Math 145
Chaos Theory

Ralph Abraham
www.ralph-abraham.org

Math Dept, UCSC
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Meeting #7T, May 16

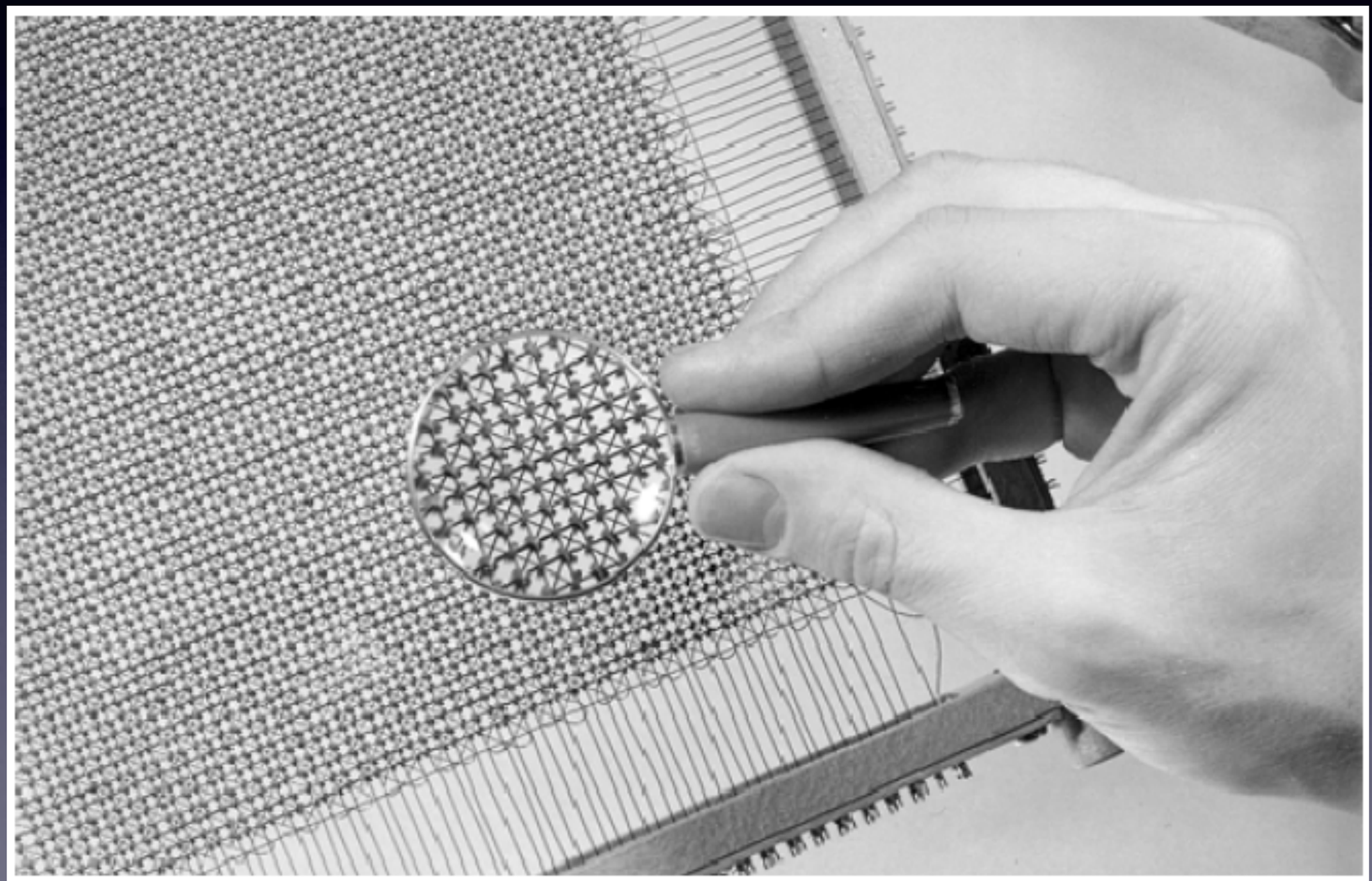
- System Dynamics
  - Jay W Forrester, b. 1918
  - Birth of SD, MIT, 1958
  - Limits to Growth, 1970

