Using Markov Chain Monte Carlo Modelling (MCMC) with the VSM to manage a COVID outbreak

Captain J Huxley PhD

Situation

Simple facts

- The virus does not think – it's a molecule

- You are always 7 days behind the spread

- Humans are vulnerable precisely because it spreads through our most valuable asset – our ability to work effectively in groups

- **To beat it you have to out organise your own organisation**

- Why were governments and organisations so slow to organise?

  - Humans, find it difficult to assess non-linear growth, put simply, they did not see, and did not believe, it was coming.

  - Politics – hard decisions without visual evidence

  - Poor social design – too many interconnected key functions

  - Society was designed for economic efficiency not resilience

The Only Way is ~~Essex~~ Ethics

- You cannot control a population for any length of time with command and control methods because you cannot easily maintain **requisite variety**

- As societies get more complicated cohesion imposes greater restrictions on peoples freedom. If the rules are imposed on them they will eventually rebel against this control as they will suffer from the imbalance in variety.

- *People will behave in their own interests if there is no social contract*. Foucault

- *You cannot make sufficient rules to maintain requisite variety* - Wittgenstein's 'Rules of a Game'

- If you dictate "one-size-fits-all" solutions you will bring your system to a standstill.

- You have to absorb the complexity that a re-organisation creates through self-organisation guided by values (Ethics)

Creating A Self-Organising Ethical System for RESILIENCE

- Ethics are the meta system behaviours. The behaviours that are needed to maintain cohesion and create coherence (meaning)

- Ethics emerge when we recognise the difference between personal desire and social values through the need to maintain reputation (trust) (Phillip Pettit).

- Leadership (followship) is vital to create a sense of 'us' (avoid creating a sense of 'us' by creating a 'them')

- Norms and Rituals and Art enable the system to 'see' into itself, through the emergence, and highlight the tension between harmony and discord to create cohesion

- **It should just work** (be self-administrating, self-regulating, self-maintaining)

