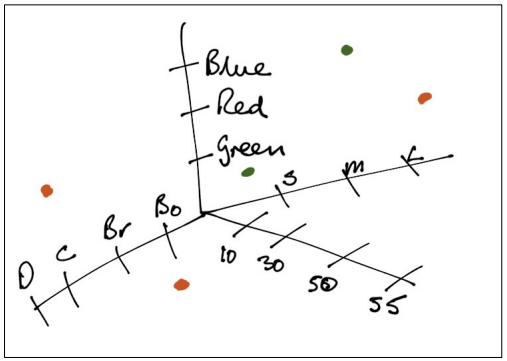
Design Space:
multiple dimensions and design rationale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- In any design there will be a very large number of decisions to make
- Each decision represents a dimension in multi-dimensional space
- We can’t draw more than two dimensions!

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- Parallel co-ordinates is a common visualisation method for high-dimensional data
- We can use it to visualise our design space…

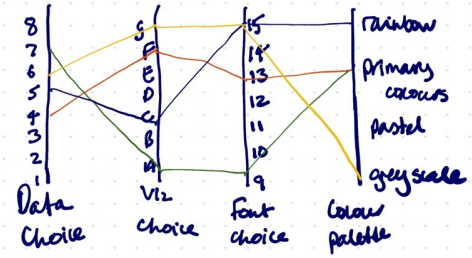
Parallel coordinates

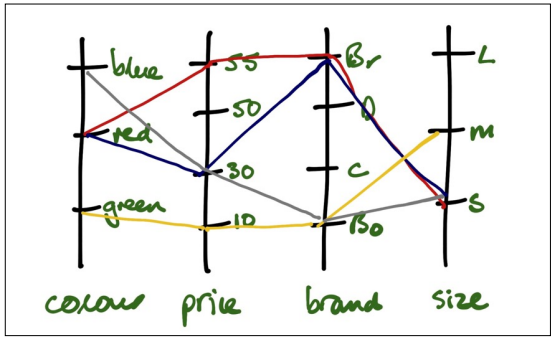
- Used for visualising multidimensional data
- Each dimension (decision) is represented as a vertical axis, with its values equally spaced along it
- The dimensions are arranged horizonatally, equally spaced
- A single data point is a line that joins its values on each dimension

Robert Kosara, "Parallel Coordinates (eagereyes)", https://eagereyes.org/techniques/parallel-coordinates, 2010 (accessed 18/04/21)

Using Parallel coordinates to visualise Design Space choices

Now we are not confined to representing only two design alternatives in two dimensions

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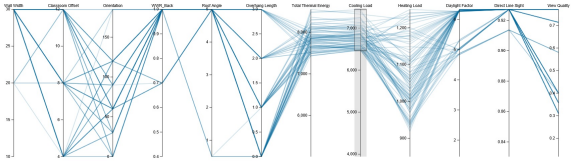
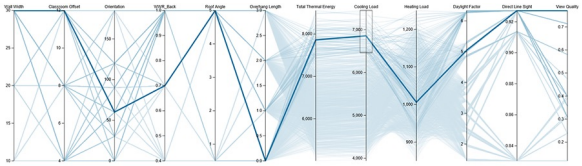
Designing a classroom



wall width, classroom offset, orientation, roof angle… daylight factor, view quality

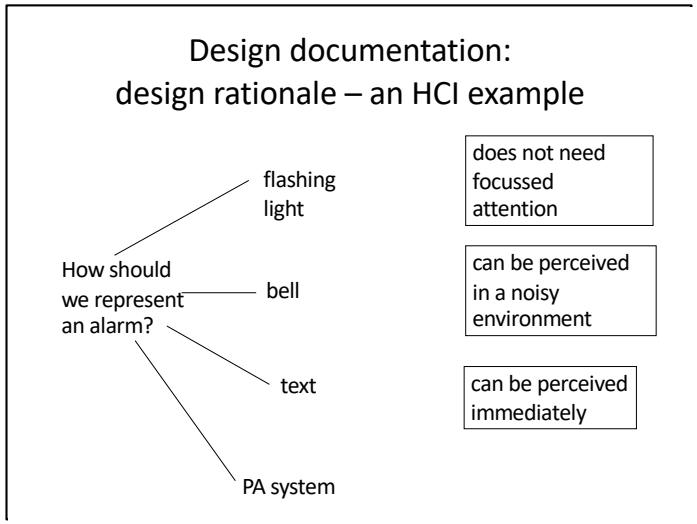


https://bernalm.gitbooks.io/design-space-construction/content/visualization_and_optimization.html