Jay W Forrester

- 1918, born on cattle ranch near Climax Nebraska
- 1939, moves to MIT
- 1940, worked on analog simulation
- 1944, head of flight simulator project Whirlwind -- the 1st real-time digital computer
- 1945, MS degree MIT, digital simulation
- 1951, head of Digital Cmptr Div'n, Lincoln Labs, MIT
- 1952, McCulloch and Pitts join Wiener at MIT
- 1953, magnetic core memory for Whirlwind

Whirlwind

Magnetic Core Memory

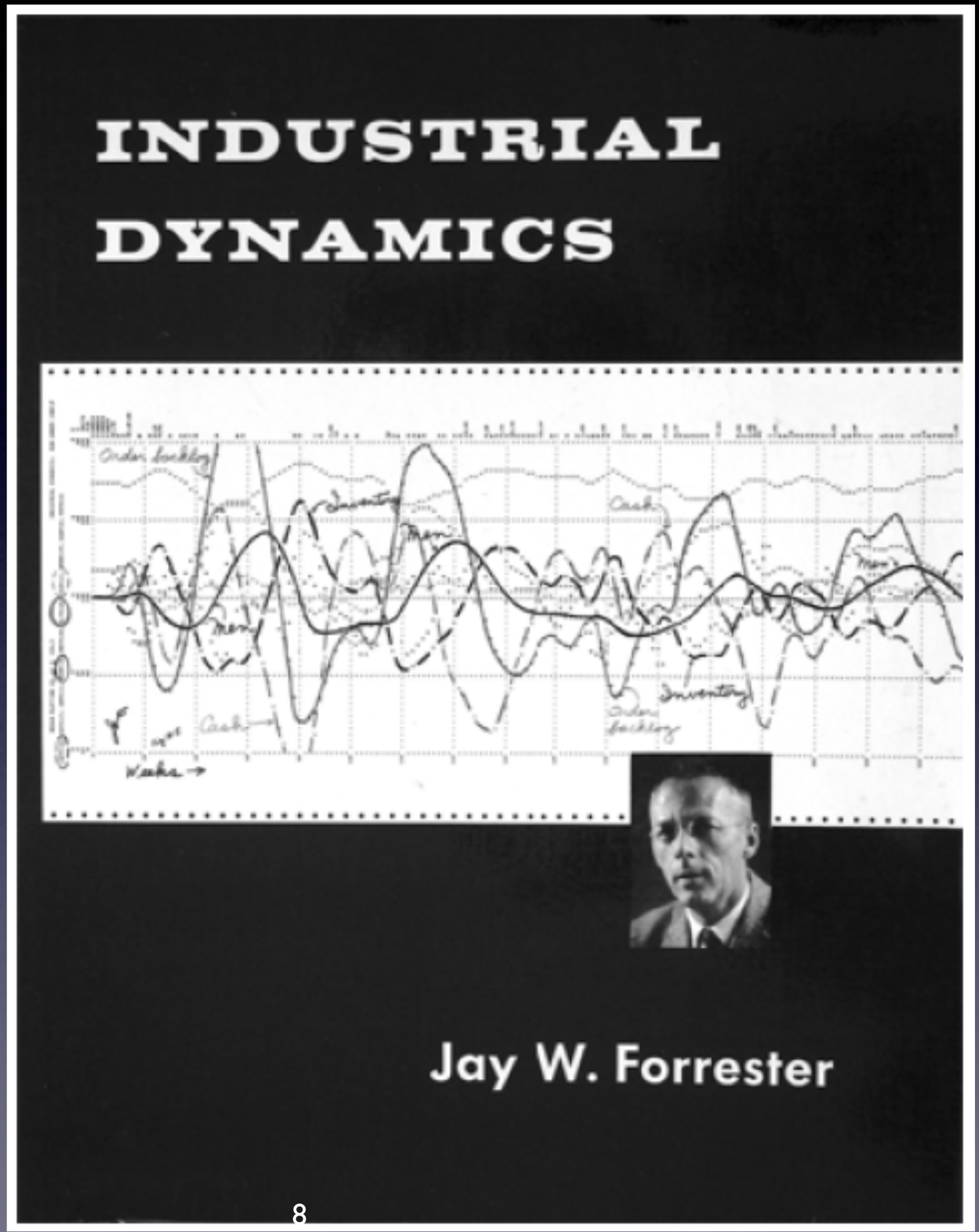


Birth of SD, MIT, 1958

- 1956, Forrester arrives at Sloane School, MIT — business cycles of General Electric
- 1958, SIMPLE language created by richard bennett, 1st language for SD
- 1959, DYNAMO created by fox and pugh, 2nd language for SD (std for 30 years)
- 1960, first mention of "system dynamics"
- 1961, forrester publ book: industrial dynamics
- 1968, forrester publ book: principles of systems
- 1969, forrester publ book: urban dynamics

Serendipitously, Forrester then became involved in a project with the General Electric Corporation. Managers at their Kentucky appliance plant were puzzled by oscillations with a three-year period in their component inventories and in their workforce numbers. The working hypothesis was that the oscillations were caused by exogenous effects; there were business cycles and these and general 'noise' was continuously imported from the market. Yet this was not a sufficient explanation and these oscillations endured despite managers' best efforts to remove them. They looked at current inventory and staffing levels and took action to try to reduce the unwelcome effect - but to no avail. The policies did not produce the intended effect; the managers' intuition had failed them. By talking to the managers Forrester elicited an account of how the system was put together, how it behaved over time and how they took actions intended to correct the oscillations.