Markov chain

Figure 1 Markov Chain Transitions
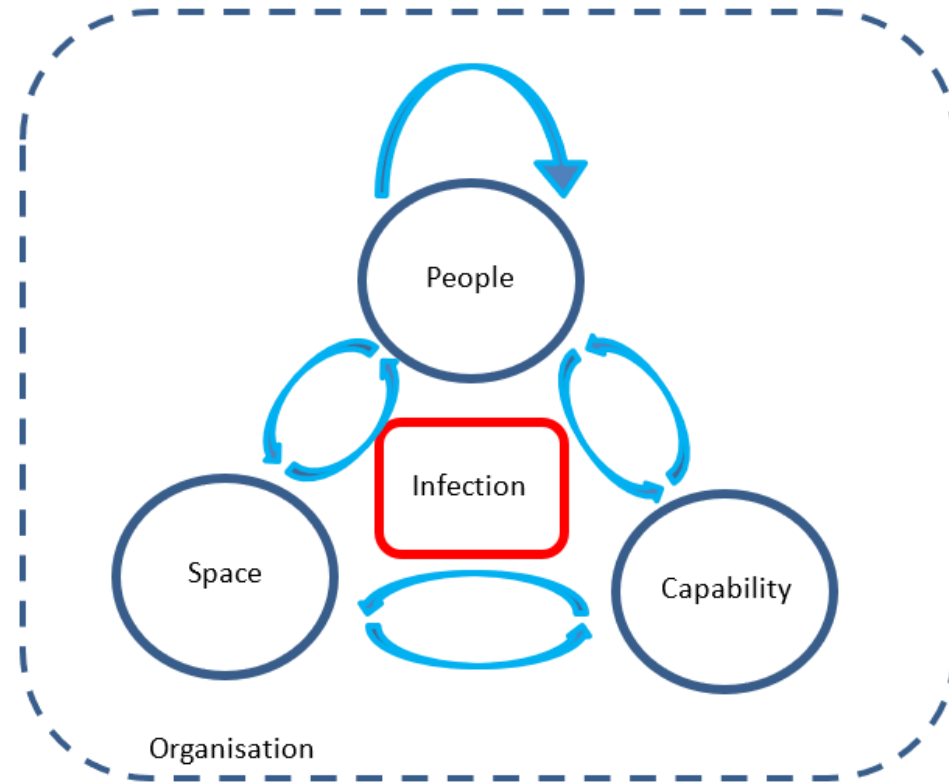
Markov Chain COVID Infection
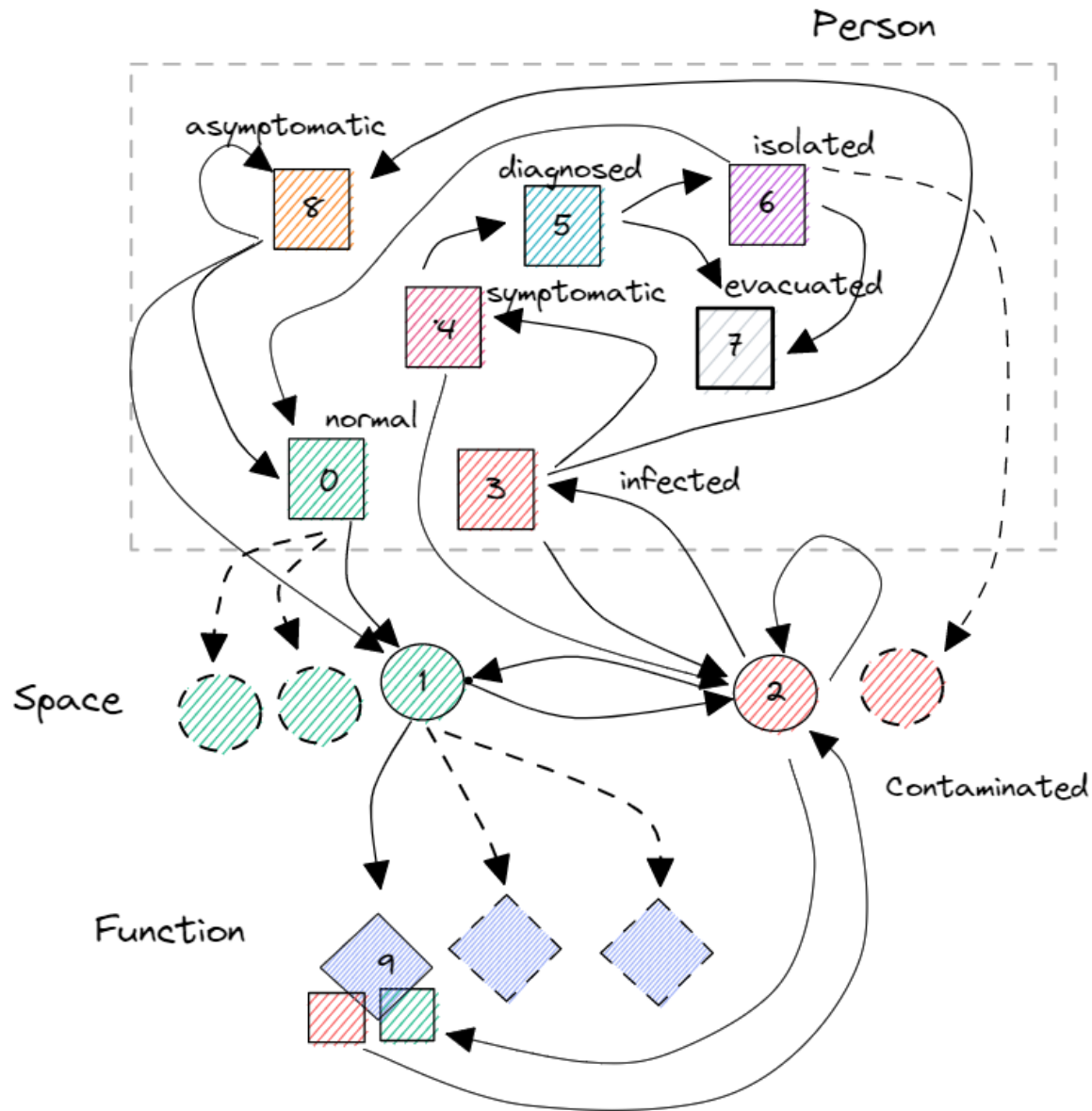
Transition Table

