Welcome

The Quest for Creative Research

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Definition of Creativity

* oxforddictionaries.com
  The use of imagination or original ideas to create something
* wikipedia.com
  A phenomenon whereby something new and valuable is created
* education.com
  How to define creativity is an age-old question
  The kind of gift associated with a Michelangelo or Einstein

Key components
  * Originality
  * Significance

Theories of Creativity

Summary by Weisberg:

* Developmental
  Developing over time; Interactions with people and environment
* Psychometric
  Testing and measurements; Domain specific, different from IQ
* Economic
  Influenced by market forces; Cost-benefit analyses
* Stage and componential process
  A series of stages or components; Linear and recursive process
* Cognitive
  Thinking; Association; Combination; Imagination; Expansion

Reference: Robert W. Weisberg, Creativity, Understanding Innovation in Problem Solving, Science, Invention, and the Arts, John Wiley & Sons, 2006.

Originality and Appropriateness

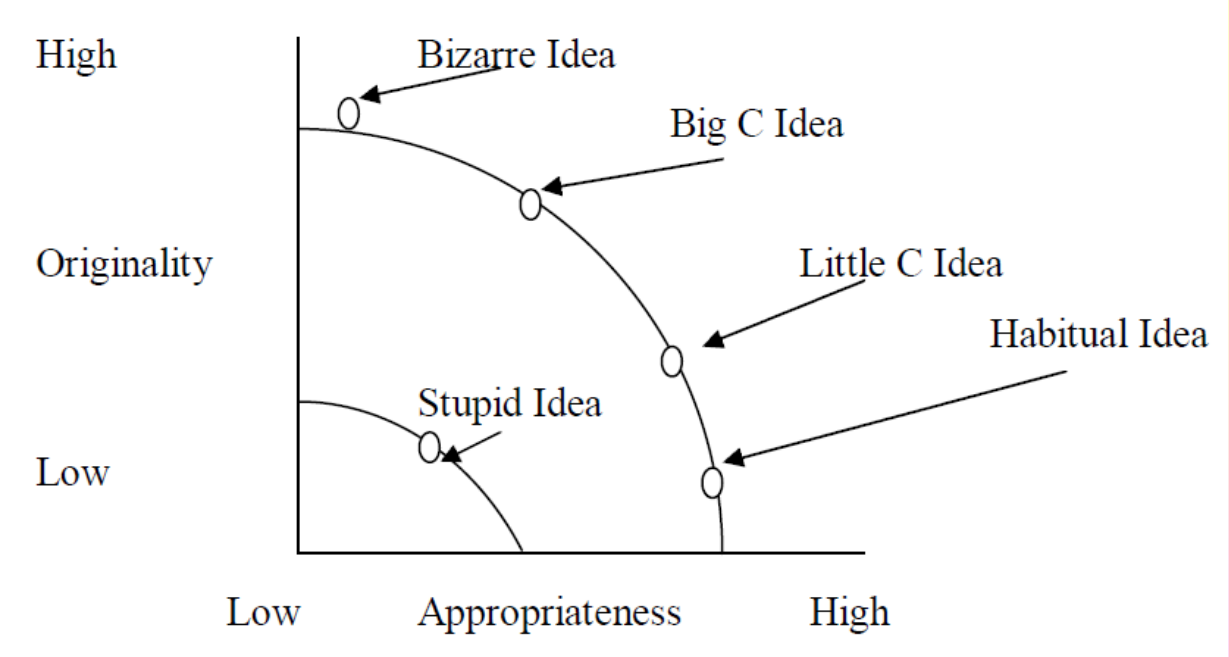


Diagram from reference: Mark Kilgour, Big C versus little c Creative Findings, Call for Creative Futures Conference Proceedings, Sanna Karkulehto and Kimmo Laine (eds), 2007.

Investment Theory of Creativity

Sternberg and Lubart:

Creative people buy low and sell high

(buy high, sell low) (buy high sell high)

(buy low, sell low) (buy low, sell high)

Buy low:

Idea unknown, out of favor, encountering resistance

Having growth potential

Sell high:

Idea workable, solving significant problem

Idea becomes very popular later (sell high)

Reference: Robert J. Sternberg, The Nature of Creativity, Creativity Research Journal, 2006.