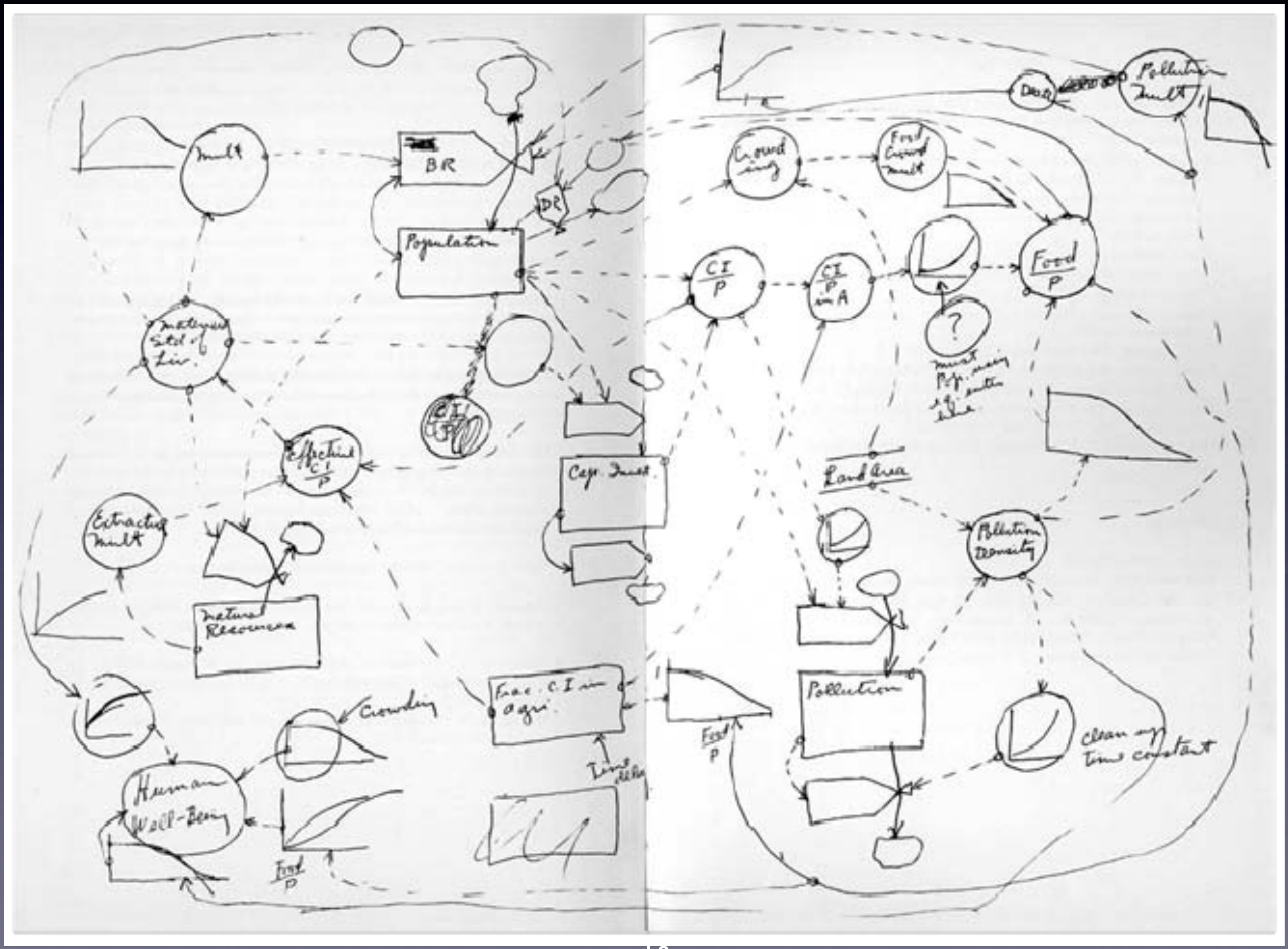
1961



Limits to Growth, 1970

- June 29-30, bern meeting of the Club of Rome
- July 04, sketch of world1
- July 20-31, Club of Rome visits MIT, world2
- 1971, Forrester publ book: World Dynamics
- 1972, Donella Meadows et all, the Limits to Growth publ, based on world3

World 1


BR
Population
DR
Cap. Invest.
Pollution
Land Area
Human Well-Being
Crowding
Natural Resources
Extraction mult
Food
P