	0	1	2	3	4	5	6	7	8	9
0		1								
1			0.02							0.98
2		0.94	0.04	0.02						
3					0.7			0.3		
4	0.15					0.85				
5							0.95	0.05		
6		0.90	0.05					0.05		
7										
8	0.2	0.8								
9	0.9		0.1							

PEOPLE INFECTED — Week

PID	Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Exec																
2	Exec																
3	Exec																
4	Exec																
5	Exec																
6	Exec																
7	Exec																
8	ME																
9	ME																
10	ME																
11	ME																
12	ME																
13	ME																
14	ME																
15	ME																
16	SE																
17	SE																
18	SE																
19	SE																
20	Comms																
21	LS																
22	Smn																
23	Smn																
24	Smn																
25	Smn																
26	Smn																
27	Smn																
28	Smn																
29	Smn																
30	Smn																
31	Smn																
32	Smn																
33	Smn																
34	Smn																
35	Smn																
36	Smn																
37	Smn																
38	Smn																
39	Smn																
40	ME																
41	ME																
42	ME																
43	SE																
44	ME																
45	ME																
46	ME																
47	ME																
48	ME																
49	MM1 ME																

SPACES INFECTED (heat map) — Week

SID	Space		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Internal Decks	Dk 06																	
2		Dk 05																	
3		Dk 04																	
4		Dk 03																	
5		Dk 02																	
6		Dk 01																	
7		Dk 1																	
8		Dk 2																	
9		Dk 3																	
10		Dk 4																	
11	External Decks	Dk 07																	
12		Dk 06																	
13		Dk 05																	
14		Dk 04																	
15		Dk 03																	
16		Dk 02																	
17		Dk 01																	
18		Dk 1																	
19	Stairwells	L																	
20		M																	
21		N																	
22	Public Areas	Pantry 06 Dk																	
23		Conference Rm 05 Dk																	
24		Pantry & Cleaning Lk 05 Dk																	
25		Officers Bar 04 Dk																	
26		Officers Bar Toilets 04 Dk																	
27		Self Service Laundry 04 Dk																	
28		Pantry & Cleaning Lk 04 Dk																	
29		PO Bar 03 Dk																	
30		PO Bar Toilets 03 Dk																	
31		Pantry & Cleaning Lk 03 Dk																	
32		Ship's Library 02 Dk																	
33		Pantry & Cleaning Lk 02 Dk																	
34		POs Office 01 Dk																	
35		Officers Saloon 01 Dk																	
36		POs Saloon 01 Dk																	
37		Crew Dining 01 Dk																	
38		Duty Mess 01 Dk																	
39		Pantry & Cleaning Lk 01 Dk																	
40		Smoking Area 01 Dk																	
41		Crew Bar 1 Dk																	
42		Crew Bar Toilets 1 Dk																	
43		Self Service Laundry 1 Dk																	
44		Pantry & Cleaning Lk 1 Dk																	
45		Gymnasium 1 Dk																	
46	Exec Areas	Bridge 07 Dk																	
47		Ops Rm 06 Dk																	
48		MCO 05 Dk																	
49		CR Office 05 Dk																	

