2.2: Imagination; Visualization

“Creative scientists…must have a vivid intuitive imagination, for new ideas are not generated by deduction, but by an artistically creative imagination”

—Max Planck

“All meaningful and lasting change starts first in your imagination and then works its way out. Imagination is more important than knowledge.”

—Albert Einstein

Main point: Imagination / visualization is important for insight.

1. Several (related) senses of “imagination”:

A) Function

i) Creation of a mental picture [understanding] a given situation
   . see something in your mind (“Imagine if you will…”)
   . inherent part of understanding for humans
     • use of analogy: captures relevant structure, and enables understanding
     • cf. diagrams

ii) Rearrangement of a mental picture: [finding] a new understanding
   . visualize possible modifications, alternatives, extensions of existing pictures
   . insight = new understanding (new arrangement of known pieces, or even new pieces)
   . create visions of possible situations, possible consequences
     • important version of this: thought experiments
   . this needs a lot of control (otherwise, get day-dreaming)

B) Modes of Operation

i) Completely conscious control (imagery)
   . deliberate access to / control of process
   . can be assisted by new areas of technology/research:
     • static: information visualization; dynamic: visual analytics
   . in both cases, using vision to think

ii) Communication with nonconscious: Get an explanation via sudden inspiration [creativity]
   . ideas just appear - often as images (thus, light bulb): imagination
     • deeper level: nonconscious preparation / processsing
     • suggestions thrown up by nonconscious mind
       • myth and metaphor - common ways of communicating with n/c mind
       • the way nonconscious mind works?
   . visual thinking at lower levels – reorganization of info into new basic categories
   . again, this process needs a lot of control
     • need to think about problem consciously, then let nonconscious systems work
2. Finding an explanation

Key aspect of training is: **do not jump to conclusions**: don’t grab the first idea that emerges (cf. need to test alternative hypotheses). **Don’t rush.**

**Evolutionary process**

1. begin by understanding existing situation (critical thinking; mental picture)
2. **generate** a set of possible hypotheses to account for the unknown (imagination)
   
   Darwin – “I steadily endeavoured to keep my mind free so as to give up any hypothesis, however much beloved”
   
   o first hypothesis is rarely the best one
3. for each, **evaluate** whether it is viable (critical thinking; mental picture), then select the best

Interaction with facts is necessary, since there are **limitations to imagination**

1. since imagery is perception “run in reverse”, it inherits many of its limitations
   
   1. skips over unfamiliar/unknown, fills in gaps (without people being aware)
   
   ▪ can’t take everything into account (e.g. consequences; rest of system)
   
   ▪ related: if can’t perceive, can’t imagine
   
   2. tends to emphasize present perspective
   
   ▪ e.g., difficult to accurately imagine what you’ll do 50 years from now
   
   3. limited ability to deal with interactions
   
   ▪ can’t take everything into account (e.g. consequences; rest of system)
   
   ▪ e.g., interactivity with environment is difficult to imagine accurately

3. How to Come up with Ideas / Insight

1. Curiosity is the primary incentive – provides basic motivation
   
   1. inherent in humans, at least to a certain age
   
   ▪ can possibly keep forever
   
   2. need to have extensive background knowledge (Taylor – see Beveridge)
   
   ▪ great set of stored patterns to draw upon

2. Discussion with others also a good stimulus

   1. different background knowledge; different perspectives
   
   ▪ combined knowledge might be enough
   
   2. people in the “real world” often have valuable experience
   
   ▪ sometimes, even suggest interesting new problems

3. Reading papers

   1. particularly overviews, editorials
   
   ▪ provides different perspectives, different assumptions
   
   ▪ similar in some ways to discussion

   2. also, trains reader in the kinds of patterns that might be relevant

4. Develop expertise in a second area – one that is different than the first

   1. provides different perspectives, different assumptions