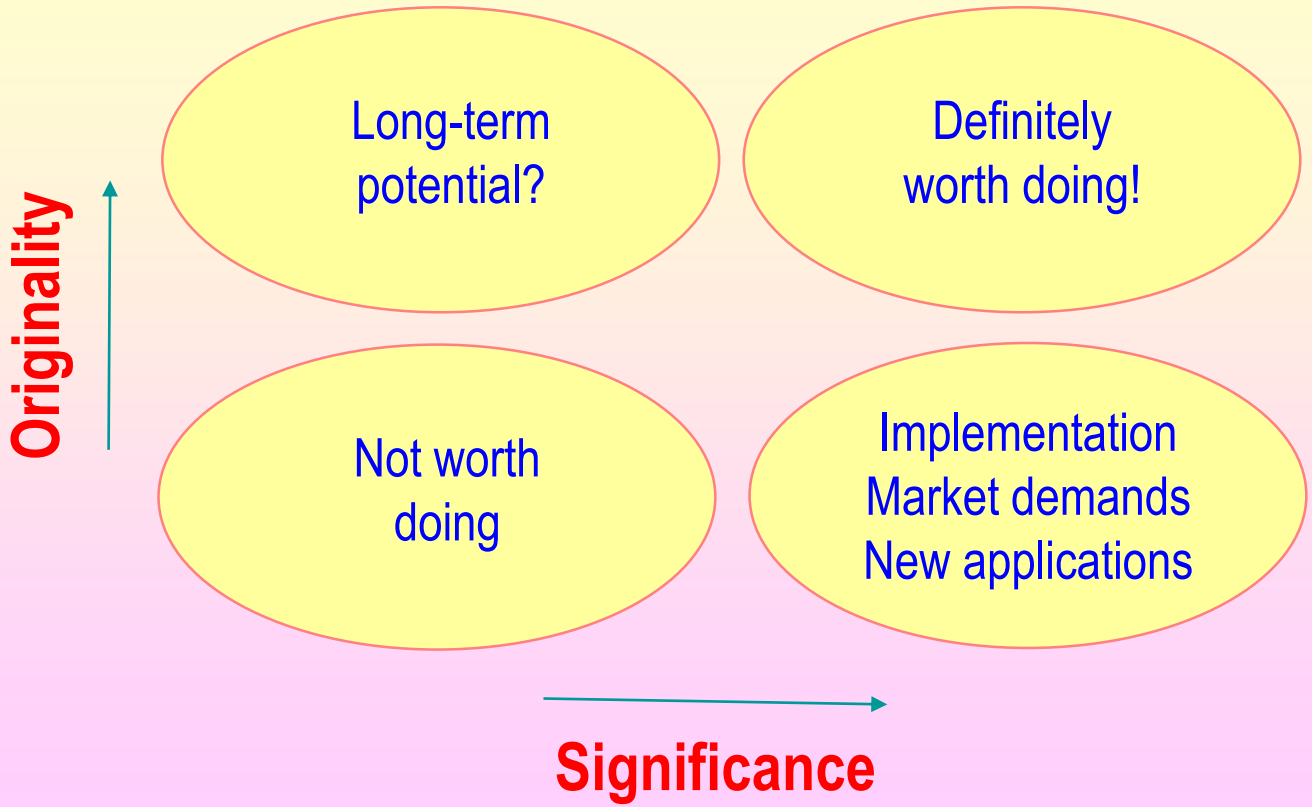
Aspects of Investment Theory

Intellectual abilities
Knowledge
Styles of thinking
Personality
Motivation
Confluence

Reference: Robert J. Sternberg, The Nature of Creativity, Creativity Research Journal, 2006.

Originality and Significance

Combining originality/appropriateness and investment theories:



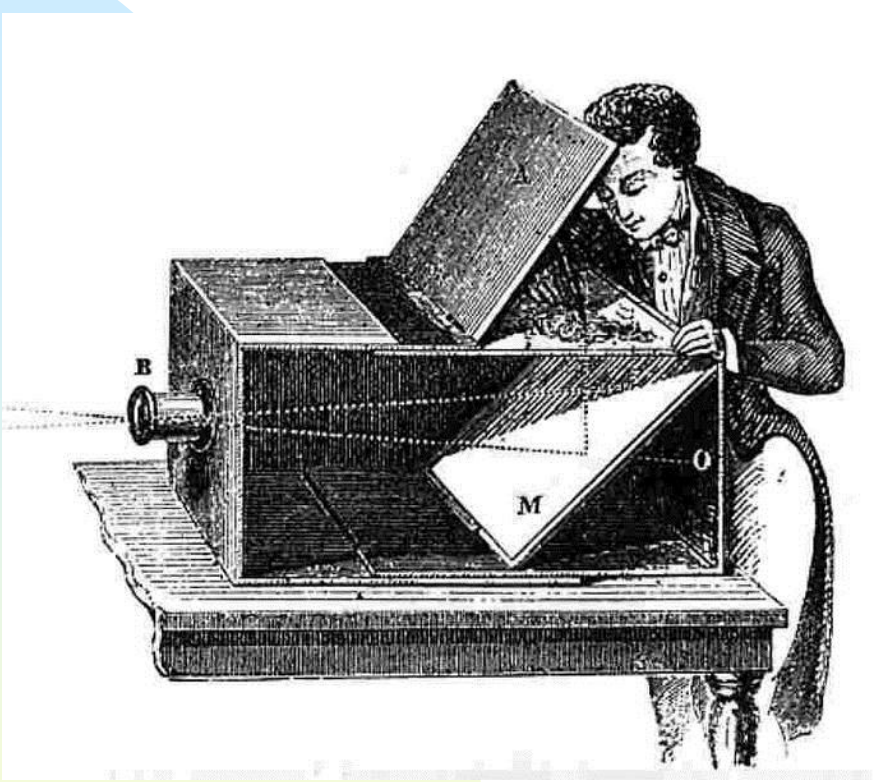
Creative R&D Work of Imaging Systems

	Drawing	Analog
1544	Camera	
1867	Movies	
1896	X-ray	
~ 1900	TV	
1975	Digital camera, Fax machine, Optical scanner	Digital
1981	HDTV, Video	
~ 1970	CT, MRI, DSA, etc	

Drawing

Image from http://www.picturedraw.co.uk/images/how_to_draw1.jpg

Cameras



1544 to 1558, ideas by Reiners Gemma Frisius and Giovanni Batista della Porta

1885, Kodak camera by George Eastman

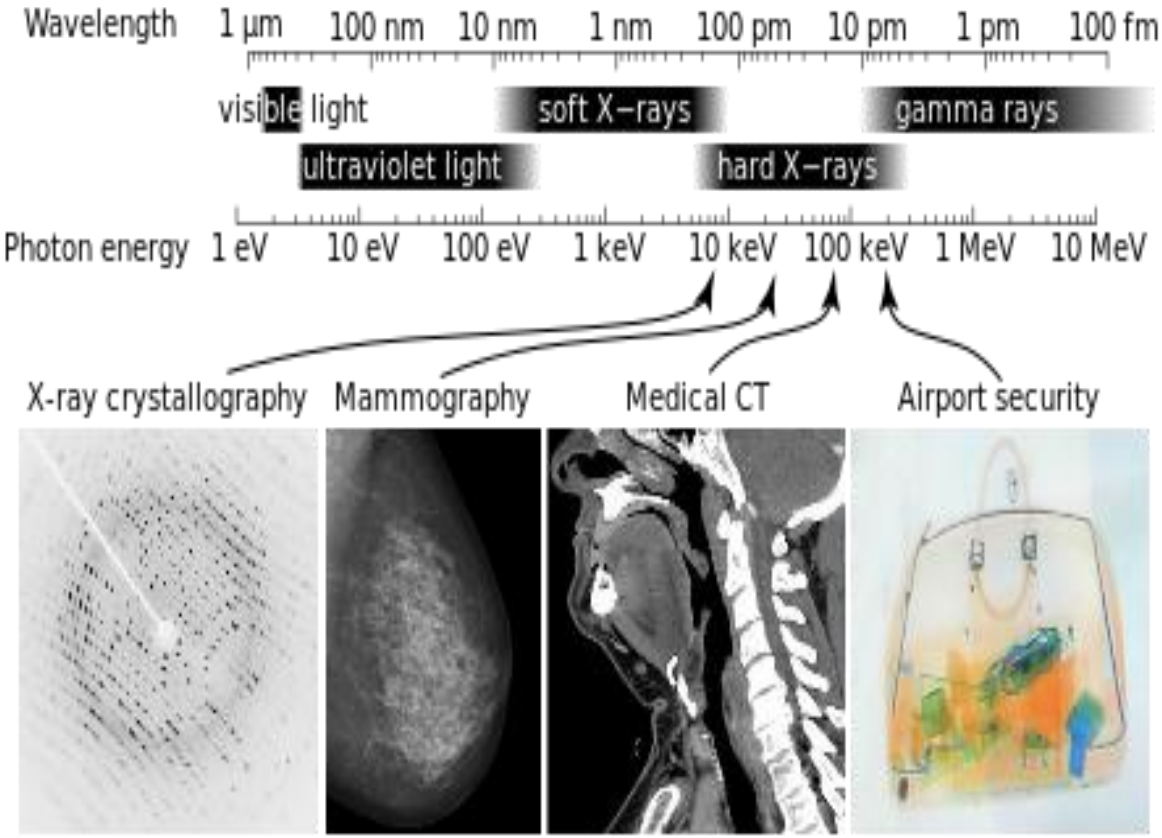
Images from http://en.wikipedia.org/wiki/History_of_the_camera