Questions Options Criteria (QOC)

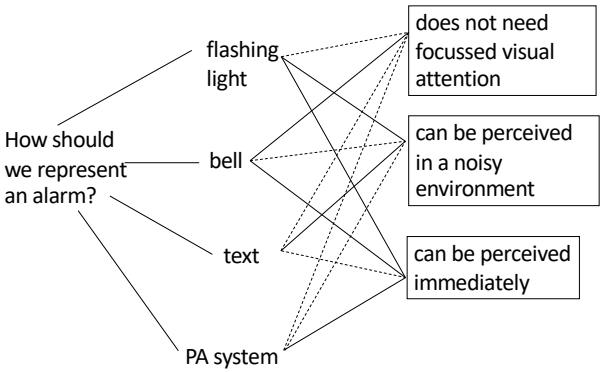
A more formal way of representing the Design Choice process and Design Rationale

- **Questions:** the key issues/choices of the design
- **Options:** possible answers to the questions
- **Criteria:** reasons for arguing for or against the options



PA system: a ‘public announcement’ system, often using speakers in the walls of a building.

Design documentation: design rationale – an HCI example

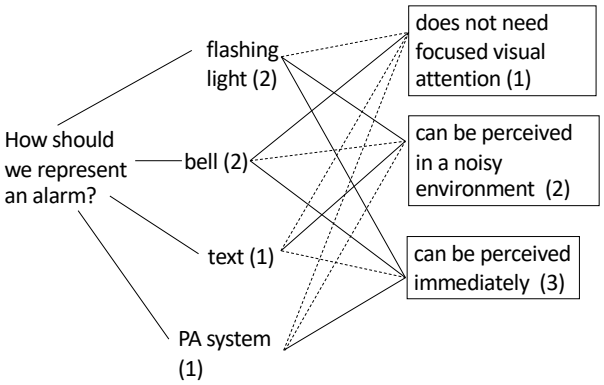


We add in solid lines for when there are positive links between options and criteria, as here in the case of a bell – which does not need focused visual attention to be perceived.

Note that a bell might not be easily heard in a noisy environment, however… and so there is a dotted line there… representing a negative link.

We are showing, with each link, a decision about whether each option is good or bad with regard to a criterion. By going through every combination of O and C, we can be thorough in our assessment of the design options.

Design documentation: design rationale – an HCI example



Here I've added the number of positive links for each option, and for each criterion, e.g. a flashing light has two positive links to the criteria. Similarly, only one design option does not need focused visual attention.

Based on this, the flashing light or the bell would be the best design option.

Since there are two equally ranked options, however, we could think about further criteria, to help narrow down on one option… or we could think of other options, to find some better alternative. Either way, there are clear reasons for that next step in the design process.

Two dimensions of choice

	AN	PT	HG	ZL
AN	385	0	100	15
PT	109	323	45	23
HG	10	0	432	58
ZL	0	0	140	360

(A)		clustered bar
(B)		100% stacked bar
(C)		stacked bar
(D)		stacked line
(E)		line
(F)		pie
(G)		radar

(1)	1x4 (correct)
(2)	1x4 (incorrect)
(3)	1x4 (%correct)
(4)	1x4 (%incorrect)
(5)	4x4 (all data)
(6)	**4x4 (all, as %)**
(7)	2x2 (HG)
(8)	1x1 (%correct)