CAPABILITY DEGRADED — Week

CID	Capability	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Executive (N9, N8)																
2	Operations (N2, N5)																
3	Communications (N6)																
4	Navigation (N3)																
5	Cargo (N3)																
6	Replenishment (N3)																
7	Aviation (N3)																
8	Seamanship (N3)																
9	Weapons (N3)																
10	Propulsion (N3) (N4)																
11	Power Gen (N3)																
12	Platform Svcs (N3)																
13	System Eng (N3)																
14	Logistics (N1, N4)																
15	Catering (N3)																
16	Steward Svcs (N3)																
17	CBRNDC (N3)(N7)																
18	Security (N3)																
19	Public Officers (N3)																
20	Public Pos (N3)																
21	Public Ratings (N3)																
22	Social (N3)																

RUN CONTROL

Run

STATE REQUIRED — Week

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
StID State	1	2	3	3	3	4	4	4	2	2	1	1	1	1	1	1

Run Settings
- Start of infection
- Monte Carlo

RESULTS - Manweeks

Total infected	8	Symptomatic	5
Isolated	7	Asymtomatic	11

People Infected Key
- Contagious Symptomatic
- Infected
- Contagious Asypromatic
- Healthy
- Not onboard
- Isolated

State Key

StID	State
1	Normal operations
2	Virus aware
3	Virus concerned
4	Lockdown

Numbers Infected

Legend: infected, contagious symptomatic

Capability Map

Personnel x Capability

PID	Rank	Dept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	CAPT(X)	Exec	3	3	2	3	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2		Exec	3	3	2	2	3	3	1	3	1		1		1		1	1	1	1	1	1	1	1
3		Exec	3	3	3	2	2	2	3		2									1	2			1
4		Exec	2	3	3	3	1	1	3	2											2			1
5		Exec	2	2	2	3	1	1	2	2	3							1	1	1	2			2
6		Exec	2	2	2	3	1	1	2	1	3							1	1	1	2			2
7		Exec	2	2	2	3	1	1	2	1									1	1	2			1
8		ME	2	1	2	1	1	1				3	3	3	3	2			1		1			1
9		ME	1	1			1			1	3	3	3	3	2			1		1				1
10		ME	1	1			2	2	2	2				3		2			1		1			1
11		ME									3	3	1		1			1		1				1
12		ME									3	3	1		1			1		1				1
13		ME							3	3	1	1		1				1		1				1
14		ME									3	3	1					1		1				1
15		ME									3	3	1					1		1				1
16		SE	1	1	2	2	2	1	1		2	2	2	3	2	1		1		1				1
17		SE	1		2	2	2	1	1		2	2	2	3	1	1		1		1				1
18		SE			1	1	1	1	1		1	1	1	3		1		1		1				1
19		SE			1	1	1	1	1		1	1	1	3		1		1		1				1
20		Comms	1	2	3																1			1
21		LS	1	1	2						3	3	3	1		1		1						1
22		Smn	1	1			1	3	1	3	1			2				1	1		2			1
23		Smn					1	3		3				2							2			1
24		Smn					1	2	3	3	1			2							2			1
25		Smn				2	3		3	1													1	1
26		Smn				1	2	3	3														1	1
27		Smn				2	3		3	1											2			1
28		Smn				1	3		3	1					1						2			1
29		Smn				1	3		3	1											2			1
30		Smn				1			3	1											2			1
31		Smn				1	2	3	3	1											2			1
32		Smn				1	2	3	3	1											2			1
33		Smn				1	2	3	3	1											2			1
34		Smn				1	2	3	3	1											2			1
35		Smn			3		1		1	1									3		2			1
36		Smn			3		1		1	1									3		2			1
37		Smn			3		1		1	1									3		2			1
38		Smn			3		1		1	1									3		2			1
39		Smn			3		1		1	1									3		2			1
40		ME							2	2	3		2			2					2			1
41	PO(E)	ME			3	3			2	2	2		2			1					2			1

