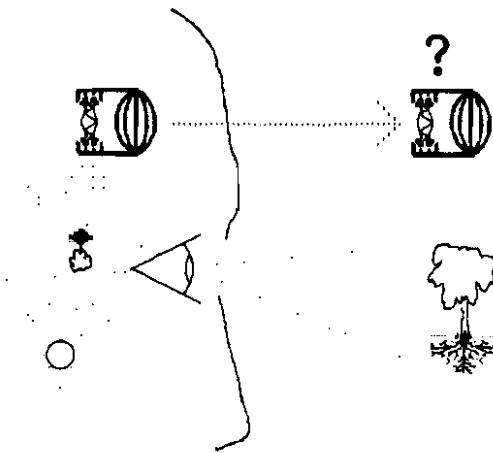?

- SUBJECT
- IMAGE
- APPETITE FOR KNOWLEDGE
- VIRTUAL STRUCTURE
- PROJECTION OF CAUSES
  (HOW WE UNDERSTAND)
- PROPOGATION OF CAUSES
  (HOW WHAT WE UNDERSTAND WORKS)

ANIMATED GLOVE ?

CONSTRAINTS ?

CONTROL IMPOSED FROM
A SYSTEM'S BOUNDARY ?

CONTROLED LIKE MEASURES ?

APART FROM CONSTRAINTS,
BEHAVIOR IS INCHOHERENT THE
SAME WAY UNCONSTRAINED
MEASURES ARE ?
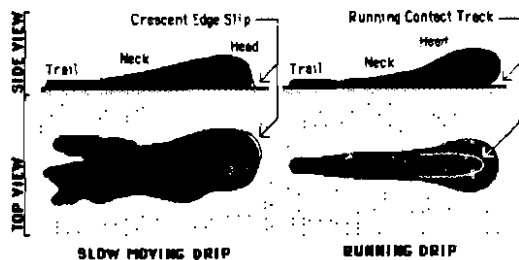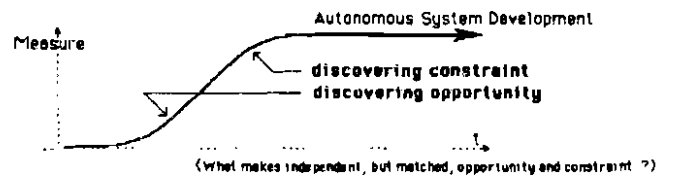
ANIMATED HAND ?

OPPORTUNITIES ?

ACTIVITY STEMS FROM USE OF
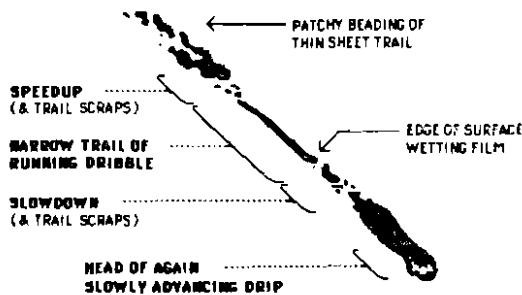CONTEXTUAL OPPORTUNITY ?

INDEPENDENTLY ASSERTIVE ?

NATURAL BEHAVIOR IS
COHERENTLY IMPULSIVE, MAKING
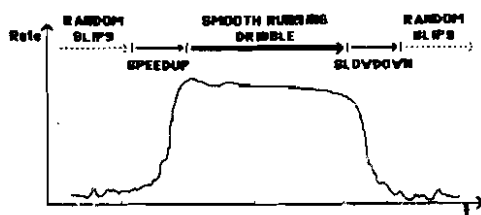USE OF DISCOVERED OPPORTUNITY
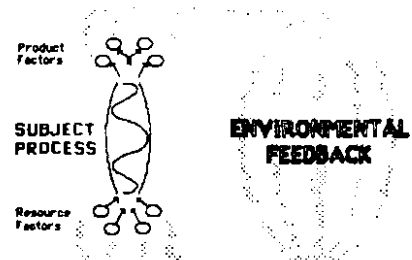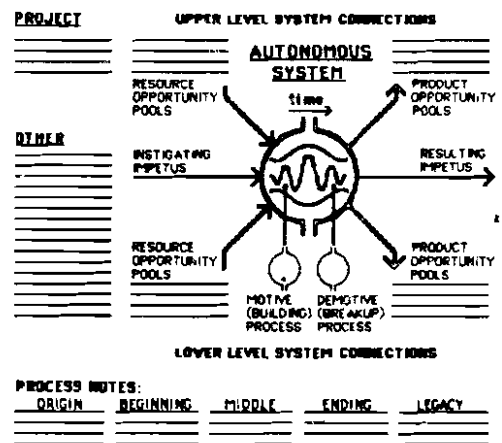THE SAME WAY FLAME AND HUNGER
DO ?