Motion Pictures

1867, animated picture machine patented in US by William Lincoln

Images from http://inventors.about.com/library/inventors/blmotionpictures.htm

X-Rays



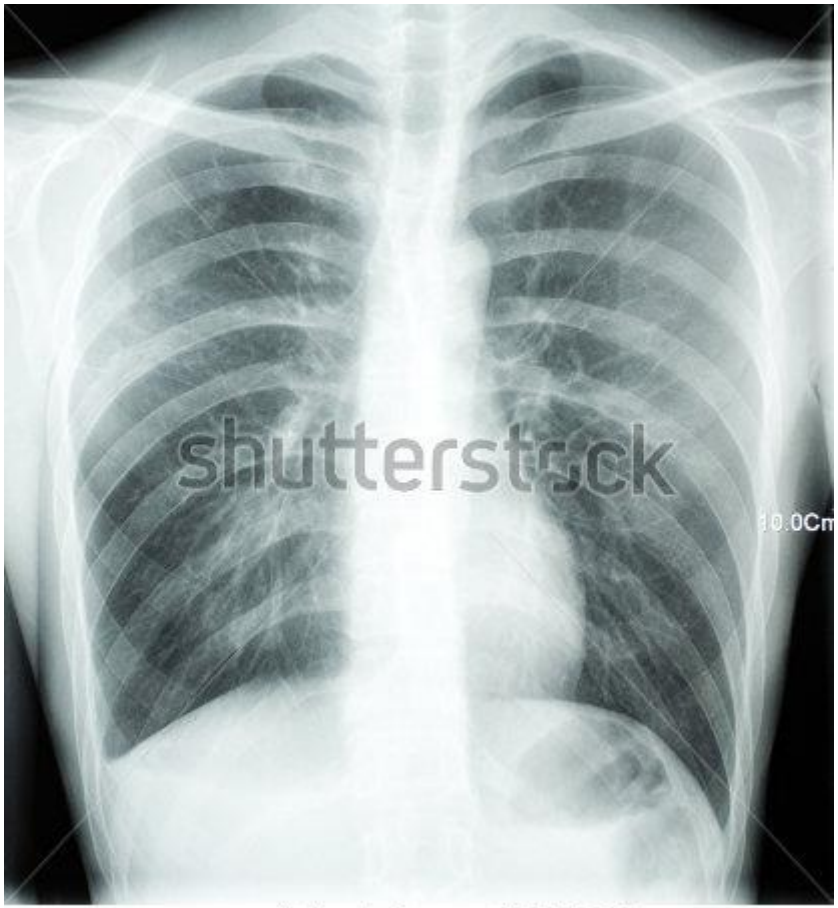
1896, Wilhelm Conrad Röntgen discovered the X-ray

1901 Röntgen received Nobel Prize

Images from http://inventors.about.com/od/xyzstartinventions/a/x-ray.htm
http://en.wikipedia.org/wiki/X-ray