Compartment x Capability

SID	Space		Max Mean ach	reliab	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Internal Decks	Dk 06	3	100	3	3	3	3					2	1	1	1	1		2		1					
2		Dk 05	3	100	3	3	3	3					2	3	3	1	3	1	2		1	3				2
3		Dk 04	3	100	3		3	3			3		3	3	3	3	3	3	2		1	3	2			2
4		Dk 03	3	100	1	3	3		3	3	3	3		3	3	1	3	3	3	3		1		3		2
5		Dk 02	3	100	1		3	3	3	3	3	3	3	3	3	1	3	3	3	3	1	1				2
6		Dk 01	3	100	1	3	3				3	3		3	3	3	3	3	1	1	3	3	2		2
7		Dk 1	3	100	1		3	3	3	3	3	3		3	3	1	1	3		1	1			2	2
8		Dk 2	3	100	1																	1				
9		Dk 3	3	100																						
10		Dk 4	3	100																						
11	External Decks	Dk 07	2	100	1		2	2					2			1										
12		Dk 06	2	100	1		2						2			1										
13		Dk 05	2	100	1								3			1										
14		Dk 04	2	100	1											1										
15		Dk 03	2	100	1						3					1										
16		Dk 02	2	100	1											1										
17		Dk 01	2	100	1			3	3		3	2				1	2	2			2	2	2	2		
18		Dk 1	2	100	1			3	3		3	2				1										
19	Stairwells	L	3	100	1		3	3	3		3			1	3	3	3		1		3	3	2			
20		M	3	100	3	3	3	3	3	3	3	2	3	3	1	3	3	3	1	1	3	3	3	2	
21		N	3	100	3		3	3	3		3		3	3	1	3	3	3	1	1	3	3	3	2	
22	Public Areas	Pantry 06 Dk	5	100	3	3	3	3								1	1	2		3				1	
23		Conference Rm 05 Dk	5	100	2	3										1	2			2	2		1	
24		Pantry & Cleaning Lk 05 Dk	5	100	3	3	3									1	1	2		3				1	
25		Officers Bar 04 Dk	5	100	1											1	2	1	2			1	
26		Officers Bar Toilets 04 Dk	5	100	1											1	2		2			1	
27		Self Service Laundry 04 Dk	5	100	1											1	1	2	1	2	2		1	
28		Pantry & Cleaning Lk 04 Dk	5	100	1											1	1	2		3			1	
29		PO Bar 03 Dk	5	100	1											1			2			1	
30		PO Bar Toilets 03 Dk	5	100	1											1			2			1	
31		Pantry & Cleaning Lk 03 Dk	5	100	1											1	1	2		3		1	
32		Ship's Library 02 Dk	5	100	1											1			2	2	2	1	
33		Pantry & Cleaning Lk 02 Dk	5	100	1											1	1	2				1	
34		POs Office 01 Dk	5	100	1							2			2	2		2	2	2		2	1	
35		Officers Saloon 01 Dk	5	100	1											1	2	1	3		1	
36		POs Saloon 01 Dk	5	100	1											1	3	1	3		1	
37		Crew Dining 01 Dk	5	100	1											1	3	1	1	3	1	
38		Duty Mess 01 Dk	5	100	1											1	3	1	3	1	
39		Pantry & Cleaning Lk 01 Dk	5	100	1											1	1	3		3	1	
40		Smoking Area 01 Dk	5	100	1											1			3	3	3	1	
41		Crew Bar 1 Dk	5	100	1											1	1		1		3	1	

Capability Key

CID	capability
1	Executive (N9, N8)
2	Operations (N2, N5)
3	Communications (N6)
4	Navigation (N3)
5	Cargo (N3)
6	Replenishment (N3)
7	Aviation (N3)
8	Seamanship (N3)
9	Weapons (N3)
10	Propulsion (N3) (N4)
11	Power Gen (N3)
12	Platform Svcs (N3)
13	System Eng (N3)
14	Logistics (N1, N4)
15	Catering (N3)
16	Steward Svcs (N3)
17	CBRNDC (N3)(N7)
18	Security (N3)
19	Public Officers (N3)
20	Public Pos (N3)
21	Public Ratings (N3)
22	Social (N3)