OR BOTH ?

Measure

Autonomous System Development

—— discovering constraint
—— discovering opportunity

(What makes independent, but matched, opportunity and constraint ?)

Crescent Edge Slip —   Running Contact Track —

Trail Neck Head   Trail Neck Heart

SLOW MOVING DRIP   RUNNING DRIP

- CONTACT EDGE AND DRIP SHAPE COMPARISON -

PATCHY BEADING OF
THIN SHEET TRAIL

SPEEDUP
(& TRAIL SCRAPS)

NARROW TRAIL OF
RUNNING DRIBBLE

EDGE OF SURFACE
WETTING FILM

SLOWDOWN
(& TRAIL SCRAPS)

HEAD OF AGAIN
SLOWLY ADVANCING DRIP

- THE REMAINS OF A WATER DRIBBLE -

Rate

RANDOM   SMOOTH RUNNING   RANDOM
SLIPS   DRIBBLE   SLIPS

SPEEDUP   SLOWDOWN

- CONCEPTUAL DRIBBLE FLOW RATE -

Product
Factors

SUBJECT
PROCESS

ENVIRONMENTAL
FEEDBACK

Resource
Factors

- A GENERIC PICTURE OF PROCESS FEEDBACK -

PROJECT   UPPER LEVEL SYSTEM CONNECTIONS

AUTONOMOUS
SYSTEM

RESOURCE   PRODUCT
OPPORTUNITY   OPPORTUNITY
POOLS   time   POOLS

OTHER

INSTIGATING   RESULTING
IMPETUS   IMPETUS

RESOURCE   PRODUCT
OPPORTUNITY   OPPORTUNITY
POOLS   POOLS

MOTIVE   DEMOTIVE
(BUILDING) (BREAKUP)
PROCESS PROCESS

LOWER LEVEL SYSTEM CONNECTIONS

PROCESS NOTES:
ORIGIN BEGINNING MIDDLE ENDING LEGACY

- BASIC MAP OF AUTONOMOUS CAUSATION -
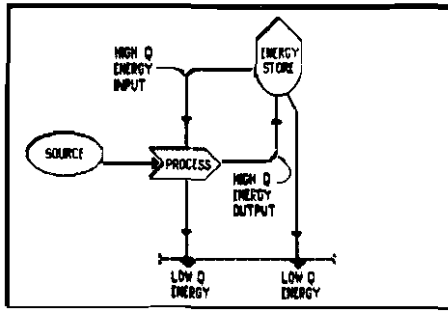
1 ENERGY BASED

COLLECTION,
TRANSFORMATION,
DISPERSAL,
TRADE

DESIGNED BY
HOWARD T. ODUM

SEE
SYSTEMS ECOLOGY,
1983
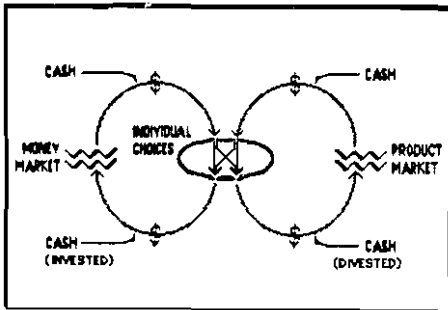
2 MONEY BASED

EXCHANGE &
CONCENTRATION,
DIVESTMENT
INVESTMENT

DESIGNED BY
PHILIP F. HENSHAW

SEE
"UNCONDITIONAL
POSITIVE FEEDBACK..."
SCSR PROCEEDINGS, 1985

ODUM ENERGY MODEL

BASIS: HIGH QUALITY FORMS OF ENERGY ARE EMPLOYED
IN CONVERTING NATURAL RESOURCES INTO OTHER HIGH
QUALITY FORMS OF ENERGY WITH A BY-PRODUCT OF VERY
LOW QUALITY FORMS OF ENERGY WASTE

USE: ENERGY SYSTEM THEORMS AND SCHEMATIC
MODELING FOR SYSTEM TRANSFORMATIONAL PROCESSES

HENSHAW MONEY MODEL

BASIS: MONEY CIRCULATES BY BEING TRANSFERED
FROM THE OWNERSHIP OF ONE PERSON TO ANOTHER,
EITHER THROUGH THE PURCHASE OF COMMODITIES
OR IN EXCHANGE FOR COMMITMENTS FOR A RETURN

