

Scientific and Graphic Design Foundations for C2



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Introduction



- **Lots to cover in a little time**
 - **Graphic Design**
 - **Psychology**
 - **Our approach**
- **Will only hit the major points**
- **We are expanding the paper into a web-based document for ease of use**



Graphic Design



- **Layout**
 - Literally the aesthetic of the display design
- **Typography**
 - Serif versus san serif
 - **Font sizes**
 - Note display type is an issue
 - Small versus large screen
 - Note viewing angle
 - Also note display medium
 - Paper has great resolution!



- **Color**

- **Associations**

Color	Associated meanings	Color	Associated meanings
Red	Stop, fire, hot, danger	Blue	Cold, water, calm, sky, neutrality
Yellow	Caution, slow	White	Neutrality
Green	Go, OK, clear, vegetation, safe	Grey	Neutrality

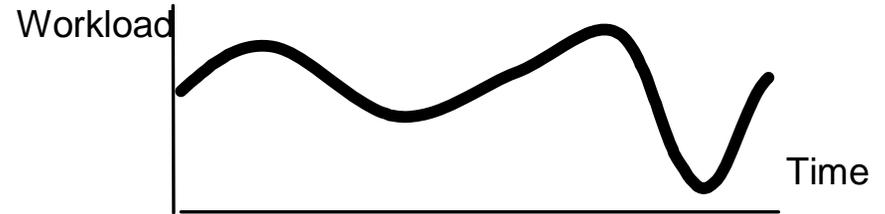
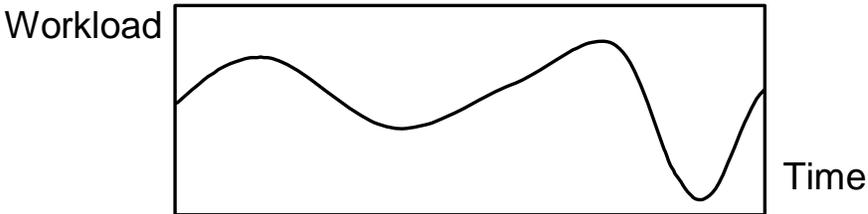
- **Consistency and redundancy**



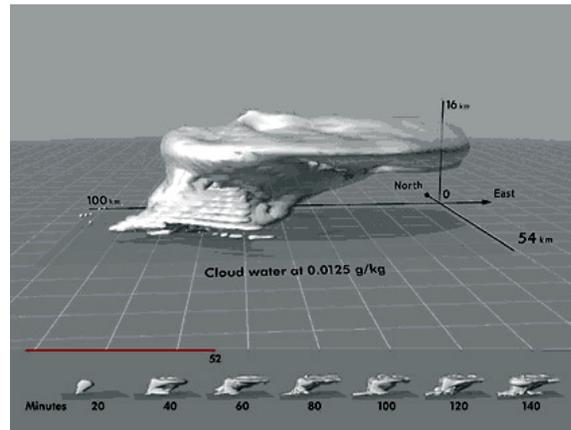
Graphic Design



- **Data graphics**
 - **Data-ink ratio (Tufte, 1983)**



- **Small multiples (Baker & Bushell, 1995)**





Visual Perception



- **Perceptual organization**

Gestalt Principle	Example Figure	Verbal Descriptor
Law of Simplicity		Every object is perceived in a way that the resulting structure is as simple as possible.
Law of Closure		Tendency to close gaps and complete unfinished objects.
Law of Similarity		Elements which look similar (example, size, color, orientation, velocity and shape) are perceptually grouped together as a object
Law of Good Continuity		Elements that are smooth and continuous are perceptually grouped together than ones that contain abrupt changes in direction.
Law of Connectedness		Elements that are physically connected are perceptually grouped together as a object.
Law of Proximity		Elements that are close together are perceptually grouped together as a object
Law of Common Fate/Common orientation		Elements with the same moving direction or orientation are perceptually grouped together as a object
Law of Balance/Symmetry		Elements in symmetrical alignment are perceptually grouped as a object
Law of Common Region		Elements tend to be group if they are located within a common region. The closed contour tends to be perceived as the boundary of the object.