X-Ray Machine

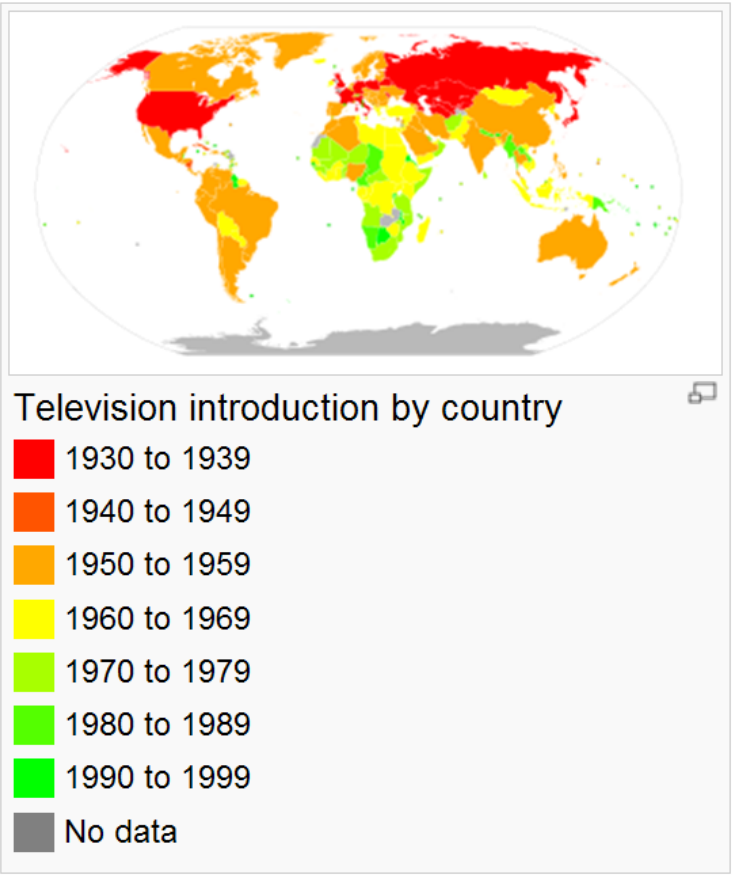
www.shutterstock.com · 124281973



www.shutterstock.com · 126598016

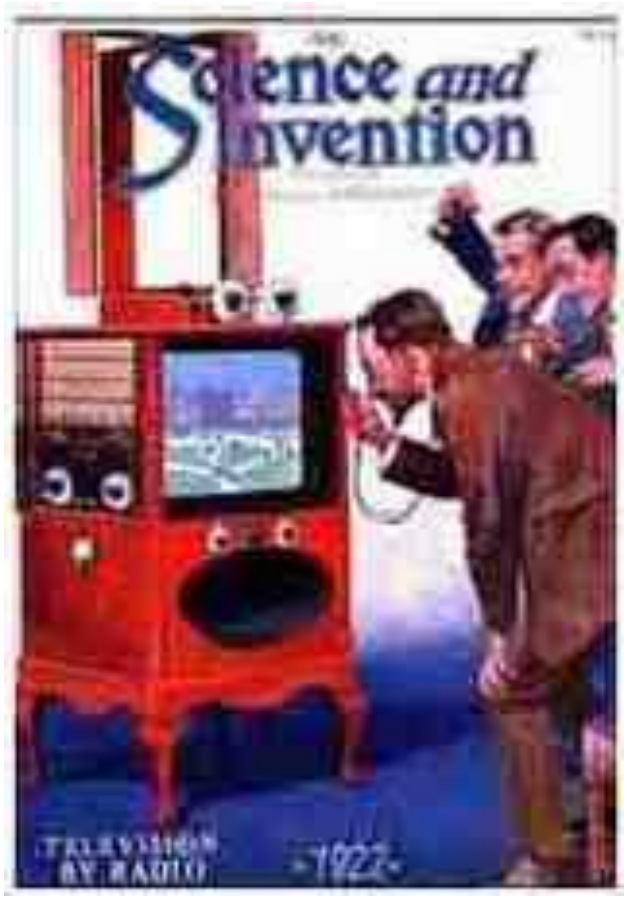
Television

Inventor: John Logie Baird
Scottish engineer
Launch year 1928



Images from http://en.wikipedia.org/wiki/Television

First TV Image



Images from http://inventors.about.com/od/tstartinventions/a/Television_Time.htm
http://en.wikipedia.org/wiki/History_of_television

Digital Camera

1975, digital camera first built by Steven Sasson at Eastman Kodak

Images from http://en.wikipedia.org/wiki/Digital_camera

Creativity in Imaging System Development

High originality and significance

Big market-forces and cost-effective solutions

Knowledge in different areas needed:

Optics, electronics, physics, memory, printing

Interdisciplinary work

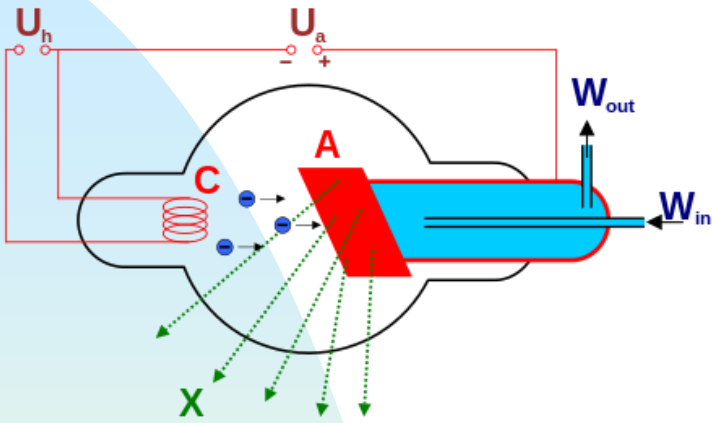
Both theoretical and experimental work

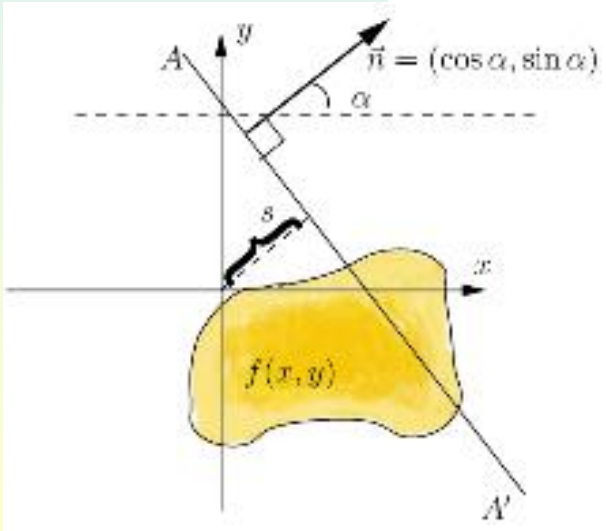
Association of different systems and processes

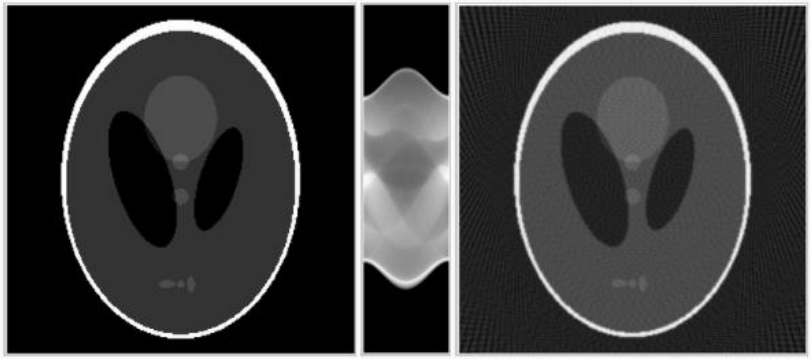
Long period of R&D

Theories of creativity: Developmental, Economic, Stage and componential process, Cognitive