USE: ECONOMIC THEORMS AND SCHEMATIC MODELING
OF ECONOMIC PROCESSES
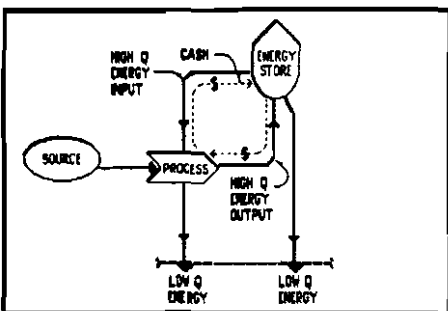
3 ENERGY BASED

ADD
COUNTERFLOW
MONEY CIRCULATION
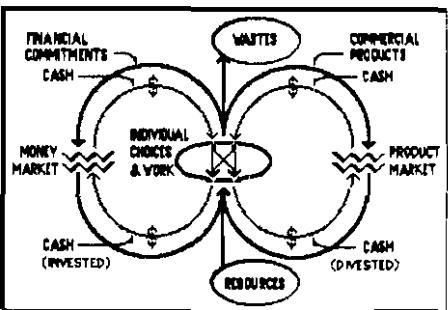
4 MONEY BASED

ADD
COUNTERFLOW
PRODUCT AND FINANCE
CIRCULATION, THEIR
RESOURCES & WASTES
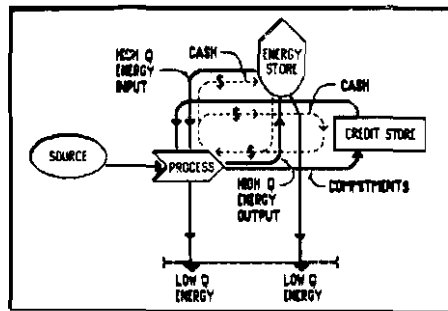
ODUM ENERGY MODEL

BASIS: MONEY FLOWS IN THE OPPOSITE DIRECTION
OF THE CREATION OF ENERGY QUALITY AS A REWARD
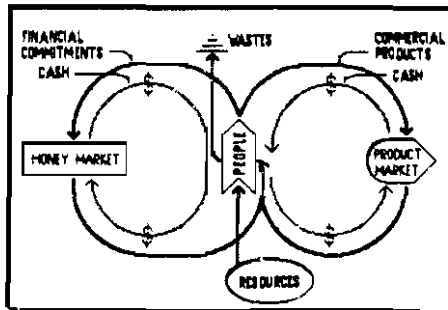FOR ENERGY VALUE ADDED

HENSHAW MONEY MODEL

BASIS: THE MATERIALS EXCHANGED ARE GOODS AND
SERVICES IN THE PRODUCT MARKET AND VARIOUS
KINDS OF COMMITMENTS FOR INVESTMENT RETURNS
IN THE MONEY MARKET

NOTE: ORIGINAL RESOURCES AND FINAL WASTES HAVE NO MONETARY
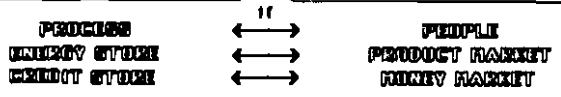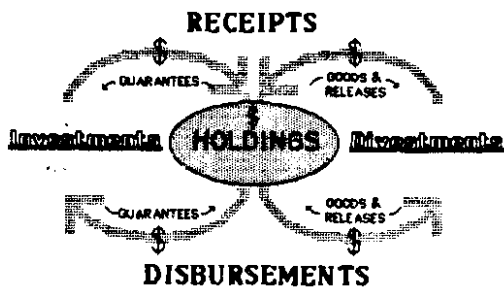VALUE BECAUSE OWNERSHIP IS NOT EXCHANGED IN THEIR USE OR DISPOSAL

5 ENERGY BASED

ADD
CREDIT STORE LOOP

CASH FOR
COMMITMENTS

6 MONEY BASED

REPLACE
MONEY WITH ENERGY
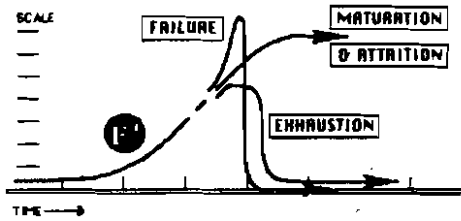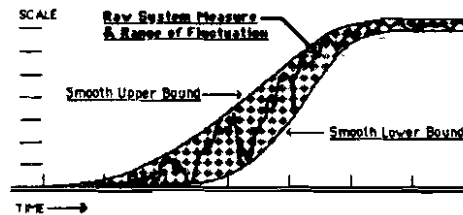MODEL SYMBOLS

