMs; component DSMs.
- Off-diagonal matrices are DMs mapping the dependencies between two domains, e.g. function-component DM.

The life cycle matrix LCM



An LCM is an MDM:

$$X == Y \quad : \text{DSM(X,X)},$$
$$X /= Y \quad : \text{DM(X,Y)},$$

where X, Y:

- N - Needs,
- F - Functional,
- C - Conceptual,
- E - Embodiment,
- D - Detailed,
- M - Manufacturing,
- P - Physical,
- O - Operational,
- R - Revision,
- A - Annihilation.