From X-Ray to CT

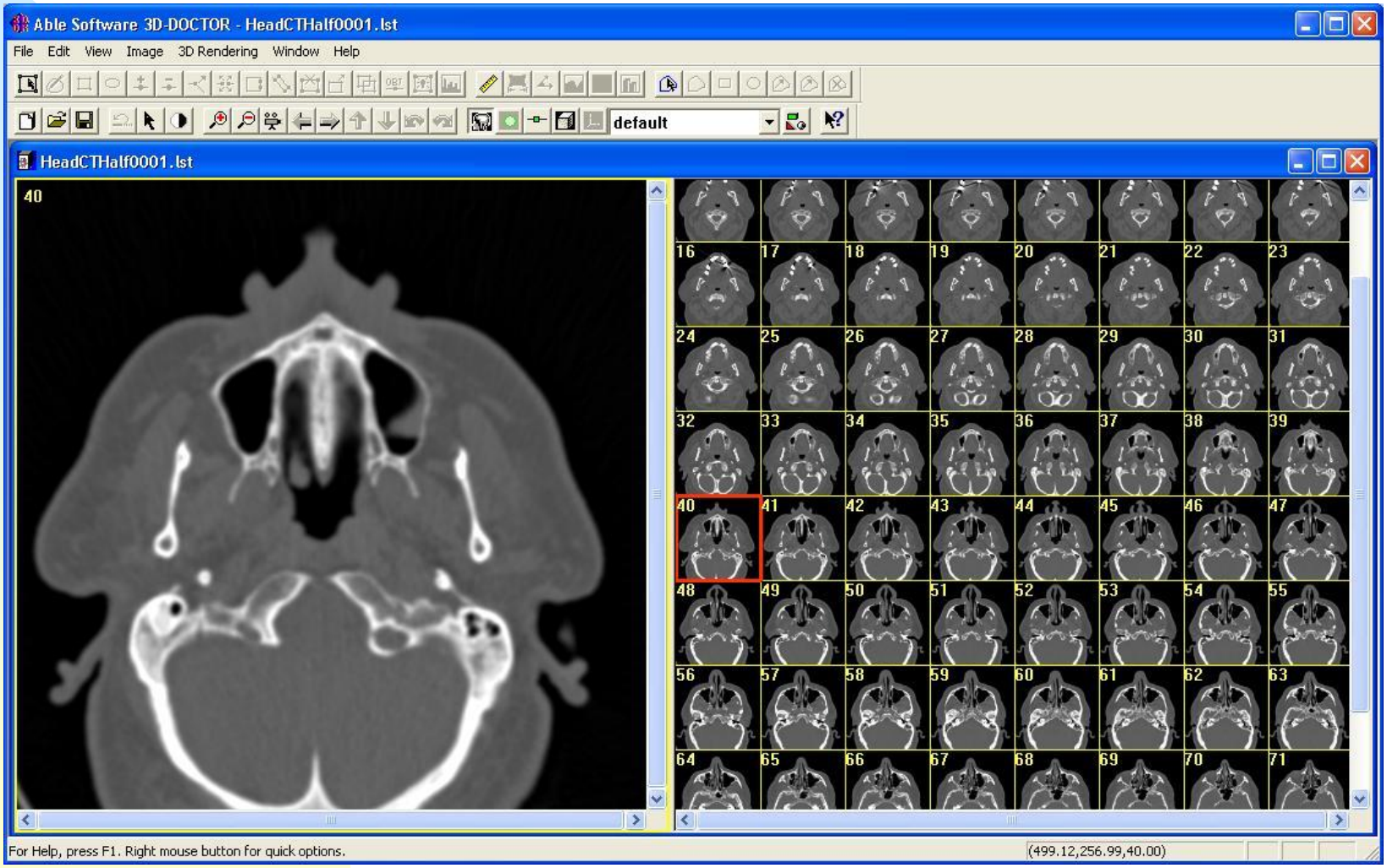






Images from http://en.wikipedia.org/wiki/X-ray
and http://en.wikipedia.org/wiki/Radon_transform

Significance of 3D Imaging



Images from http://www.ablesw.com/3d-doctor/tutor11.jpg

Creative Work in CT Development

1896	X-Ray imaging
	2D information
1917	Mathematical transform by Johann Radon
	Quiet period
1950's	Theoretical formulation of CT by Allan Cormack
	Quiet period
1971	Actual CT built by Godfrey Hounsfield
	3D information
1979	Cormack and Hounsfield received Nobel Prize

Unpopular idea → Popular idea → Useful products

First Magnetic Resonance Image

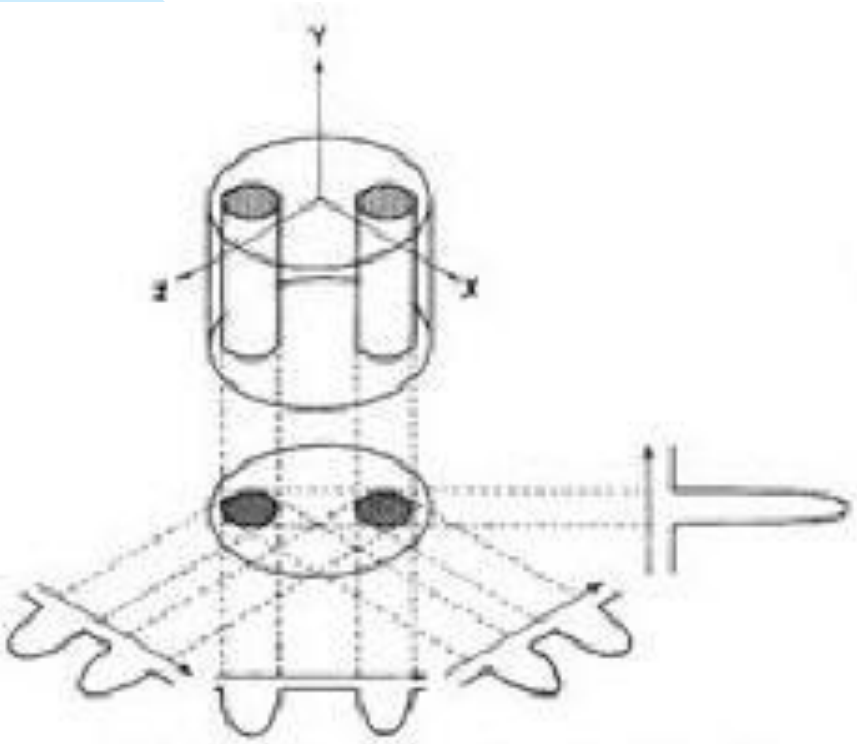


Fig. 1 Relationship between a three-dimensional object, its two-dimensional projection along the Y-axis, and four one-dimensional projections at 45° intervals in the XZ-plane. The arrows indicate the gradient directions.

Fig. 2 Proton nuclear magnetic resonance zeugmatogram of the object described in the text, using four relative orientations of object and gradients as diagrammed in Fig. 1.

Images from http://benbeck.co.uk/firsts/2_The_Human_Subject/scanningh.htm

Lauterbur's Paper on Zeugmatography (MRI)

Editor: Insufficiently wide significance for inclusion in Nature

Lauterbur: Resubmitted the paper and explained the importance

Reviewer: The example is a trivial one

Reviewer: Further evidence of the usefulness needed

Accept because of Lauterbur was already well-known

Lawyer: Patent not worthwhile

SUNY: Inability to identify potential market

Cannot license the technology to industry

2003 Paul Lauterbur and Peter Mansfield received Nobel Prize

(30 years after the first image was published)

Reference: Amit Prasad, Imperial Technoscience, Transnational Histories of MRI in the United States, Britain, and India, MIT Press, 2014.