ODUM ENERGY MODEL ⟷ HENSHAW MONEY MODEL
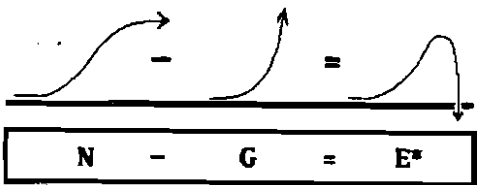
PROCESS	⟷	PEOPLE
ENERGY STORE	⟷	PRODUCT MARKET
CREDIT STORE	⟷	MONEY MARKET

RECEIPTS

GUARANTEES — GOODS & RELEASES

Investments — HOLDINGS — Divestments

GUARANTEES — GOODS & RELEASES

DISBURSEMENTS

• BASIC MODEL OF TOTAL EXCHANGE •

| N | – | G | = | E* |

| THE NORMAL BASIS OF NEW WEALTH | COMMITMENTS TO DELIVER NEW WEALTH | THE NET EQUITY OF THE ECONOMY |

SCALE

FAILURE — MATURATION / 0 ATTRITION

EXHAUSTION

TIME ⟶

• THREE GENERAL TYPES OF GROWTH CLIMAX •

SCALE

Raw System Measure & Range of Fluctuation

Smooth Upper Bound

Smooth Lower Bound

TIME ⟶

• IMPLIED SMOOTH GROWTH ENVELOPE •

Productivity Index (inflation adjusted)

(still) Expected Trend ⟶

(& that required for financial system stability)

Actual Trend

150

100

50

0 1890 00 1920 1940 1960 1980 90

(U.S. Dept of Commerce & Business Conditions Digest statistics to 1984)

The History of Labor Productivity in the U.S. Economy

1958 = 100 units

Share of Total Tax-Exempt Securities Market

21%

15%

7%

5%

0   '74   '76   '78   '80   '82   '84

(adapted from New York Times/Aug 30, 1984)

GROWTH OF INSURED TAX-EXEMPT SECURITIES

FED.$

S_t ... N_t

1 ... D

S_{t-1} ... N_{t-1}

R_n

$N < S_m$

• THE NORMAL EARN/SPEND/SAVE ECONOMY •

$(1-F_s) \cdot G_t$ ... $P_r \cdot R_m \cdot G_{t-1}$

G_t ... $P_s \cdot G_t$

1 ... $F_s \cdot G_t$ ... D

$R_m > R' > 0$

R_m

R'