Visual Perception



- **Pre-attentive processing**
 - **Certain information “pops” out**
 - **Other information cannot be “ignored”**
- **Two examples**
 - **Stroop**
 - **Visual Search**



Visual Perception



- **Stroop task (say the color as quickly as possible)**
 - Humans can't not read the color name

RED

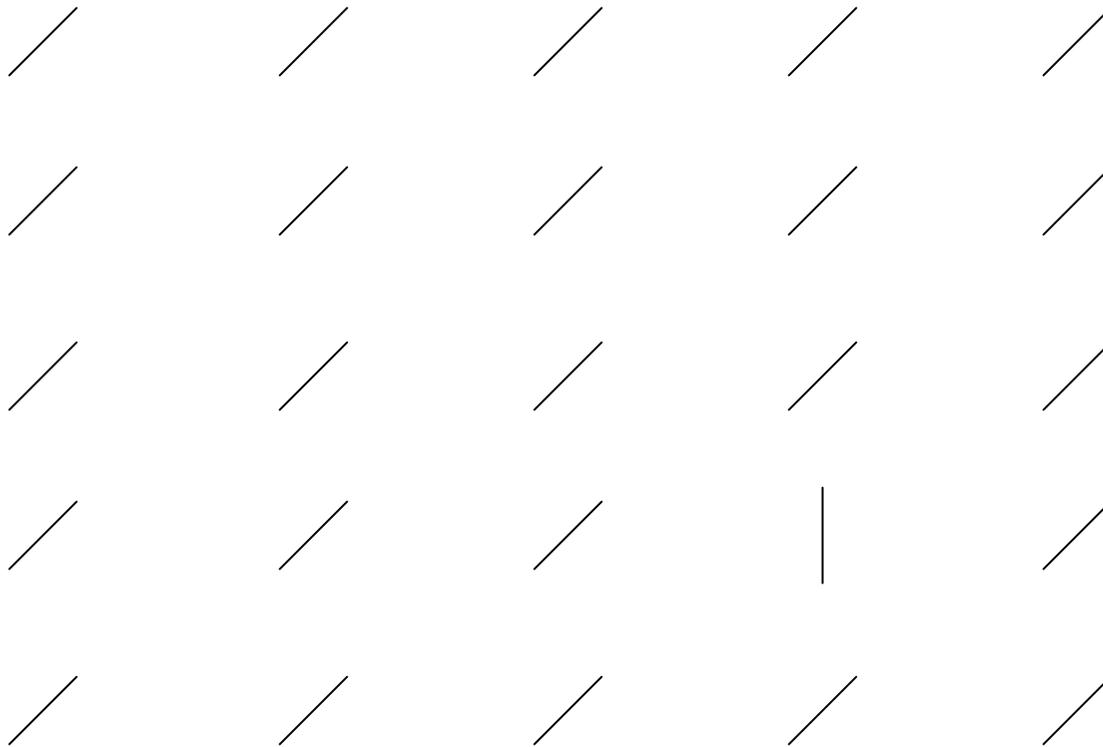
RED



Visual Perception



- Find the vertical bar

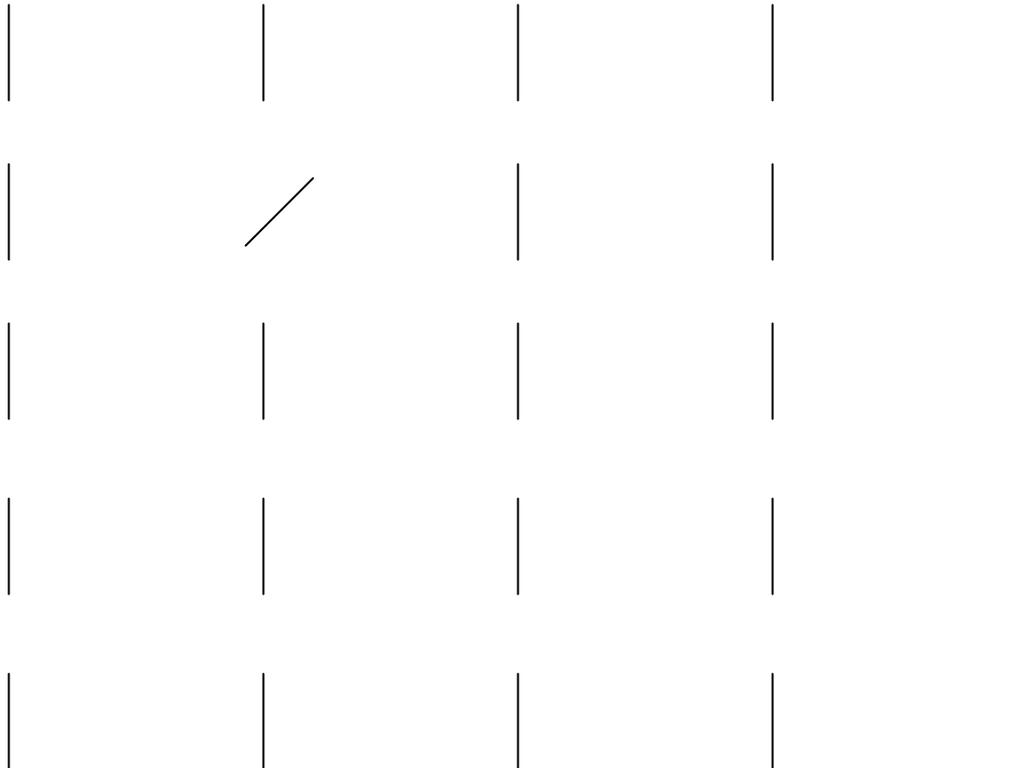