MRI Spin Warp Sequence

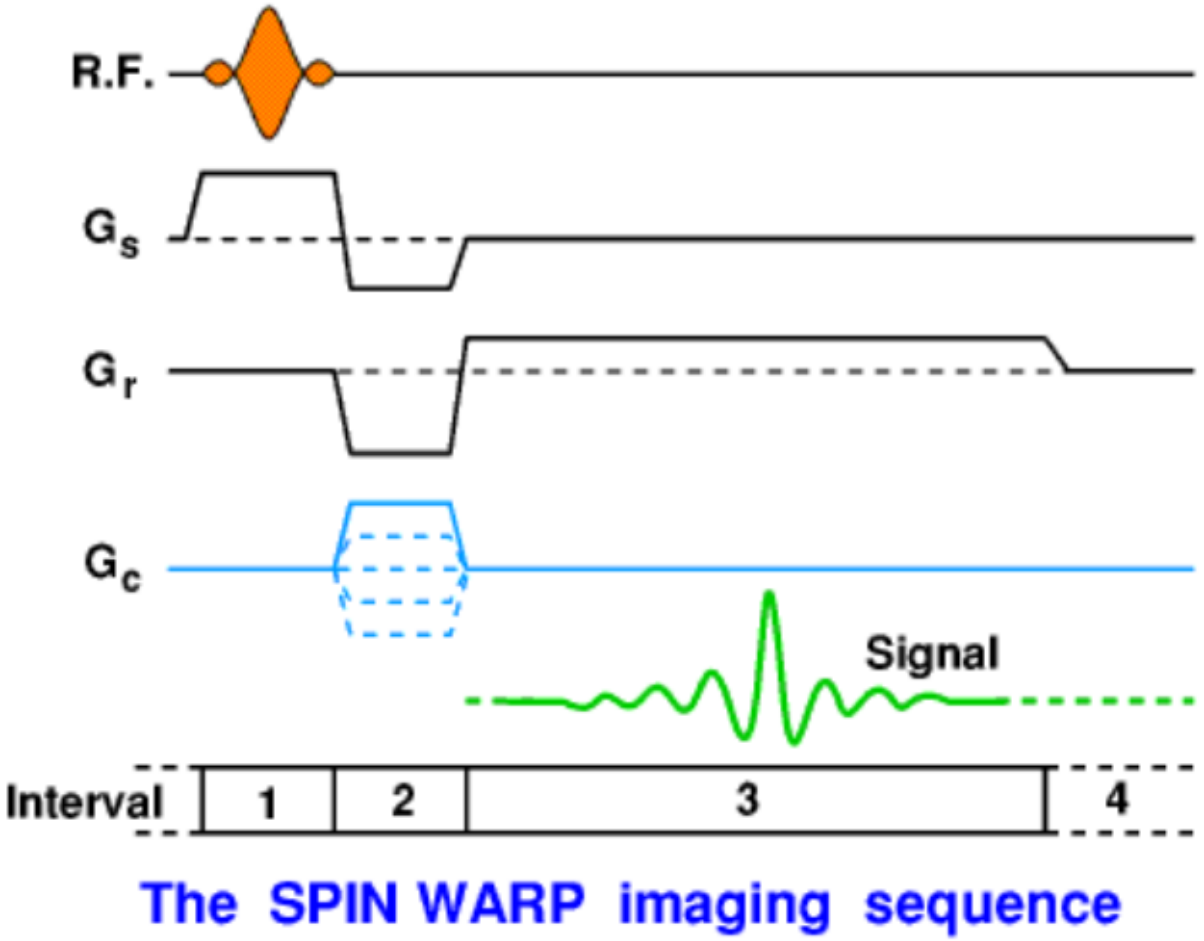
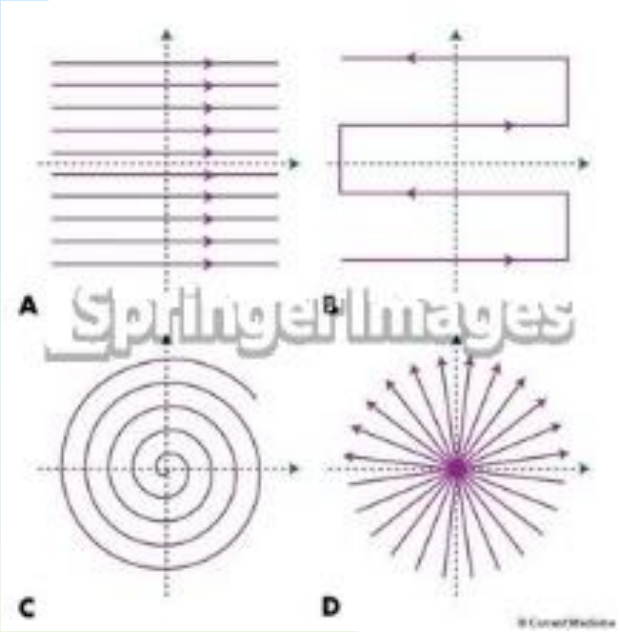
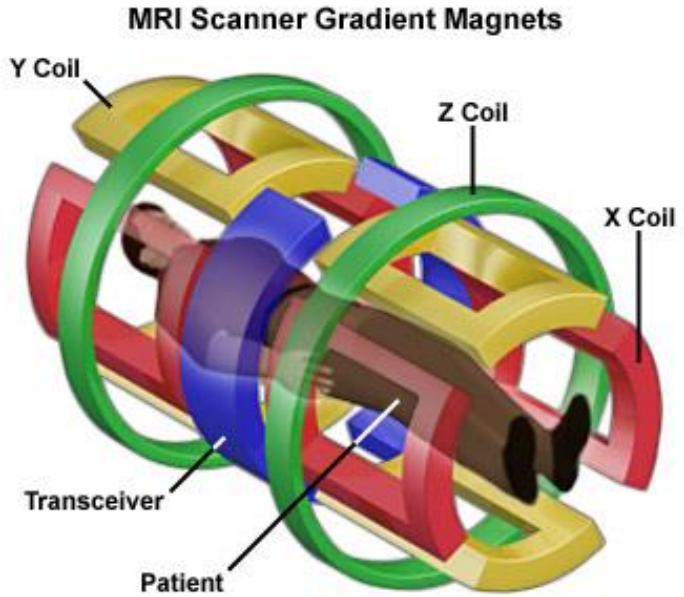


Image from http://www.hutch73.org.uk/MRI-imeth/spinwarp.html

The K-space Concept





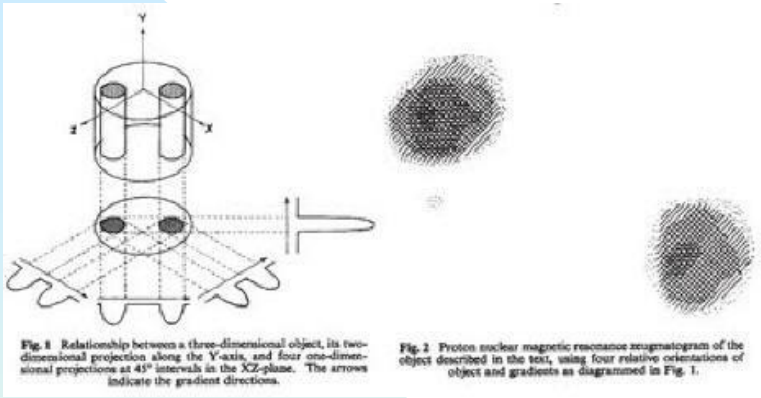
K-space = 2D Fourier spatial frequency space