World 2

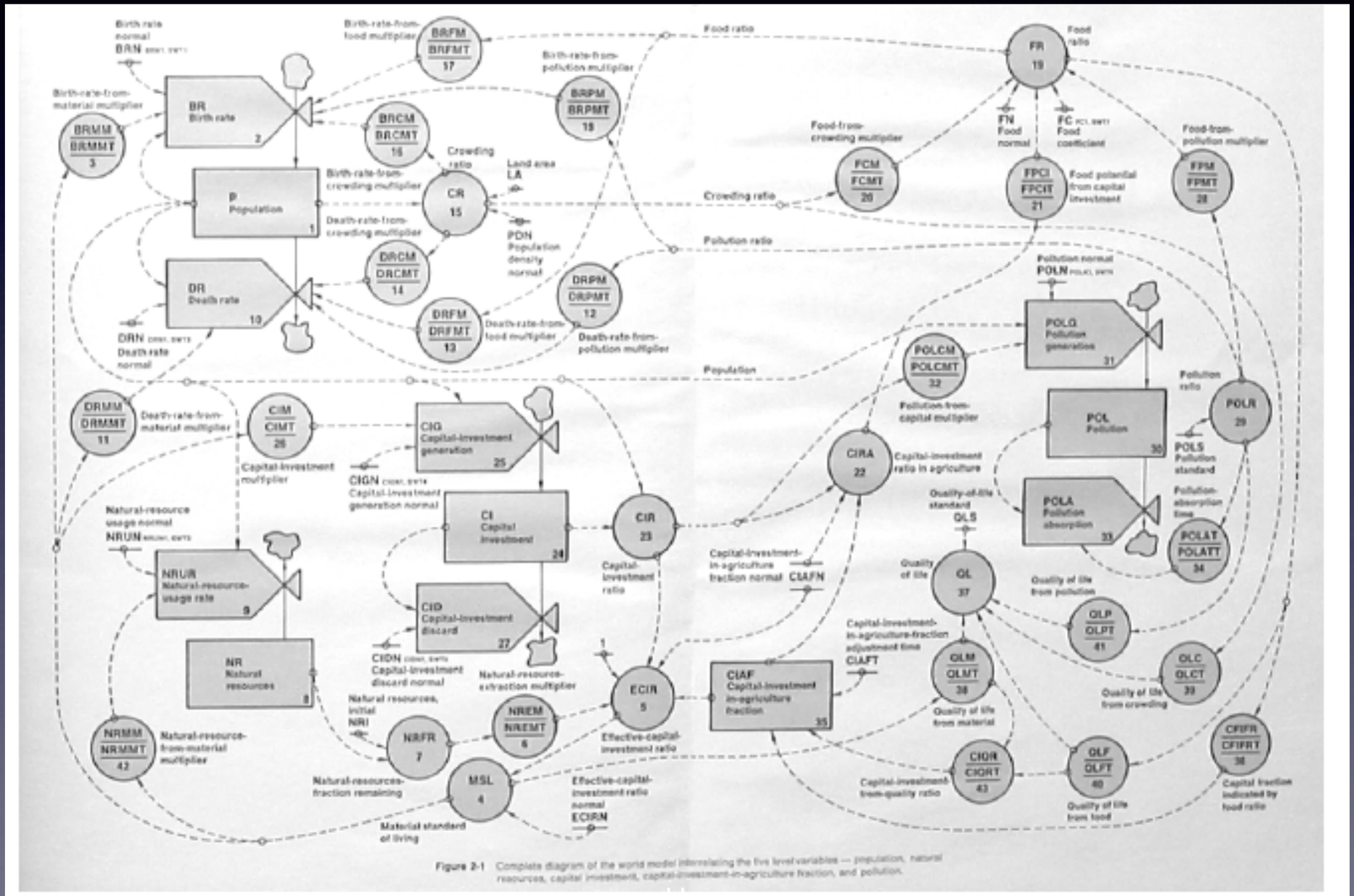