Visual Perception



- Find the diagonal bar





Visual Perception



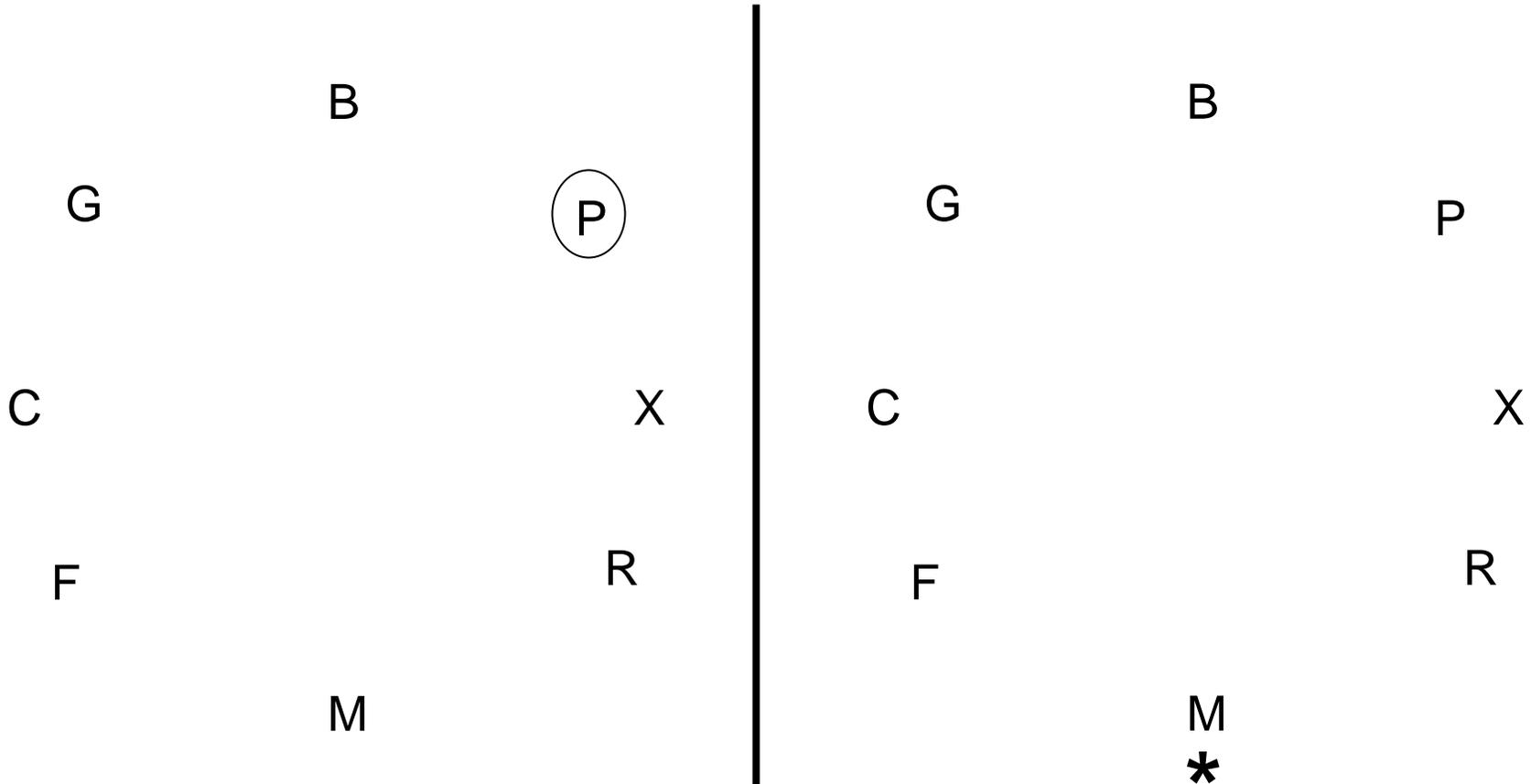
- **Theories of visual attention**
 - **Space-based – attention distributed over space irrespective of objects**
 - **“Spotlight” theories of attention**
 - **Object-based - attention distributed based on objects (e.g., Gestalt laws)**
 - **Resource allocation theories of attention**
 - **Both (see Logan, 1996)**