STATES

Measures

SmID	Measure	State (StID) 1	2	3	4	5	6
1	Ventilation		1	1	1	1	1
2	Hand wash		1	1	1	1	1
3	Sanitisation			1	1	1	1
4	Limit use				1	1	
5	Social Distancing				1	1	
6	Patients Isolated		1	1	1	1	1

Measures Effectiveness

SmID	Measure	Prob
1	Ventilation	5
2	Hand wash	10
3	Sanitisation	30
4	Limit use	80
5	Social Distancing	80
6	Patients Isolated	95

Contagion Rates

Type	Contact	Prob
Infection from person	1.Weekly	2
	2.Daily	5
	3.Hourly	10
Infection from surface	1.Weekly	0
	2.Daily	3
	3.Hourly	6

Capability x State

CID	capability	State (StID) 1	2	3	4	5	6
1	Executive (N9, N8)	1	1	1		1	1
2	Operations (N2, N5)	1	1	1		1	1
3	Communications (N6)	1	1	1		1	1
4	Navigation (N3)	1	1	1		1	1
5	Cargo (N3)	1	1	1		1	1
6	Replenishment (N3)	1	1	1			1
7	Aviation (N3)	1	1	1			1
8	Seamanship (N3)	1	1	1		1	1
9	Weapons (N3)	1					1
10	Propulsion (N3) (N4)	1	1	1		1	1
11	Power Gen (N3)	1	1	1	1	1	1
12	Platform Svcs (N3)	1	1	1	1	1	1
13	System Eng (N3)	1	1	1	1	1	1
14	Logistics (N1, N4)	1	1	1		1	1
15	Catering (N3)	1	1	1	1	1	1
16	Steward Svcs (N3)	1					1
17	CBRNDC (N3)(N7)	1	1				1
18	Security (N3)	1	1				1
19	Public Officers (N3)	1	1				1
20	Public Pos (N3)	1	1				1
21	Public Ratings (N3)	1	1				1
22	Social (N3)	1					

State Key

StID	State
1	Normal operations
2	Virus aware
3	Virus concerned
4	Lockdown
5	Recovery stage 1
6	Recovery stage 2

Infection Times

Type	Wks	Prob
Incubation (weeks)	1	100
	2	0
	3	0
Cantagious (weeks)	1	100
	2	0
	3	0

Diagnostic Efficiency

	Prob
Diagnostic Efficiency	70

Asymptomatic Rate

	Prob
Asymptomatic Rate	35

Patients Immune

	Prob
Immune to re-infection	Y

Recovery Rate

	Prob
Recovery Rate	95

PEOPLE INFECT: Week

PID	Rank		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		Exec																
2		Exec																
3		Exec																
4		Exec																
5		Exec																
6		Exec																
7		Exec																
8		ME																
9		ME																
10		ME																
11		ME																
12		ME																
13		ME																
14		ME																
15		ME																
16		SE																
17		SE																
18		SE																
19		SE																
20		Comm																
21		LS																
22		Smn																
23		Smn																
24		Smn																
25		Smn																
26		Smn																
27		Smn																
28		Smn																
29		Smn																
30		Smn																
31		Smn																
32		Smn																
33		Smn																
34		Smn																
35		Smn																
36		Smn																
37		Smn																
38		Smn																
39		Smn																
40		ME																
41		ME																
42		ME																
43		SE																
44		ME																
45		ME																
46		ME																
47		ME																
48		ME																
49		ME																
50		ME																
51		LS																
52		LS																
53		LS																
54	)	LS																
55	)	LS																
56	)	LS																
57	)	LS																
58		LS																
59		LS																
60		LS																