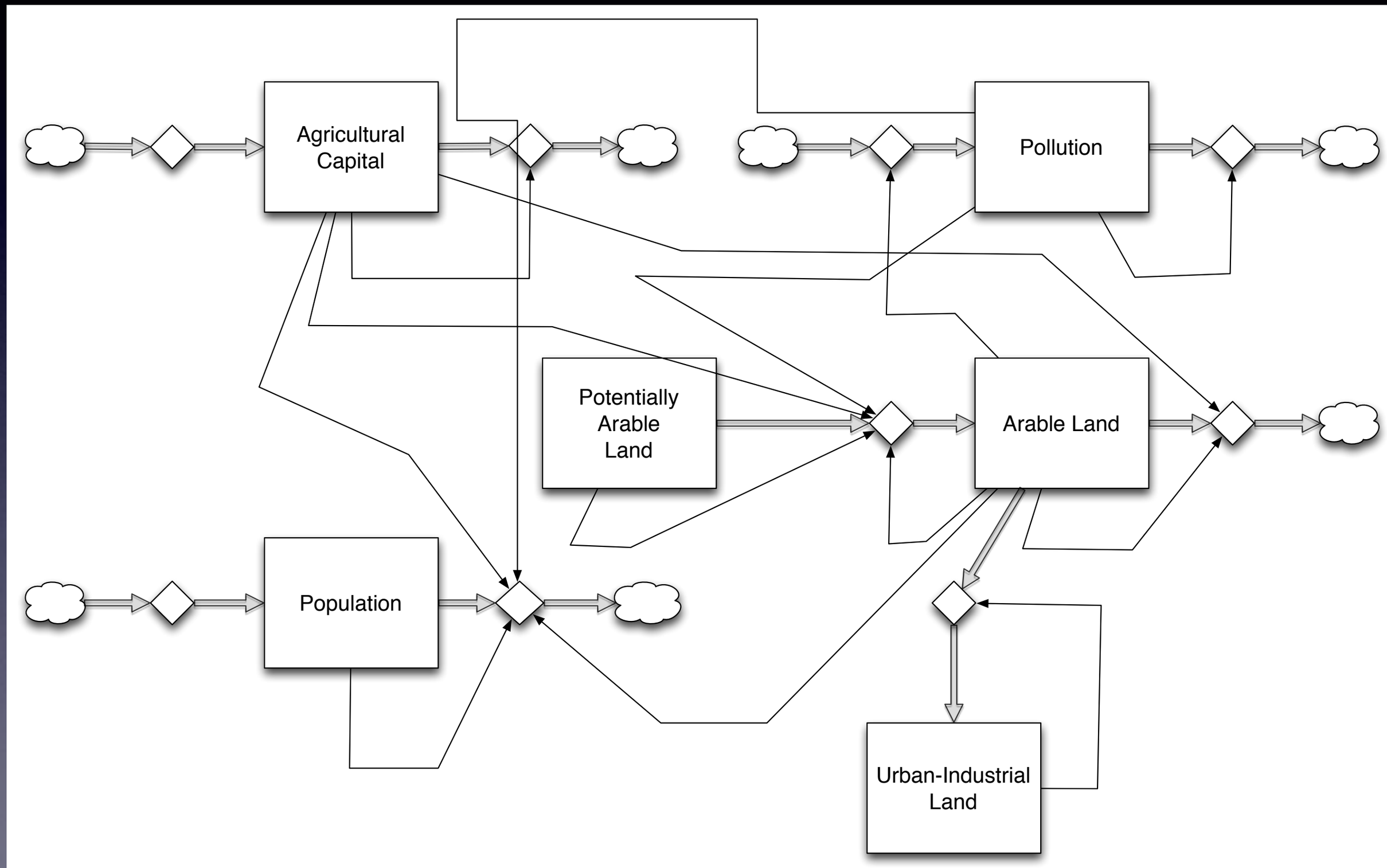