Visual Perception



- Theories of visual attention cues
 - Exogenous – automatic response to visual cue

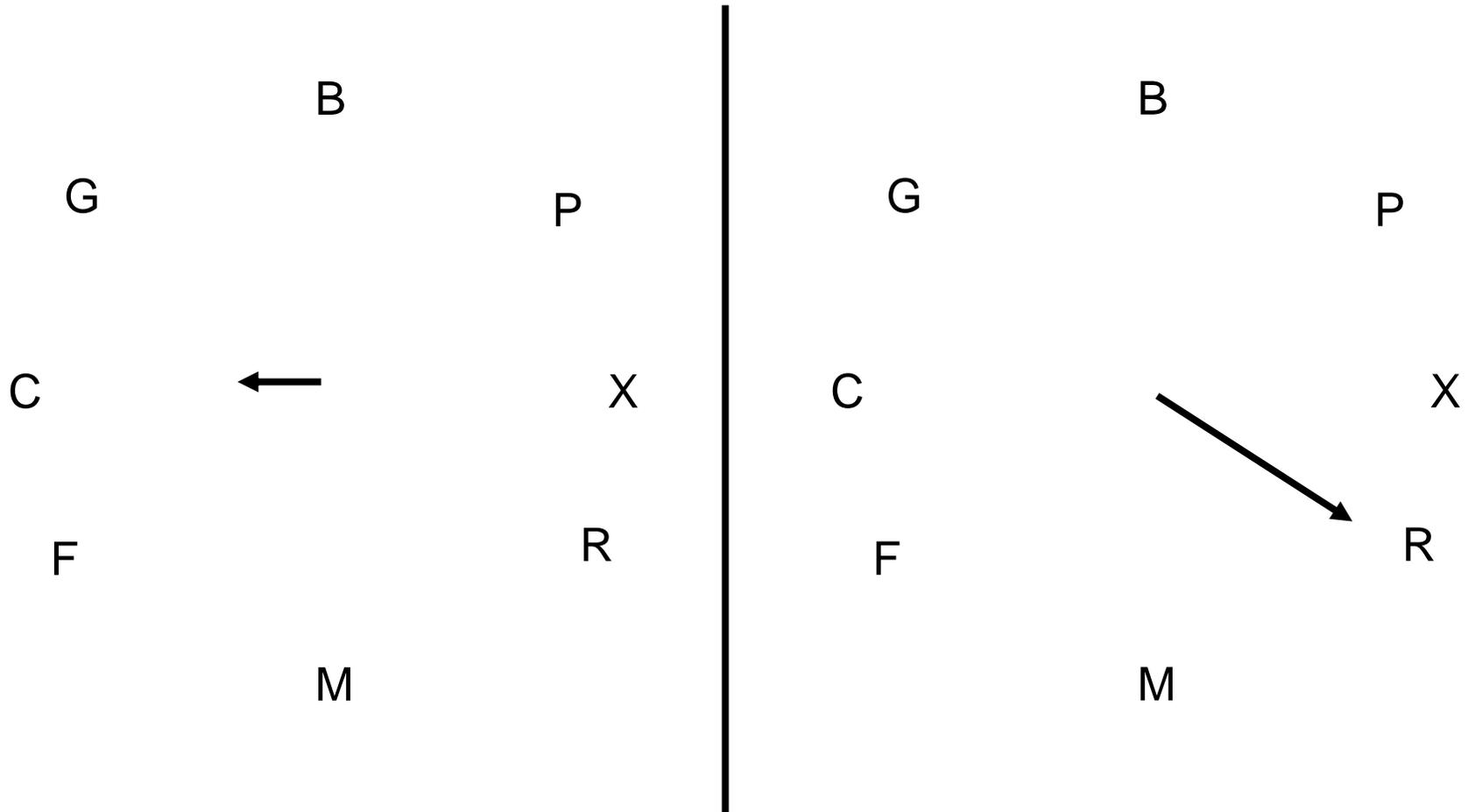




Visual Perception



- Theories of visual attention cues
 - Endogenous – under voluntary control





Visual Perception



- **3D and depth perception**
 - **Monocular versus binocular**
- **Do we need 3D**
 - **What is true 3D**
 - **When is it useful?**



