12/9/85

Chit Chat Club

The Second Half

I. Computer and Robot System

A. Computer

1. Machine for handling abstractions.

2. Stores, retrieves and processes data.

B. Robot

1. Machine for accomplishing concrete physical actions.

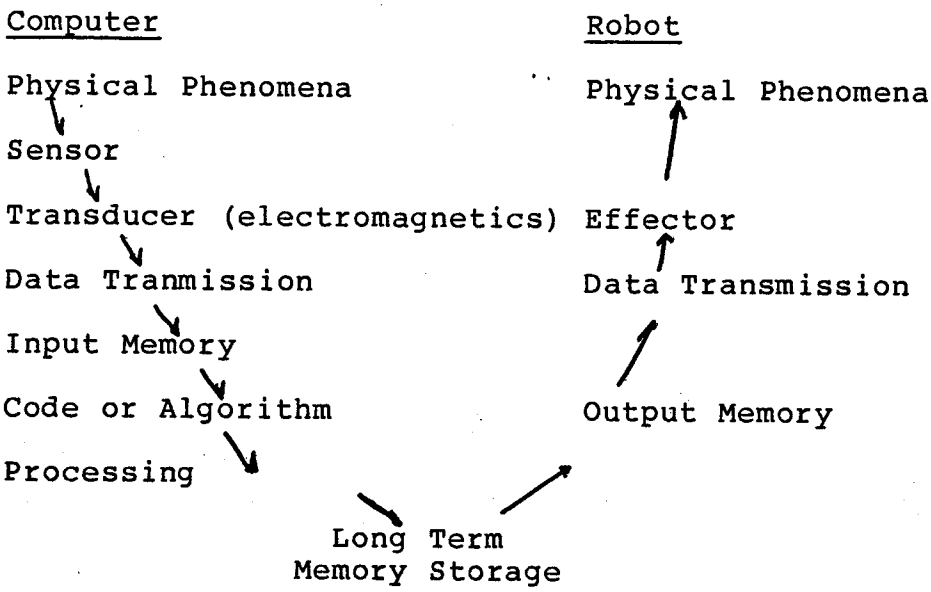
2. Human-like and takes action without human control.

3. Not the extension of a computer - it is the physical fulfillment.

II. Computer

A. Assembly of components which take symbols representative or derivative of physical reality and commonly reduces them to Ø's/1's.

B.



C.

1. Computer deals in data and symbols.

2. An assembly of on/off switches with capability for flow of electrons.

3. Not the actual electron flow, only potential.

4. Very foundation is abstraction - a lifting out.

5. Data which has no reference to things.

III. Robot

A.

1. Assembly of components which takes abstraction of Ø's/1's and converts them to physical reality or concrete action.

2. It is the other half.

B.

1. A robot, as generally conceived, is many potentialities in human form or taking human-like action without human control.

2. But this human inference is too narrow.

3. A better definition is in terms of degrees of freedom of action or potential dimensions of movement. How many ways can it move by itself?

IV. Usable Degrees of Freedom Define Man's Process in Shaping Nature - The Number of Dimensions of Freedom

A. One degree machine -

1. A push rod.

2. In/out, up/down.

3. A hydraulic cylinder.

B. Two degree machine -

1. A tilt steering wheel.

2. Up/down and rotation.

3. A rear wheel on a car.

C. Three degrees of freedom -

1. Up/down, right/left, rotation.

2. A front wheel on a car.

D. All the above relate to tools.

1. Machine tools have proceeded to five or six degrees of freedom - limits of mechanical or electromechanical components.

2. But there progress stopped - limited by data storage.

3. Even then, the results are impressive:

a. Punched tape - Numerical Controlled Machine tools.
b. Punched cards.
c. Analogue or curve followers.
d. Mechanical computers.

E. Then came the interface with digital computers.

1. Opening for very many degrees of freedom, almost an unlimited number.

2. From this interface with the first half of the system came the real possiblity for true robots.

Relate to Human History

1. Pre-historic	1960
2. Dawn	1960-1965
3. Dark Ages	1965-1970
4. Renaissance	1970-mid 1980's
5. Future	After 1985

V. Generation of Robots

A. First Generation - Prehistoric - Before 1960

1. Simple movements.

2. One or two degrees of freedom.

3. Hard wired memory.

4. Started in U.S. Moved to Japan. Japan is heavy.

5. Followed by Dark Ages - 1960-1965 - little action or change - perhaps a digestion or a waiting for growth in computer capability.

B. Second Generation - Dawn - 1960-1965

1. Welding - tracking.

2. Painting.

3. Materials handling.

4. Mostly hard-wired, little software.

5. Highly programmed and hard to reprogram.

6. Requires hands-on or on-line teaching.

7. Japan is heavy/U.S. catching up particularly in

electronics and autos/Europe slow.