Signal sampling in image or spatial frequency domains

Theory well developed in signal processing and digital telecommunications

Images from http://img.springerimages.com/Images/ImagesMD/MRI/WATER_MRI0101-02-006.jpg
and http://www.magnet.fsu.edu/education/tutorials/magnetacademy/mri/images/mri-scannercoils.jpg

Today's MRI Technology



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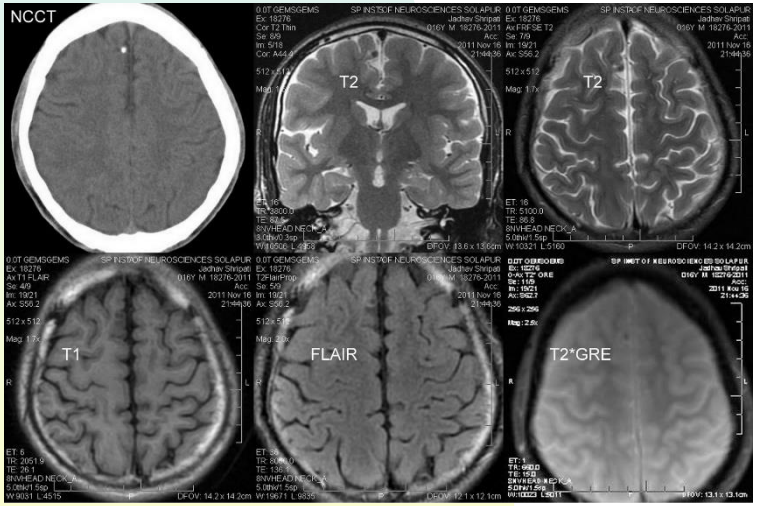


Images from http://benbeck.co.uk/firsts/2_The_Human_Subject/scanningh.htm, http://thumbs.dreamstime.com/z/mri-scan-complete-real-upper-part-human-body-34800538.jpg, http://1.bp.blogspot.com/-iolzA-LE52Q/Tsk_kSA1BLI/AAAAAAAA3dY/fSPIYcytymU/s1600/calcified+granuloma+CT+MRI.jpg

Creative Work in MRI Development

Learning from other fields

Starting with unpopular ideas

Initial results may not be perfect

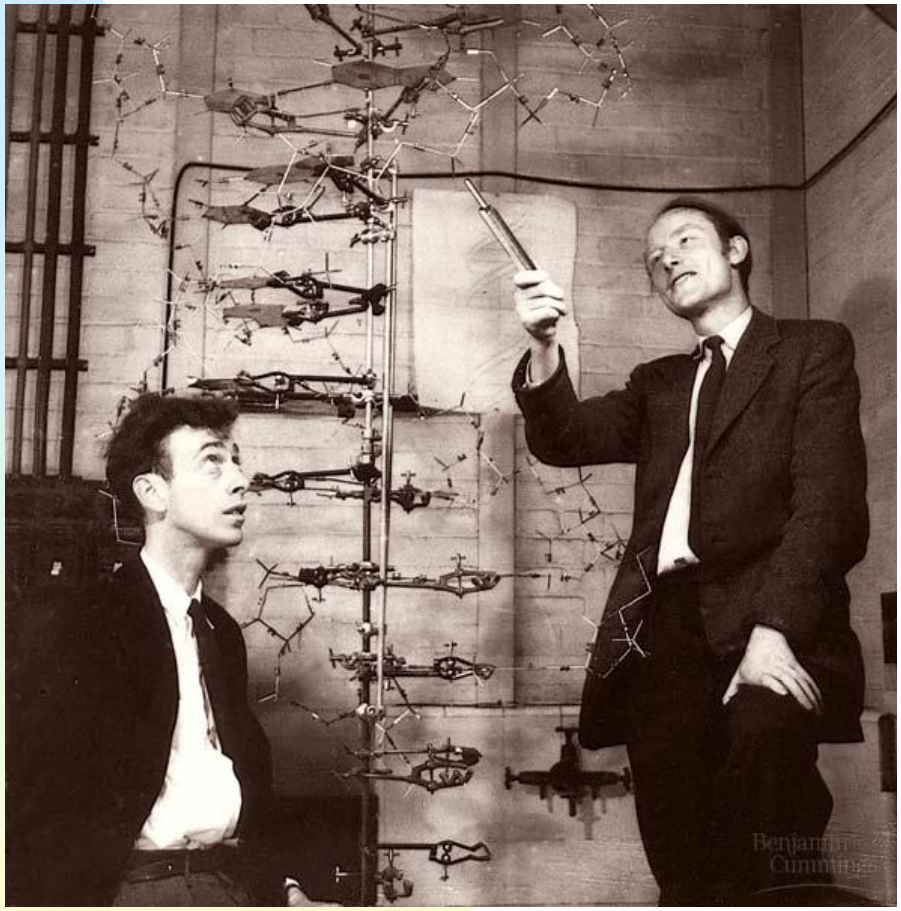
Significance may not be obvious initially

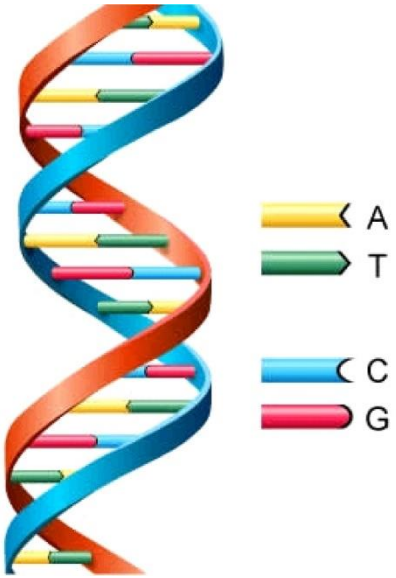
Overcoming resistance to new ideas

Having confidence with one's work

Persistent in achieving one's goals

Double Helix Structure of DNA





Francis Crick, James Watson and Maurice Wilkins received Nobel Prize in 1962.