Memory



- **Memory and displays?**
 - **Sensory memory**
 - **Sperling experiments**
 - **Short term memory**
 - **Miller's magic number**
 - **Long term memory**
 - **Declarative versus procedural**
 - **Prospective memory**
 - **Remembering to remember**



Information visualization system (IVS)



- **How do we evaluate graphical displays we create?**
 - **What are the types of experiments?**
 - **What questions can be asked?**
 - **e.g., Situation awareness, memory question, or questions about the IVS**
- **Examples of visual information fall under low and high level visual tasks**



Information visualization system (IVS)



- **Low level visual tasks - Wehrend and Lewis (1990)**
 - **Locate**
 - **Identify**
 - **Distinguish**
 - **Categorize**
 - **Cluster**
 - **Distribution**
 - **Rank**
 - **Compare within entities**
 - **Compare between relations**
 - **Associate**
 - **Correlate**



Information visualization system (IVS)



- **High level visual tasks - Zhou and Feiner's (1998)**

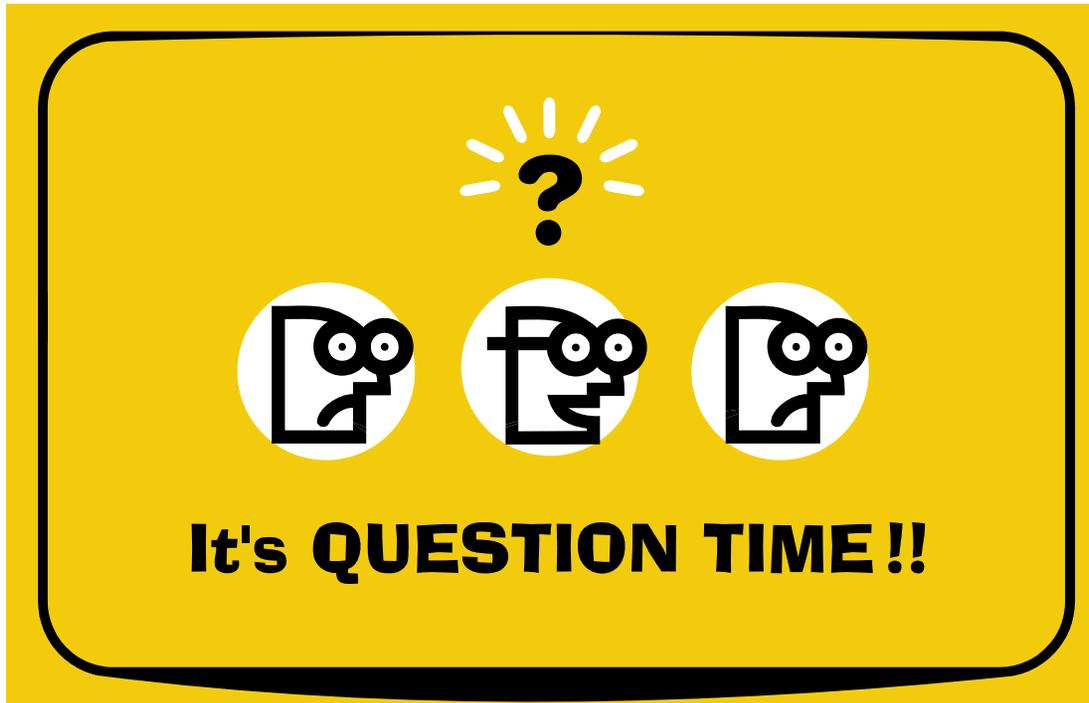
Visual Implication	Type	Subtype	Elemental tasks
Organization	Visual grouping	<i>Proximity</i>	Associate, cluster, locate
		<i>Similarity</i>	Categorize, cluster, distinguish
		<i>Continuity</i>	Associate, locate, reveal
		<i>Closure</i>	Cluster, locate, outline
	Visual attention		Cluster, distinguish, emphasize, locate
	Visual sequence		Emphasize, identify, rank
	Visual composition		Associate, correlate, identify, reveal
Signalling	Structuring		Tabulate, plot, structure, trace, map
	Encoding		Label, symbolize, portray, quantify
Transformation	Modification		Emphasize, generalize, reveal
	Transition		Switch



How to Apply to C2 Information Displays



- **Don't apply en masse – use as needed**
- **What if one is building from the ground up?**
 - **Not done perfectly (we all have biases)**
 - **Can test by component parts first**
 - **Interdisciplinary background teams essential**
- **So how does one test the “final product”**
 - **Again test components first**
 - **Test in small settings before large**
 - **Keep abreast of testing research and theories**



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