C. Third Generation - Renaissance - 1970-mid 1980's

1. Simple assembly.

2. Quality control.

3. Adaptive programming or off-line programming.

4. Some limited learning.

5. Some optical sensing.

6. Von Neuman computers and serial logic processing.

D. Fourth Generation of Robots - The Future - after 1985

1. Complicated assemblies.

2. Steps beyond human shape and action.

3. Android or non-anthropamorphic.

4. Totally redesigned systems and products.

5. Parallel Processing

VI. Examples of Third Generation -

Four typical concepts

a. No screws.
b. No blind spaces.
c. Better quality or tolerance control.
d. Seeing.

A. No screws

1. Human shoulder - 3 degrees of freedom.

2. Human elbow - 3

3. Human wrist - 3

4. Human fingers - 1, 2, 3 - end effector.
5. Screws may require some of all above plus a huge memory and two complicated data transmission systems - stereochemical (hormonal) in blood stream and neural (electrical) in nerves.

6. Solution - use snap or push fasteners.

7. The Fiero Space Frame.

B. No blind spaces.

1. Requires feel.

2. Can't see.

3. Must remember.

4. Suffers with fluid or dirt hang-up.

5. Requires orientation.

6. Requires much memory.

C. Better tolerances.

1. Judgment is expensive in memory and sensors.

2. But electronics makes sensing faster.

3. Robots require and make better tolerances.

4. Better quality is a result.

D. Seeing or Vision - Optical Input/Output.

1. The concept of vision is not understood.

2. Principals

Lines - parallel
Lines - intersecting
Groups of lines - Philosophical Concept
Chairness
Forkness
Bottleness

3. Binary seeing - black/white.
Grey scale seeing.
Color seeing.

4. Quantitive Sphere of Value/hue/chroma.

a. Albert H. Munsell - Color theory - 1858-1918 - American - Boston
b. Non-scientist - Normal Art School in Boston
c. Terrible artist
d. Paint matching

E. Work stations.

1. Robot is the center piece.

2. Input materials handling and supply.

3. Input coding or orientation.

4. Tool specification and supply.

5. Output coding.

6. Quality control or inspection.

7. Output materials handling.

8. Peripherals are in 3x cost of robot.

9. Peripherals will grow 10x and robots 3x to 1989.

F. Communication.

1. GM has 40,000 intelligent machines. Only 15% can communicate.

2. 1990 - GM will have 200,000 programmable devices.

3. MAP - Machine Automation Protocal.

4. GM will have 50% of U.S. robots by 1990. They also make 50% of U.S. robots - GMF.
5. 15,000 robots by 1990. As many as whole U.S. prediction by people of 150 Key Delphi respondents.

6. Simplistically GM bought for 7-8 billion

a. Ross Perot's company to handle software.
b. Hughes to provide hardware.

VII. Fourth Generation - Artificial Intelligence - The Future Beyond 1985

A. Characteristics

1. Proceeding from serial processing to internal, responsive, self-programming.

2. Machines writing their own code.

3. SDI - 10 million lines of code - perhaps 100 million lines.

4. New rules for writing code.

5. Word "artificial" may be a put-down.

B. Results of AI

1. Divergence and diversity.

2. Reduction of code space, CRAY II vs. Sun machine or Apple in computer chess.

3. New machines such as Cal Tech's Hypercube.

VIII. Objectives for a Late Third Generation Robot Which can Grow

into Fourth Generation

A. Software-based design rather than a derivative androidal mechanism. A programmable rather than a teachable system.

B. Designed for reproducible optical control.

C. Light weight with modular and interchangeable parts.

D. Minimal moving parts.

E. No drive motors on arm.

F. Scaleable up or down in size.

G. Applicable to hostile environments.

H. Low cost or high cost embodiments.

I. Low precision or high precision embodiments.

J. High angular deflection rates and large overall curvature possible.

K. Prototype of some parts in hard. A system working in 1-2 years.

IX How are Robots Doing?

A. Miserable. Commercially.

1. 1970's - multi billion $ projections by 1985.

2. Facts of 1985 - $300,000,000.

3. 90 companies. Few, if any, are profitable.
4. Little major business except auto companies.

5. Third Generation saturation of auto industry by late 1980's.

B. Why?

1. Robot out of the box concept.

2. Software inadequacy.

3. Robot and product designs not adaptable to change.

4. 70% of manufactured hardware in U.S. is batch processed; i.e., small runs.

5. Manufacturing people don't think in terms of software driven systems.

C. What will happen?

1. Common language - MAP.

2. Product redesign.

3. Labor cost pressures - $2,000 per cap U.S. gap.

4. Cheaper computers - 10x better each 4 yrs.

5. CAD/CAM.

6. Most important - a new generation of engineers and designers.

D. What will be the results.

1. 4% labor reduction by 1990. Each robot is 2-3 workers. But net effective on labor is small.

2. Will offset rising labor costs.

3. Stimulating to different kinds of products - machines designed and machine built products (CAD/CAM).

4. Man in supervision position not action both in design and manufacture - CAD/CAM - AI.

5. CAD/CAM leads to AI.

X. The Other Half

A. As the computer grows, so will the robot.

B. Several recent examples of log/leap in technology:

1. Computer	1950's-1960's
2. Lasers	1960's-1980's
3. Biotechnology	1960's-1980's

C. The other half - the robot - should leap in the 1990's.