SPACES INFECTED (heat map): Week

SID	Space		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Internal Decks	Dk 06																
2		Dk 05																
3		Dk 04																
4		Dk 03																
5		Dk 02																
6		Dk 01																
7		Dk 1																
8		Dk 2																
9		Dk 3																
10		Dk 4																
11	External Decks	Dk 07																
12		Dk 06																
13		Dk 05																
14		Dk 04																
15		Dk 03																
16		Dk 02																
17		Dk 01																
18		Dk 1																
19	Stairwells	L																
20		M																
21		N																
22	Public Areas	Pantry 06 Dk																
23		Conference Rm 05 Dk																
24		Pantry & Cleaning Lk 05 Dk																
25		Officers Bar 04 Dk																
26		Officers Bar Toilets 04 Dk																
27		Self Service Laundry 04 Dk																
28		Pantry & Cleaning Lk 04 Dk																
29		PO Bar 03 Dk																
30		PO Bar Toilets 03 Dk																
31		Pantry & Cleaning Lk 03 Dk																
32		Ship's Library 02 Dk																
33		Pantry & Cleaning Lk 02 Dk																
34		POs Office 01 Dk																
35		Officers Saloon 01 Dk																
36		POs Saloon 01 Dk																
37		Crew Dining 01 Dk																
38		Duty Mess 01 Dk																
39		Pantry & Cleaning Lk 01 Dk																
40		Smoking Area 01 Dk																
41		Crew Bar 1 Dk																
42		Crew Bar Toilets 1 Dk																
43		Self Service Laundry 1 Dk																
44		Pantry & Cleaning Lk 1 Dk																
45		Gymnasium 1 Dk																
46	Exec Areas	Bridge 07 Dk																
47		Ops Rm 06 Dk																
48		MCO 05 Dk																
49		CB Office 05 Dk																
50		Nile Store 02 Dk																
51		XO Office 01 Dk																
52		Deck Changing Room 01 Dk																
53		Gangway Security Offices 01 Dk																
54		Pump Rm																
55		Deck Stores 01 Dk																
56		Pipe Tunnel 1 Dk																
57		RASCO 02 Dk																
58		Deck Focastle Spaces																
59	Flight Spaces	Hangar and Store Rms																
60		Hangar Office and Store Rms																

CAPABILITY DEGR: Week

CID	Capability	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Executive (N3, N8)																
2	Operations (N2, N5)																
3	Communications (N6)																
4	Navigation (N3)																
5	Cargo (N3)																
6	Replenishment (N3)																
7	Aviation (N3)																
8	Seamanship (N3)																
9	Weapons (N3)																
10	Propulsion (N3) (N4)																
11	Power Gen (N3)																
12	Platform Svcs (N3)																
13	System Eng (N3)																
14	Logistics (N1, N4)																
15	Catering (N3)																
16	Steward Svcs (N3)																
17	CBRNDC (N3)(N7)																
18	Security (N3)																
19	Public Officers (N3)																
20	Public Pos (N3)																
21	Public Ratings (N3)																
22	Social (N3)																

RUN CONTROL

Run

STATE REQUIRED: Week

StID	State	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		1	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1

Run Settings

Start of infection	8
Monte Carlo	1

RESULTS - Manweeks

Total infected	8	Symptomatic	8
Isolated	8	Asymtomatic	15

People Infected Key

Contagious Symptomatic	
Infected	
Contagious Asymptomatic	
Healthy	
Not onboard	
Isolated	

State Key

StID	State
1	Normal operations
2	Virus aware
3	Virus concerned
4	Lockdown
5	Recovery stage 1
6	Recovery stage 2

Numbers Infected

Legend: infected; contagious symptomatic; contagious asymptomatic; isolated

Enterprise solution

- Must create a seamless system that allows people to
- Tease out its problems and solutions - no whiteboards, yellow stickies, papers, reports or email trails – just using the model
- It is a education tool that helps people understand the problems
- It is means of communicating the Strengths Weaknesses Opportunities and Threats
- It creates coherence in beliefs and attitudes
- It is a audit tool
- Creates cohesion and coherence
- Recognises change

VSM Principles used to manage the model

- System 1
  - Maintain output
  - Empowerment
  - Its ok to fail
  - Mutual reassurance and a feeling of care and support
  - Upward alert of resilience, risks, trends etc