$G_t P_s (1+R_m)(1-F_s)G_{t-1}$

• THE COMPOUNDED INVESTMENT ECONOMY •

FED.$ ... $P_r \cdot R_m \cdot G_{t-1}$

$F_s \cdot G_t$

1 ... E^* ... D

G_t

$P_r \cdot R_m \cdot G_{t-1} > F_s \cdot G_t$

$E^* < N - R'_s \cdot R^{'t}$

• THE NORMALLY COMPOUNDED ECONOMY •

Henshaw 85

- NET RETURNS
- INVESTMENT COSTS
- RETURNS SPENT
- COMPOUNDED RETURNS

NEW INVESTMENT

- NEW SAVINGS
- SAVINGS SPENT
- GROSS RETURNS ON INVESTMENT
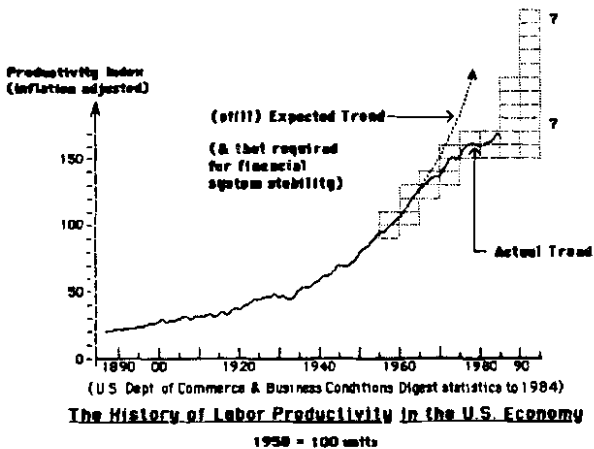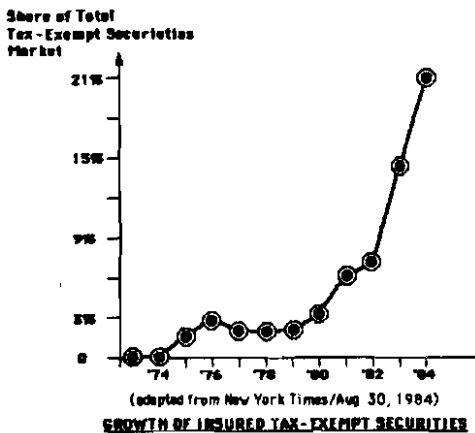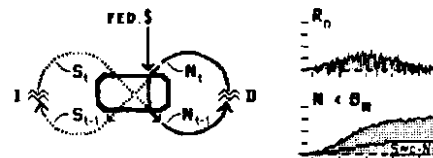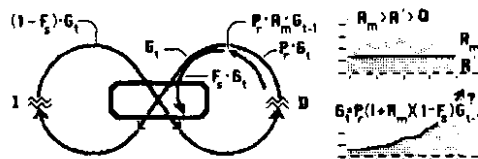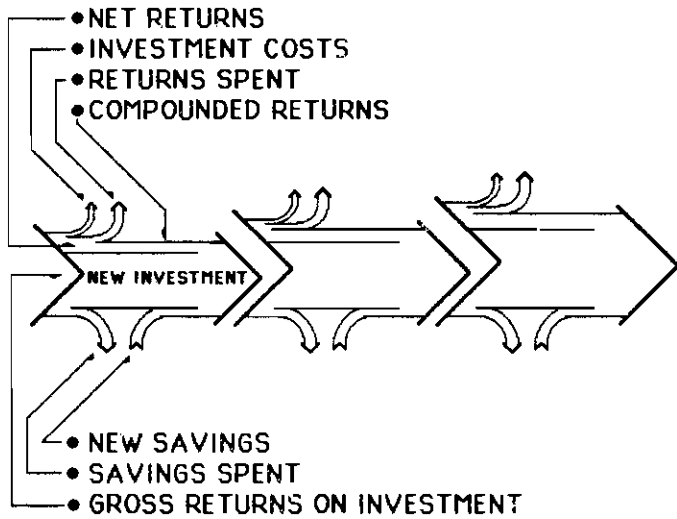
- IDEALLY UNIFIED GROWTH SYSTEM
- UNCONDITIONAL POSITIVE FEEDBACK OF SUCCESS
- MAXIMUM FEASIBLE STABILITY
- DIVERGENCE ENDS AT MAXIMUM SYSTEM CAPACITY TO CONCENTRATE WEALTH

PROGRESSIVELY INTENSIFIED COMPETITION
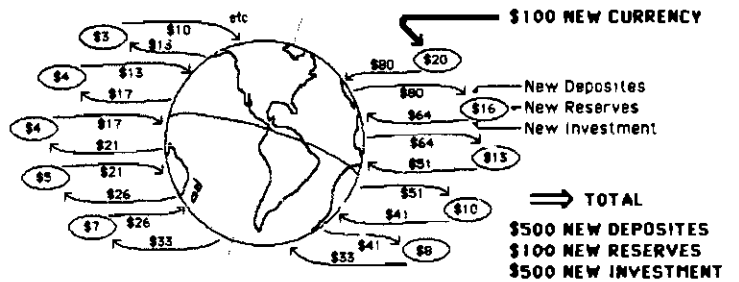
AGGREGATE

CLIMAX

100 YEARS ?
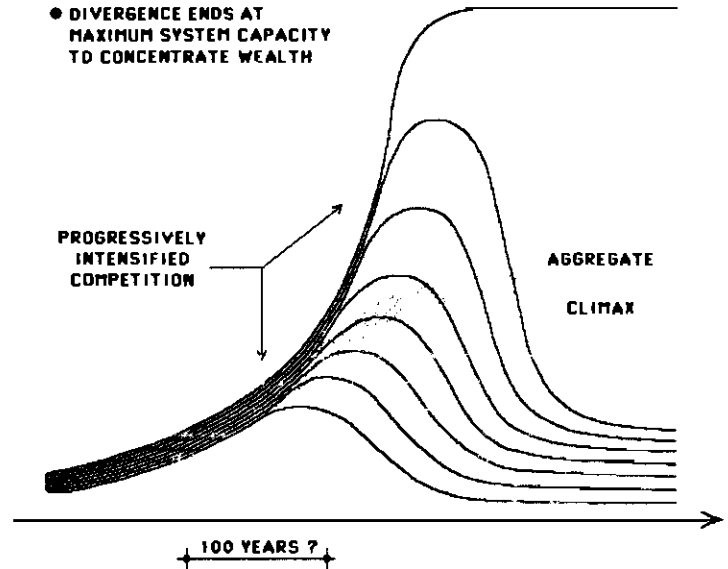
"Hence the stock of capital and the level of employment will have to shrink until the community becomes so impoverished that the aggregate of savings has become zero, the positive savings of some ...being offset by the negative savings of others."   J. M. Keynes
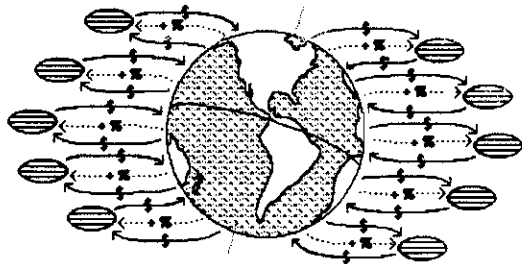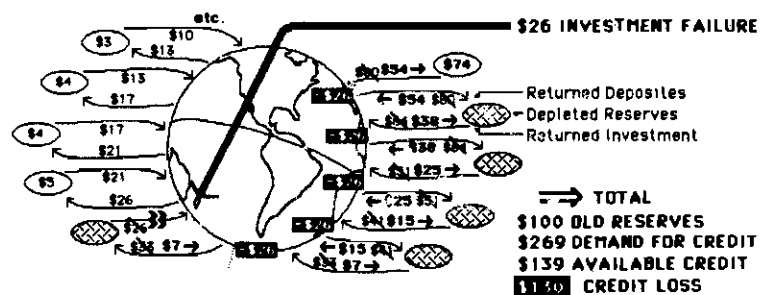
IDEALIZED EXPANSION OF CREDIT
NEW CURRENCY NORMALLY SUPPLIED AS ECONOMY EXPANDS