Images from http://www.astrochem.org/sci_img/dna.jpg and http://1.bp.blogspot.com/-PD7HkdoJsfY/T0xhoHvNZYI/AAAAAAAACjM/N4YFypOwSwk/s1600/watsoncrick.jpg

Creative Research in DNA Structure

Edwin Chargaff's Rules:

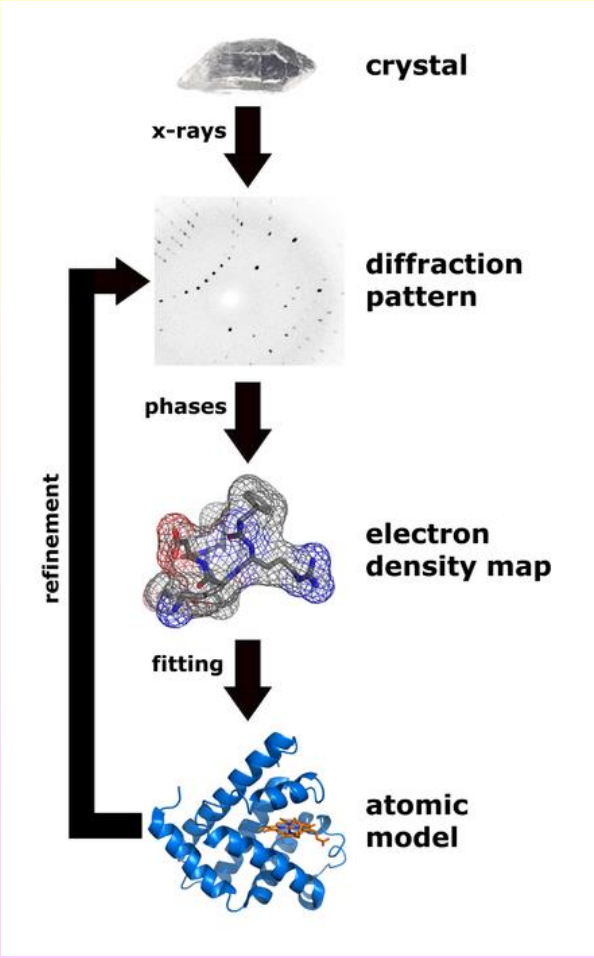
1. $N_A = N_T$, $N_C = N_G$

   People though $N_A = N_C = N_G = N_T$

2. DNA composition different for different species

X-ray diffraction images obtained by Rosalind Franklin and Maurice Wilkins.

X-Ray Crystallography



William Lawrence Bragg and William Henry Bragg shared Nobel Prize in 1915 for discovery of Bragg's law in X-ray scattering.

Dorothy Crowfoot Hodgkin was awarded Nobel Prize in 1964 for her work on X-ray crystallography of biomolecules.

Dorothy Crowfoot Hodgkin worked on the structure of insulin for 34 years and publish it in 1969.

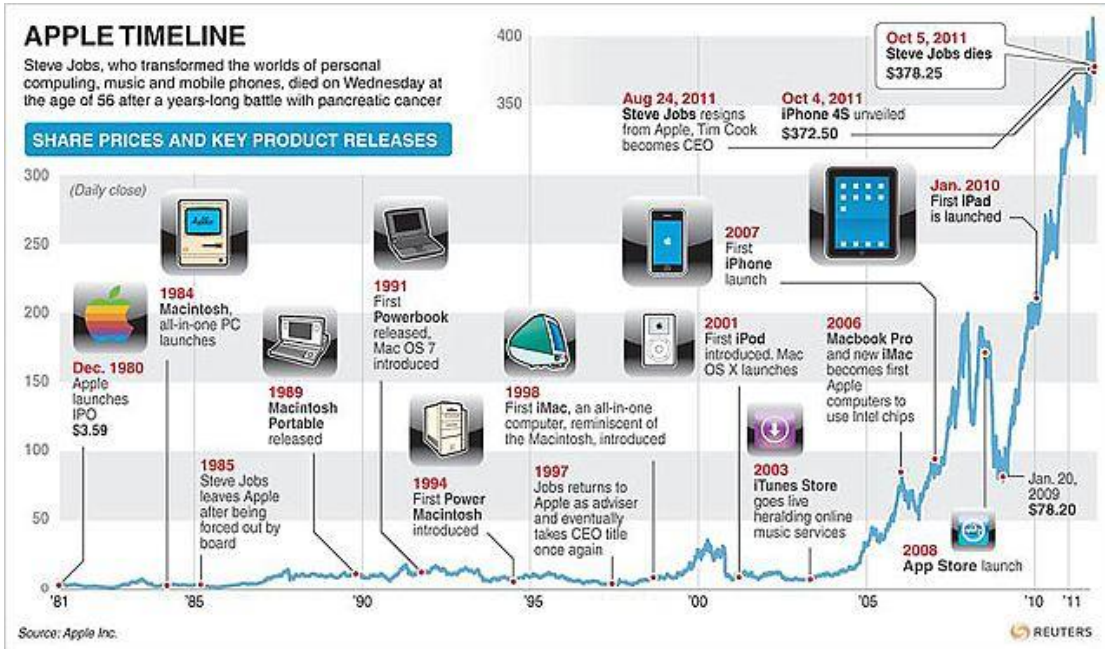
Image fromhttp://en.wikipedia.org/wiki/X-ray_crystallography#cite_note-85

Steve Jobs' View of Creativity

Creativity is just connecting things. When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something. It seemed obvious to them after a while. That's because they were able to connect experiences they've had and synthesize new things. And the reason they were able to do that was that they've had more experiences or they have thought more about their experiences than other people.

Keywords: Connecting things

Apple's Products



Images from http://www.thegraphicmac.com/wp-content/uploads/web_apple-then-now.jpg and http://i.dailymail.co.uk/i/pix/2011/10/07/article-2046397-0E46062300000578-455_634x372.jpg

Apple's Success: Connecting Things

Introducing mouse as a pointing device

Attractive design: combining arts and technology

Putting music on portable devices

Creating online music services

Introducing multi-touch to mobile phones

Tablet: bridging notebook and mobile phone

Summary

Two key components in creativity:
- Originality and Significance

Recognize and aim to solve significant problems

Learn from different fields

Deep understanding of the problems

Don't be afraid of trying unpopular methods

Don't be afraid of resistance and setbacks

Connect things, imagination, combination and expansion

Results may not be perfect initially

Both theoretical and experiment work needed

Persistent in achieving one's goals

End of Presentation

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http://www.ee.cityu.edu.hk/~hpyan

Thank you

for

attending the presentation