Figure 2-1 Complete diagram of the world model interrelating the five level variables — population, natural resources, capital investment, capital-investment-in-agriculture fraction, and pollution.

World 3


Agricultural Capital
Pollution
Potentially Arable Land
Arable Land
Population
Urban-Industrial Land

1970

A POTOMAC ASSOCIATES BOOK

THE LIMITS TO growth

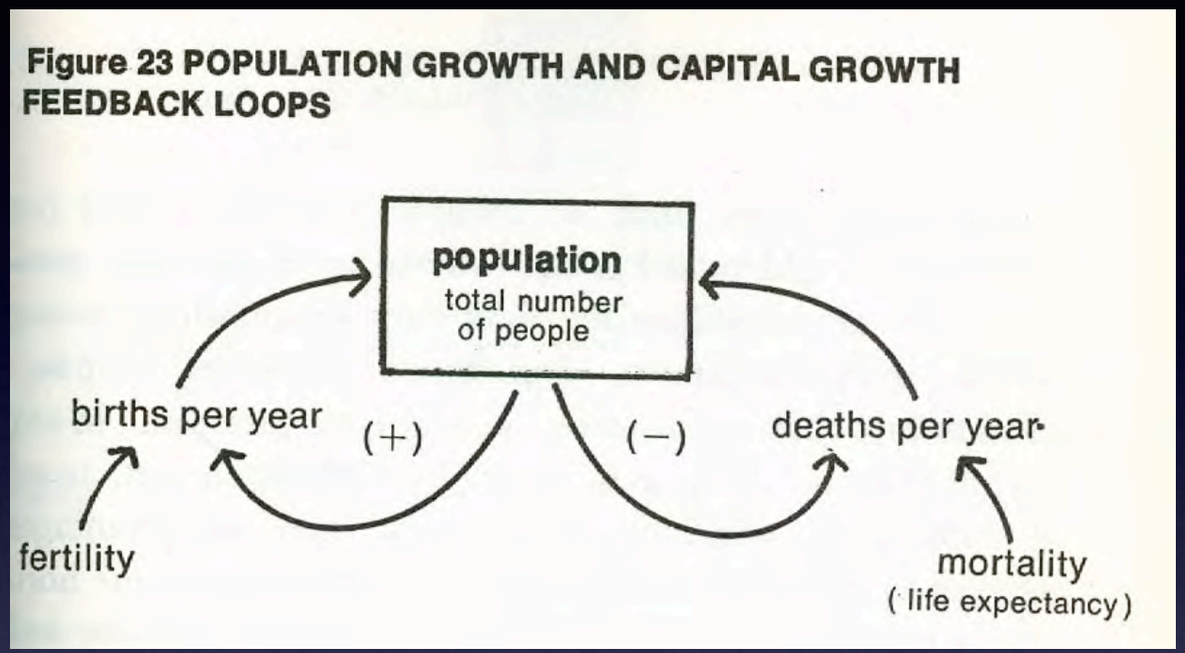
A REPORT FOR
THE CLUB OF ROME'S PROJECT ON
THE PREDICAMENT OF MANKIND

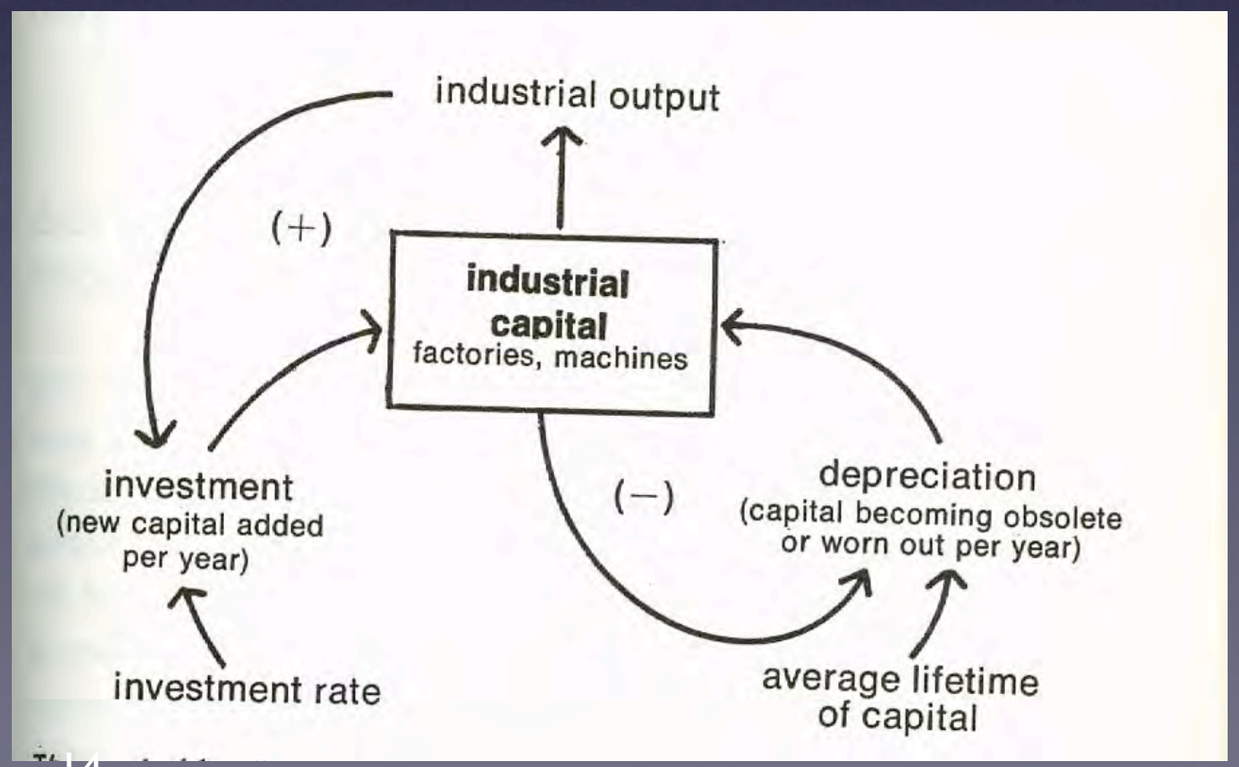
Donella H. Meadows
Dennis L. Meadows
Jørgen Randers
William W. Behrens III

