

cMRT Conflict Models

Reverse-Engineering the original
Horrey & Wickens (2003) Conflict Matrix

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8	0.6	0.6	0.4	0.7	0.5	0.4	0.2
V _a			0.8	0.4	0.6	0.5	0.7	0.2	0.4
A _s				0.8	0.4 [*]	0.7	0.5	0.4	0.2
A _v					0.8	0.5	0.7	0.2	0.4
C _s						0.8	0.6	0.6	0.4
C _v							0.8	0.4	0.6
R _s								0.8	0.6
R _v									1.0

Wickens/Horrey Conflict Model for In-Vehicle Technology Domain

Conflict Specification Heuristic:

0.0 = no conflict; full resource sharing

1.0 = impossible to share resource concurrently

Add 0.2 for each common dimension in MRT cube
“Tweak” according to domain knowledge/experience

Constructing the Conflict Model

Step-by-Step Procedure

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8							
V _a			0.8						
A _s				0.8					
A _v					0.8				
C _s						0.8			
C _v							0.8		
R _s								0.8	
R _v									1.0

Apply intra-resource conflict parameters along the diagonal

0.8 acknowledges possibility of some sharing when great effort is applied

R_v-R_v = 1.0 since two tasks cannot share a vocal response channel simultaneously

Conflict Model

Object/Symbol

Spatial

	V_f	V_a	A_s	A_v	C_s	C_v	R_s	R_v
V_f	0.8							
V_a		0.8						
A_s			0.8					
A_v				0.8				
C_s					0.8			
C_v						0.8		
R_s							0.8	
R_v								1.0

Identify structural similarity for each inter-resource conflict pairing (i.e., shared dimensions of the MRT cube)

Modality

Code

Stage

Identify structural similarity for each inter-resource conflict pair (i.e., shared dimensions of the MRT cube)

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8	0.6	0.6	0.4			0.4	0.2
V _a			0.8	0.4	0.6			0.2	0.4
A _s				0.8	0.6			0.4	0.2
A _v					0.8			0.2	0.4
C _s						0.8		0.4	0.2
C _v							0.8	0.2	0.4
R _s								0.8	0.2
R _v									1.0

Translate MRT
dimensional overlap
for Perceptual and
Response stages into
conflict values

0.2 added per shared
dimension

0.2 added as “Cost of
Concurrency”

Modality Code Stage

Assigning a Conflict Score for Cognitive Stage Resources

“...since cognitive resources do not involve the A-V distinction, their conflict with perceptual resources (that do involve this distinction) is defined as an average value between sharing and separate modality resources. (Hence, the odd numbers within the cognitive cells.)”

Wickens (2002; p. 170)

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8	0.6	0.6	0.4			0.4	0.2
V _a		0.6	0.8	0.4	0.6			0.2	0.4
A _s		0.6	0.4	0.8	0.6			0.4	0.2
A _v		0.4	0.6	0.4	0.8			0.2	0.4
C _s						0.8		0.4	0.2
C _v							0.8	0.2	0.4
R _s								0.8	0.2
R _v									1.0

Reflect Perceptual Stage scores into “negative” side of diagonal to aid in the computation of Cognitive stage conflict

Modality Code Stage

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8	0.6	0.6	0.4	0.7	0.5	0.4	0.2
V _a		0.6	0.8	0.4	0.6	0.5	0.7	0.2	0.4
A _s		0.6	0.4	0.8	0.6	0.7	0.5	0.4	0.2
A _v		0.4	0.6	0.6	0.8	0.5	0.7	0.2	0.4
C _s			0.7		0.5	0.8	0.6	0.4	0.2
C _v							0.8	0.2	0.4
R _s								0.8	0.2
R _v									1.0

Compute Cognitive Stage Conflicts

Cognitive-Spatial example:

$$V_f-C_s = (V_f-V_f + V_f-A_s)/2 = (0.8+0.6)/2 = 0.7$$

Cognitive-Verbal example:

$$V_f-C_v = (V_f-V_a + V_f-A_v)/2 = (0.6+0.4)/2 = 0.5$$

Modality Code Stage

Conflict Model

		V _f	V _a	A _s	A _v	C _s	C _v	R _s	R _v
V _f		0.8	0.6	0.6	0.4	0.7	0.5	0.4	0.2
V _a		0.6	0.8	0.4	0.6	0.5	0.7	0.2	0.4
A _s		0.6	0.4	0.8	0.6*	0.7	0.5	0.4	0.2
A _v		0.4	0.6	0.6	0.8	0.5	0.7	0.2	0.4
C _s			0.7		0.5	0.8	0.6	0.4	0.2
C _v							0.8	0.2	0.4
R _s								0.8	0.2
R _v									1.0

Modality Code Stage

Horrey & Wickens (2003) liberally “tweaked” the Cognitive-Response conflict levels to reflect the cognitive costs of response selection in the in-vehicle technology domain.

Conflict Model

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V_f		0.8	0.6	0.6	0.4	0.7	0.5	0.4	0.2
V_a			0.8	0.4	0.6	0.5	0.7	0.2	0.4
A_s				0.8	0.4 [*]	0.7	0.5	0.4	0.2
A_v					0.8	0.5	0.7	0.2	0.4
C_s						0.8	0.6	0.6	0.4
C_v							0.8	0.4	0.6
R_s								0.8	0.6
R_v									1.0

Wickens/Horrey Conflict Model
for
In-Vehicle Technology Domain

Calculation of Horrey & Wickens (2003)

cMRT Prediction Validation Exercise using Revised Conflict Model

Condition	Observed	Demand	Scaled Conflict	Prediction 1 (D + Scaled C)		Normalized Demand	Prediction 2 (norm D + Scaled C)
City-HUD	0.61	1.13	0.87	2.00		0.753	1.62
City-HDD	0.92	1.25	0.87	2.15		0.833	1.70
City-Audio	0.05	1.50	0.33	1.83		1.000	1.33
Straight-HUD	0.44	0.88	0.87	1.75		0.586	1.46
Straight-HDD	0.65	1.00	0.87	1.87		0.667	1.54
Straight-Audio	0.00	1.25	0.33	1.58		0.833	1.16
Curves-HUD	0.75	1.13	0.87	2.00		0.753	1.62
Curves-HDD	1.00	1.25	0.87	2.12		0.833	1.70
Curves-Audio	0.15	1.50	0.33	1.83		1.000	1.33