$100 NEW CURRENCY

New Deposites
New Reserves
New Investment

$3 $10
$4 $13
$4 $17
$5 $21
$7 $26

$80 $20
$80
$64 $16
$64
$51 $13
$51
$41 $10

TOTAL

$500 NEW DEPOSITES
$100 NEW RESERVES
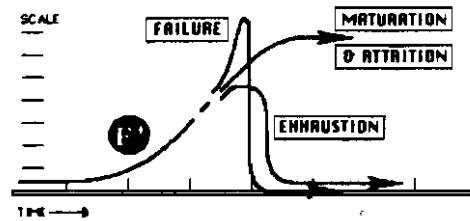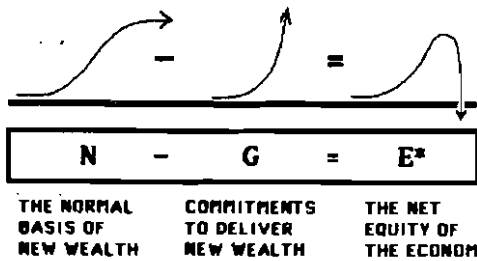$500 NEW INVESTMENT

IDEALIZED COLLAPSE OF CREDIT
NORMALLY PREVENTED BY PROFITS SUFFICIENT TO COVER LOSSES

$26 INVESTMENT FAILURE

Returned Deposites
Depleted Reserves
Returned Investment

TOTAL

$100 OLD RESERVES
$269 DEMAND FOR CREDIT
$139 AVAILABLE CREDIT
CREDIT LOSS

RECEIPTS

GUARANTEES
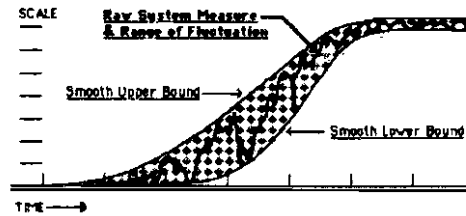GOODS & RELEASES
Investments HOLDINGS Divestments
GUARANTEES
GOODS & RELEASES

DISBURSEMENTS

• BASIC MODEL OF TOTAL EXCHANGE •

N	−	G	=	E*

THE NORMAL BASIS OF NEW WEALTH	COMMITMENTS TO DELIVER NEW WEALTH	THE NET EQUITY OF THE ECONOMY

SCALE

FAILURE
MATURATION
0 ATTRITION
EXHAUSTION

TIME ⟶

• THREE GENERAL TYPES OF GROWTH CLIMAX •

SCALE

Raw System Measure & Range of Fluctuation
Smooth Upper Bound
Smooth Lower Bound

TIME ⟶

• IMPLIED SMOOTH GROWTH ENVELOPE •

Productivity Index (inflation adjusted)

(still) Expected Trend

(& that required for financial system stability)

Actual Trend

150
100
50
0
1890 00 1920 1940 1960 1980 90

(U.S. Dept of Commerce & Business Conditions Digest statistics to 1984)

The History of Labor Productivity in the U.S. Economy

1958 = 100 units

Share of Total Tax-Exempt Securities Market

21%
15%
9%
3%
0
'74 '76 '78 '80 '82 '84

(adapted from New York Times/Aug 30, 1984)

GROWTH OF INSURED TAX-EXEMPT SECURITIES

FED.$

S_t
S_{t-1}
N_t
N_{t-1}

R_n

$N < B_N$

• THE NORMAL EARN/SPEND/SAVE ECONOMY •

$(1-F_s) \cdot G_t$
$P_r \cdot R_m \cdot G_{t-1}$
G_t
$P_r \cdot G_t$
$F_s \cdot G_t$