- System 2
  - Self and team generated coordination routines

Pask Conversation – The theory of the thread
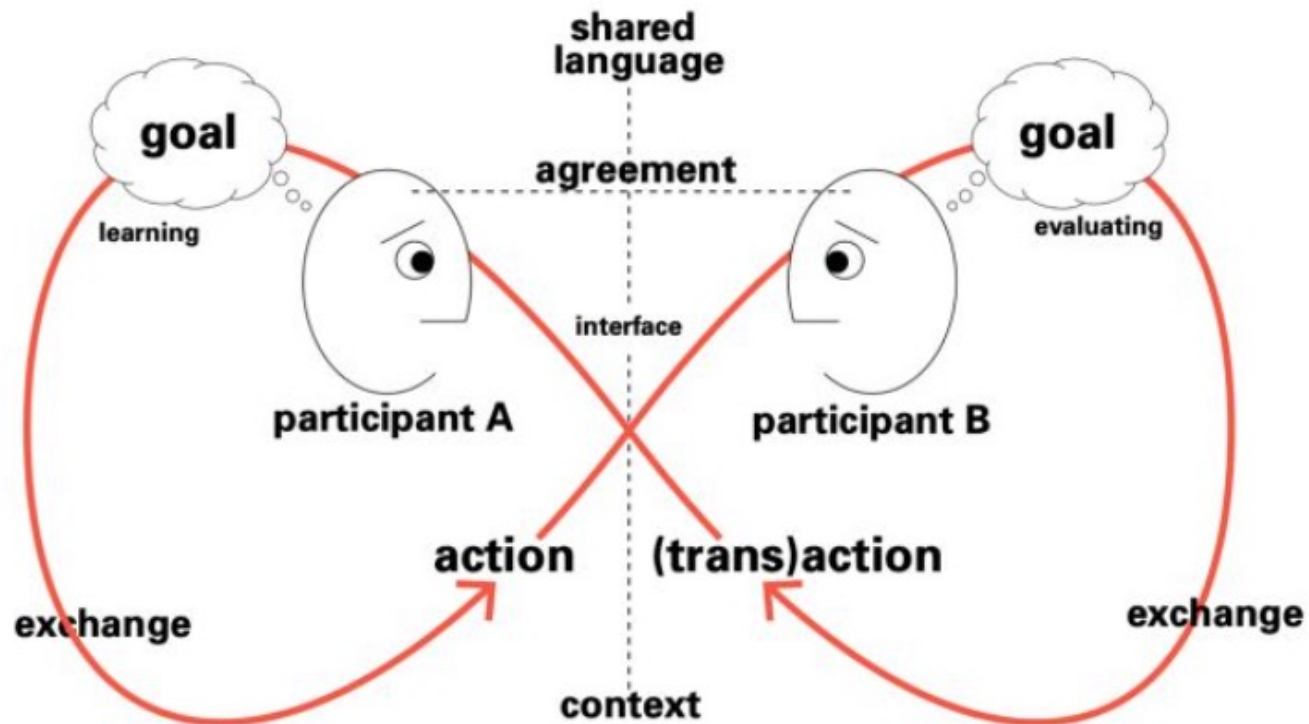
VSM Principles used to manage the model

- System 3
  - Creation of purpose understanding and meaning - Create a shared narrative
  - Build system integrity
  - Importance of reputation- Reward honesty Algenode
  - Transparency- not management or social blame
  - "Say what you do and do what you say"
  - Communication of purpose risks and issues
  - Algedonic Gossip channel

VSM Principles used to manage the model

- System 3*
  - Audit of effectiveness

VSM Principles used to manage the model

- System 4
  - Anticipation of change
  - Monitor trends to see changes
  - Assessment of risk
  - (quick response to changes)
  - Propose solutions

VSM Principles used to manage the model

- System 5
  - A sense of purpose
  - Mediate between System 3 and System 4 to maintain identity/purpose
  - Leadership style
  - Gardening
  - Top down meets bottom up
  - Set an Example

Questions