Universe Books
NEW YORK

Subsystems

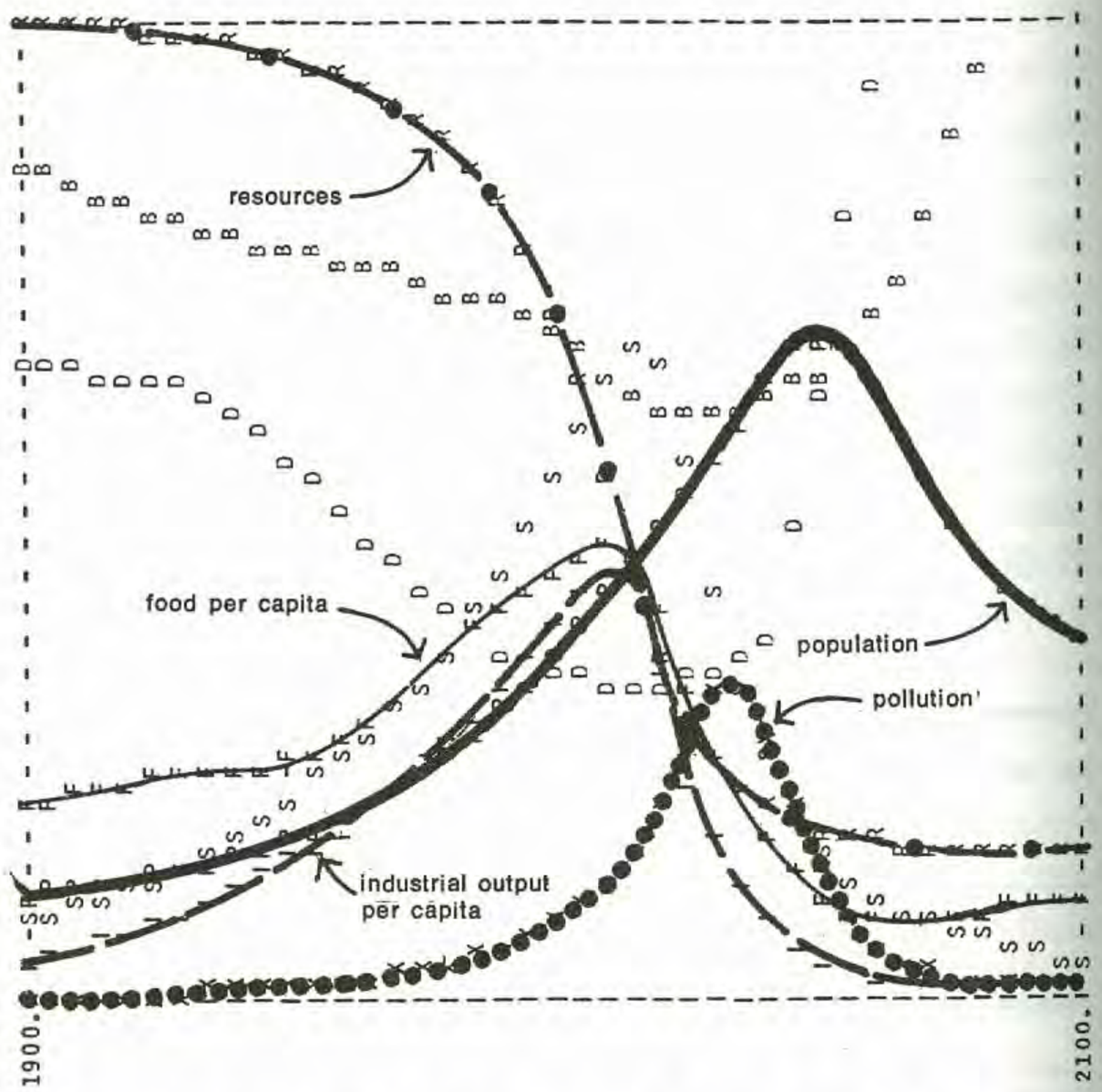
Figure 23 POPULATION GROWTH AND CAPITAL GROWTH FEEDBACK LOOPS





Results

Figure 35 WORLD MODEL STANDARD RUN



The "standard" world model run assumes no major change in the physical, economic, or social relationships that have historically governed the development of the world system. All variables plotted here follow historical values from 1900 to 1970. Food, industrial output, and population grow exponentially until the rapidly diminishing resource base forces a slowdown in industrial growth. Because of natural delays in the system, both population and pollution continue to increase for some time after the peak of industrialization. Population growth is finally halted by a rise in the death rate due to decreased food and medical services.

Summary

The "standard" world model run assumes no major change in the physical, economic, or social relationships that have historically governed the development of the world system. All variables plotted here follow historical values from 1900 to 1970. Food, industrial output, and population grow exponentially until the rapidly diminishing resource base forces a slowdown in industrial growth. Because of natural delays in the system, both population and pollution continue to increase for some time after the peak of industrialization. Population growth is finally halted by a rise in the death rate due to decreased food and medical services.

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End