$R_m > R > 0$

R_m
R

$G_t P_r (1 + R_m X 1 - F_s) G_{t-1}$

• THE COMPOUNDED INVESTMENT ECONOMY •

FED.$
$P_r \cdot R_m \cdot G_{t-1}$
$F_s \cdot G_t$
$E*$
G_t

$P_r \cdot R_m \cdot G_{t-1} > F_s \cdot G_t$

$-E* < N - R \cdot e^{R \cdot t}$

• THE NORMALLY COMPOUNDED ECONOMY •

Henshaw 85

constructed curve derivatives showing discontinuities

y

Data ──⊖──── 'Smooth' Curve
Rate ──◇── — dy/dt
Accel ─⊟──── d^2y/dt

Continuity
Irregularity
in d^2y/dt

Continuity
Irregularity
in dy/dt

0

Continuity
Irregularity
in d^2y/dt

t
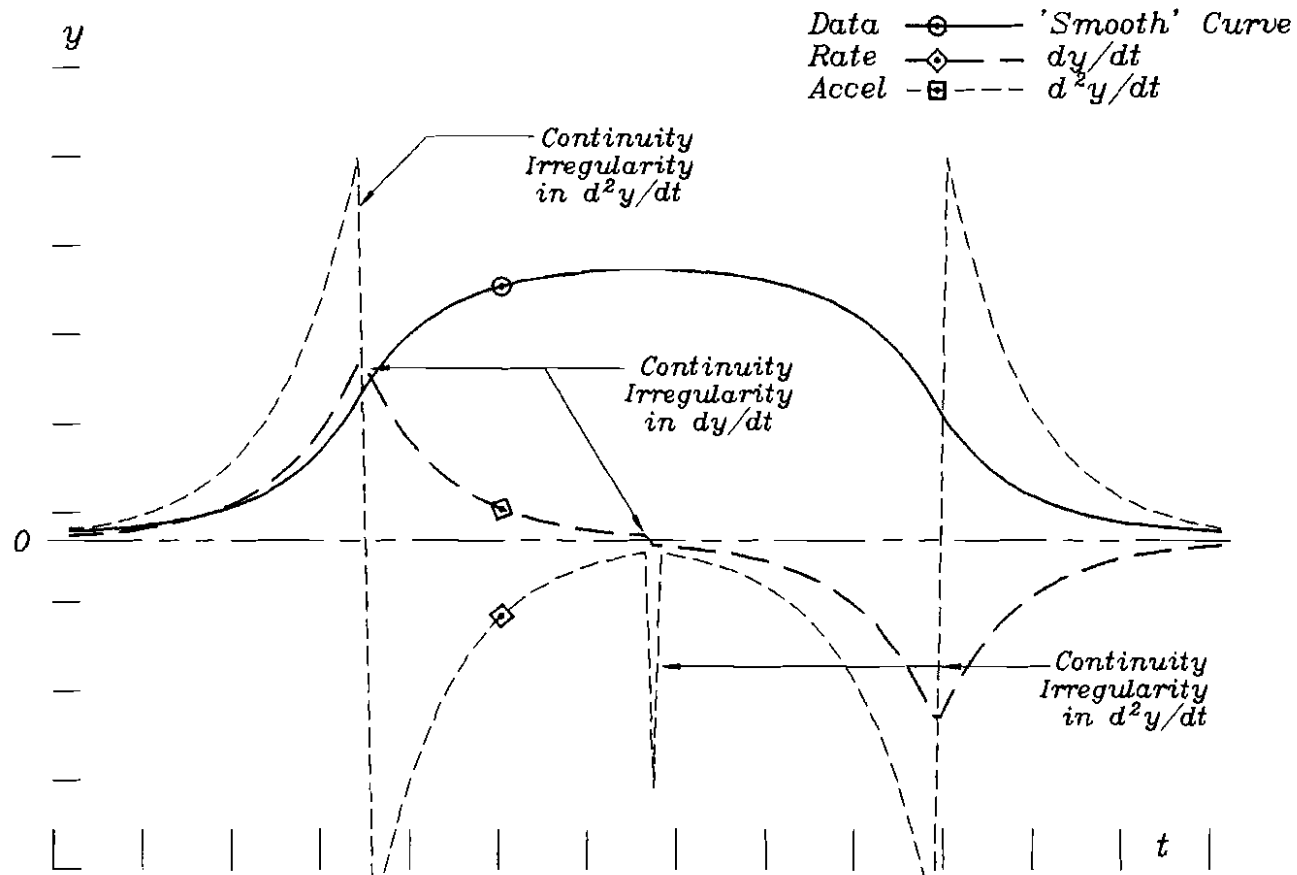
Derivatives Emphasize Underlying Curve Structure