A 2D space of 56 design options

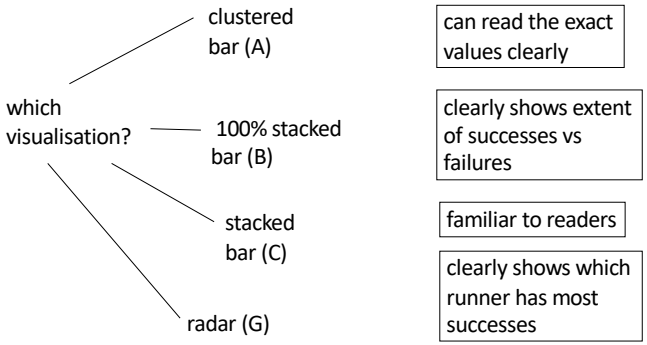
	1	2	3	4	5	6	7	8
clustered bar	X	X	X	X				X
100% stacked bar	X	X	X	X				X
stacked bar	X	X	X	X				X
stacked line	X	X	X	X	X	X	X	X
line	X	X	X	X	X	X	X	X
pie					X	X	X	X
radar	X	X	X	X			X	X

1. 1x4 (correct)
2. 1x4 (incorrect)
3. 1x4 (%correct)
4. 1x4 (%incorrect)
5. 4x4 (all data)
6. 4x4 (all, as %)
7. 2x2 (HG)
8. 1x1 (%correct)

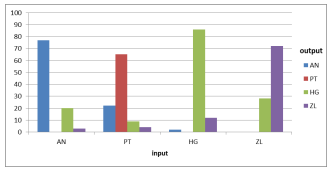
Remember this?

Representing data choice (6)
4x4 (represented as %)

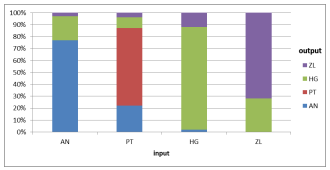
	AN	PT	HG	ZL
AN	77	0	20	3
PT	22	65	9	4
HG	2	0	86	12
ZL	0	0	28	72



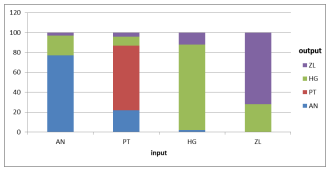
clustered bar (A)



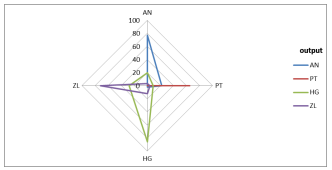
100% stacked bar (B)



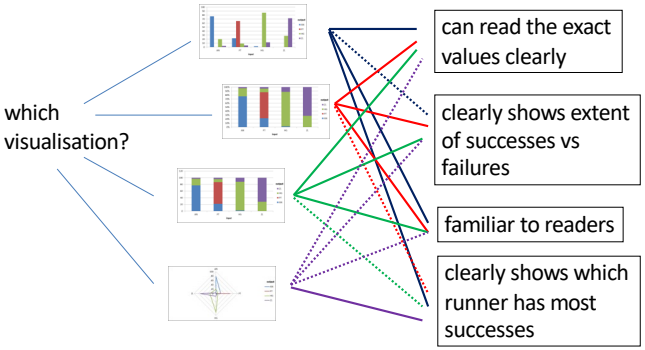
stacked bar (C)



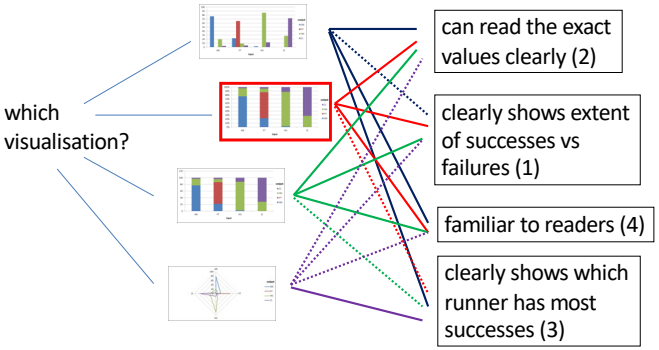
radar (G)



Representing data choice (6)
4x4 (represented as %)



Representing data choice (6)
4x4 (represented as %)



Design process

- What are the design decisions?
- Which combinations are
  - possible
  - impossible
  - relevant
  - preferable
  - under-explored (gap-detection)
- Which options best satisfy our criteria?

https://www.slideshare.net/StephenMacNeil1/cocreating-dimensions-and-examples-using-design-space-gaps (extract)

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