Reports on the Visual Thinking Experience

There are many anecdotal reports of the importance of visual thinking in science. Perhaps the best known visual discoveries are the benzene ring and the helical structure of DNA. Friedrich Kekule envisioned the benzene ring in a dream of a snake biting its own tail.

- "The most striking - and a unique - feature of the mind is the acceptance and use of things as symbols standing for other things. Symbols may stand for, refer to, or mean other things which may or may not lie within the world of physics.....In this sense we find the mind in computing machines". Richard L. Gregory in Mind of Science

Using geometrical representations of physical properties transcends the use of graphics for presentational value. In some cases graphical representations become integral part of developing and understanding the theory. In the first sentence of J. Willard Gibbs first of three historic publications, "Graphical Methods in the Thermodynamics of Fluids":

- "Although geometrical representations of propositions in the thermodynamics of fluids are in general use and have done good service in disseminating clear notions in the science, yet they have by no means received the extension in respect to variety and generality of which they are capable."

Such statements inspired James Clerk Maxwell to create in clay and plaster representation surfaces of thermodynamic property relationships derived by Gibbs. Maxwell sent one of three models to Gibbs at Yale in 1874 which now gathers dust in a display case next to a trash bin.

With this basic principle we can conclude that computer graphics can enhance our ability to think visually. In fact this hypothesis will be the underlying theme in this course. Max Planck noted an interesting parallel between abstract, visual thinking and inquiry in science:

- "My original decision to devote myself to science was a direct result of the discovery which has never ceased to fill me with enthusiasm since my early youth - the comprehension of the far from obvious fact that the laws of human reasoning coincide with the laws governing the sequences of the impressions we receive from the world about us; that, therefore, pure reasoning can enable man to gain an insight into the mechanism of the later. In this connection, it is of paramount importance that the outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life". Max Planck in Scientific Autobiography.

Even more vivid was Albert Einstein's explanation of visual thinking.

- "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined .... this combinatory play seems to be the essential feature in productive thought before there is any connection with logical construction in words or other kinds of signs which can be communicated to others". Albert Einstein in a letter to Jacques Hadamard.

A more contemporary example of visual thinking is given by James Gleick from "The Life and Science of Richard Feynman", Vintage Books, New York, 1992.

- "Visualization - you keep repeating that", he (Feynman) said to another historian, Silvan S. Schweber, who was trying to interview him

Feynman: "What I am really try to do is bring birth to clarity, which is really a half-assedly thought-out-pictorial semi-vision thing. I would see the jiggle-jiggle-jiggle or the wiggle of the path. Even now when I talk about the influence functional, I see the coupling and I take this turn - like as if there was a big bag of stuff - and try to collect it in away and to push it. It's all visual. It's hard to explain."

Schweber: "In some ways you see the answer - ?"

Feynman: "The character of the answer, absolutely. An inspired method of picturing, I guess. Ordinarily I try to get the pictures clearer, but in the end the mathematics can take over and be more efficient in communicating the idea of the picture."

"In certain particular problems that I have done it was necessary to continue the development of the picture as the method before the mathematics could be really done."

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