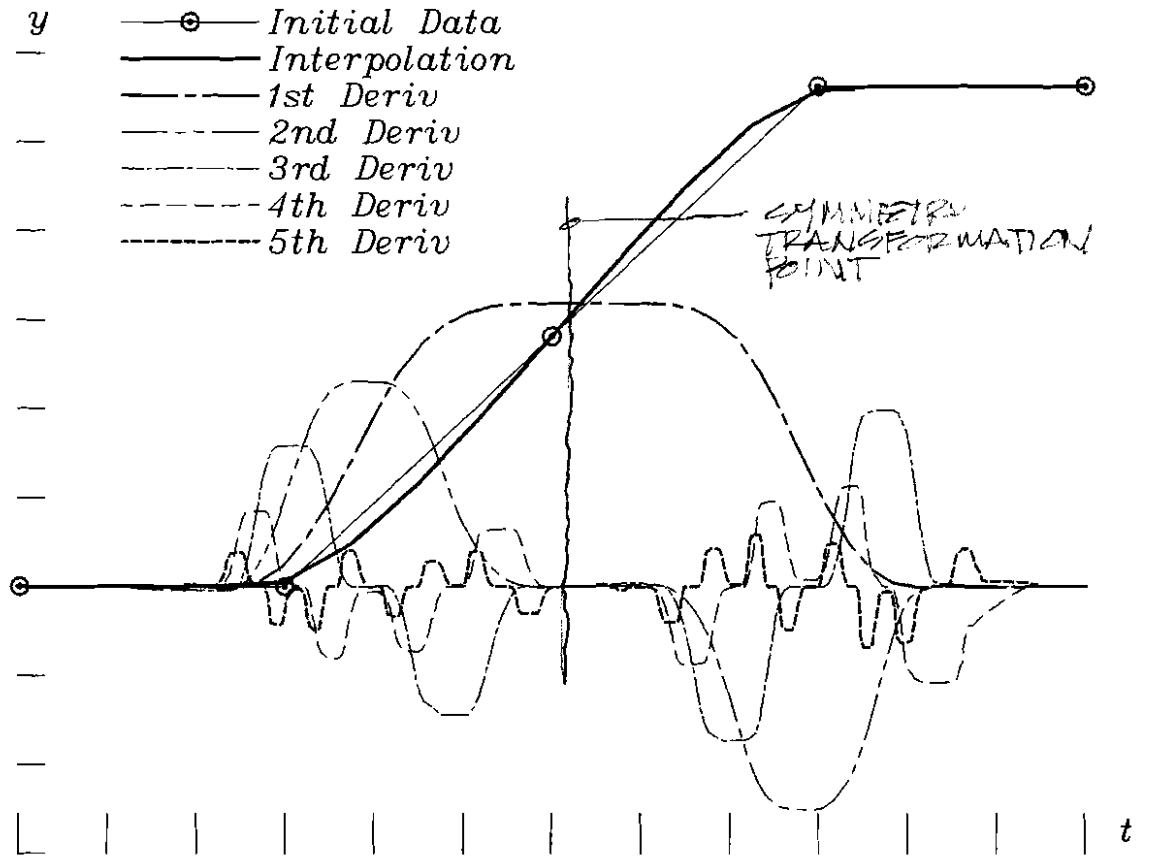*Exponential Segment Mirrored, Joined and Differentiated*

2

Starting Curve: 2Pt Step,
Smoothing: Din2, Din2, Ddsm—2x1
1st Deriv: Dif—2, Ddsm—2x1, Din2, Tsep—2, Ddsm—2x1
2nd Deriv: Dif—2, Ddsm—2x1, Tsep—2, Ddsm—2x1, Din2, Ddsm—2x2,
3rd Deriv: Dif—2, Ddsm—2x2, Tsep—2, Tsep—2, Ddsm—2x4,
4th Deriv: Dif—2, Dasm—1 2—PTx2, Tsep—2, Tsep—2, Ddsm—2x2, Ddsm—2x2,
5th Deriv: Dif—2, Dasm—1 3—PTx2, Tsep—2, Tsep—2, Ddsm—2x2

Transforming a step into an continuous event hierarchy

y

—⊝— Initial Data
———— Interpolation
——— 1st Deriv
——— 2nd Deriv
——— 3rd Deriv
——— 4th Deriv
——— 5th Deriv

SYMMETRY
TRANSFORMATION
POINT

t

Derivatives as Nesting of Independent Events

Constructed with derivative smoothing & trend compression