TIME PATTERNS OF TECHNOLOGICAL CHOICE OPTIONS

Cesare Marchetti

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INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
2361 Laxenburg, Austria

Resume

The analysis of the behavior of individual and social organizations, defined as groups of individuals informationally connected, reveals unsuspected dynamic stability over the life of the individual or the institution. This implies the presence of clocks, if not physical, at least psychological, as this stability actually has time as an independent variable.

The behavior is mostly measured by physical outputs, paintings by painters, cars by car makers, or cathedrals by religious groups.

In the case of technological options it appears that the creative forces are tuned to societal pulses.

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Time is a central element in our perception and organization of the external world. It also appears to have a central role in the operation of society and its subsets. What I will show is that the relations can be put in a quantitative form, holding stable for a life span or for a thousand years. This implies the existence of "clocks" also at the level of a society, perhaps better qualified as a "cultural structure".

Over the fact that time flow is so quintessential to our selfperception and to what we experience through our sensory channels and vicarious informational channels, so much literature has been generated that it doesn't seem the case to add a word more, unless it is a really new one. What I can add is that we appear to operate quantitatively in a time cage, with a limited play for the frills of the *free will*. The examples I will give about personal behavior are taken from people which for some reason have been quantified by society. E.g., an artist or a scientist whose output has been studied, organized and put into catalogs.

The very interesting thing is that the *time patterns* in the production of these works always follow the same simple functional relationship. Because the parameters of the function can be calculated using a partial set of data, e.g., the production of 15 years, we can use the equation in a predictive mode, i.e., calculate *how many works* a certain artist will produce and *when*.

Figure 1 to 4 show some of the charts for dead artists or scientists. I obviously have also charts for living personalities, but checking them for their predictive potential is a lenghty operation, and I will talk about them ten years from now. The fitting equation for the cumulative number of works is a three parameter logistic. The point here however is not free will, but a *quantitative time organization* in significant long-term *actions* for a given person. The poison is in the word quantitative, because it implies inter alia a clock that stays tuned for life. Physical time, which is the variable, appears to be really quintessential.

At a second look this may not be wholly surprising. After all, we are also biological machines and the *vis vitalis* can grow and ebb according to biological paradigms. Growth processes in biology are in fact most often describable by logistics, e.g, the size of a tree. The curious thing is that the same happens to Mercedes (or VW) if we measure its size by the number of cars it produces as shown in chart n 5. Attributing genetic control and all the rest to Mercedes is clearly far fetched. But we can look at it as superindividual created by an interactive set of people, with purpose, image, input and output like any of us.

Where the regulations and control of this *super-us* is located and how they work I really don't know. But phenomenologically it certainly behaves like an individual, *including the internal clock*. Another curious analogy is that like the molecules in a living organism, the *us* may be metabolized various times during the life of the company, but its identity (and clock!) stay put. It is exactly like the preservation of our identity during our life span. Incidentally, what is preserving it? The time structure of the memories?

That companies are in a way individuals has been in the air since ever. A full set of anthropomorphic descriptions are normally used for them. The only disturbing point may be that things are so precise, so quantitative, so intrinsically protected from human tinkering. But that a whole nation can behave that way with the utmost precision should defy the wild dreams of romantic nationalists. A whole nation is a lot of things, but what I will take is quantitatively measurable action in a certain

precise area. Chart n 6 reports the act of possessing a car in Italy. Trivial or revolutionary, the possession, as expressed by the actual number of registered cars, fits the patterns with a precision of a fraction of a percent, *over thirty years*. Excellent time keeping!

A nation state is in many ways a strongly connected unit, via administration, economy and language. The anthropomorphic version is often a plump and pretty young female wrapped in flags and other national symbols. The idea of the body of the nation does'nt appear completely original. But that of the clock of the nation it might, as I never heard of it before. As people operate in structures and organizations of transnational character, one may try a peep also in this direction. Religion is a typical case and it has the advantage of visibility and good records. The chart n 7 reports on a grandiose religious undertaking, which lasted for the first half of our millennium: the construction of Gothic cathedrals.

The commitment to build a cathedral was certainly stupendous and the actual reasons were certainly numerous and variegated. But the process was not operating in a vacuum. An intense cultural drive was sitting behind the scene and running the show. And running it well, if we stop to reflect on the precision of the fit, representing the temporal spread of the laying of the first stone. I took this precise point in time as an indicator, as it represents the first materialization of the will to act. Like the conception of the phenotype. The magnificent fit would not have been possible without a magnificent clock, however, keeping good time for five centuries. But religion is no exception. Even more worldly structures like railways behave the same way. Chart 8 organizes the "starts" of national railway nets using the date of the opening of the first line as a quantifier. One world, one clock!

This long prologue brought us fully armed into the hearth of the problem I have to deal with more in detail: the clocking of invention and innovation. In the context of what we have seen, it would be hard to expect a wild patch in such strongly regulated social systems. Contrary to what people in the patch would like

to think, also invention and innovation appear strongly regulated. At least the ones that finally reach success. The big problem in all these quanitative analyses is to find significant and comparable indicators. Gerard Mensch did classify innovations with the state of the first commercial sell and the inventions with the date of the first working prototype.

The data of Mensch are organized in chart 9. He had found three bunches of inventions and innovations and I organized them separately assuming they could be considered as "products" like cars or fridges, generated in response to a demand, the demand for innovation. Apart from the logic behind, which may be open to discussion, the fitting is certainly good, and it permits to peep into the morphology of the operation. The distance between the centers of the pulses is 55 years, reminiscent of the ill-famed Kondratiev long cycles. Incidentally, if we measure the murder rates in the US they also have a cycle of 55 years, as can be seen in chart 10. Obviously, the moods of our societies flow and ebb in regular tides.

One of the arguments of endless debates is the distance in time between prototype and commercial unit. The current opinion is that it kept decreasing since ever and, under the influence of accelerating "progress" the prototype will be delivered straight into the hands of the consumer, as some dishonest companies already do. What we see in fact is quite curious, the distance decreases regularly inside a certain wave, but starts larger again in the next. So we have a see-saw process. Furthermore, the order in the lists of inventions and innovation is basically kept, so that in case an invention is spotted, assuming it will be commercially successful, we can predict the date of commercialization. The timing appears all finely regulated! So much that I confidently predicted the present wave of inventions and innovations reported in chart 9 without experimental points. I obviously do not know the name of the winners, but the regulatory system tells me the time sequence of their appearance on the stage.

Sociologists and economists, trying to reconcile the evident microscopic chaos of the system and the persistent macroscopic order, have invoked the intervention of an invisible hand. Kind of laic

deus ex machina. I tried to x-ray its bones and tendons, although I could'nt spot its muscles and nerves.

But a lead could be that our culture is an informational pool, with a complex hierarchical structure, where informational configurations (genotypes) are generated, multiplied and substituted just like in the biological systems. The mathematic of the phenotypes is identical which is already a strong support for the hypothesis. But this would leave the mistery of the clocks open. Just like in the biological case.

Last notation: We should probably fundamentally redefine the concept of *choice*, and that of *option*.

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Note

These references are basically limited to my connected work. Literature on the application of Volterra-Lotka equations is vast and easily retrievable.

COMMENTS TO THE CHARTS

The charts fit the cumulative number of things produced, independent of their size and the importance attributed to them.

The fitting equation is a three parameter logistic of the type

$$N(t) = \frac{\overline{N}}{1+\exp-(at+b)}$$

where N is the cumulative number of objects at time t and $\overline{N}$ is the asymptote or saturation level. $\overline{N}$, a and b are usually calculated by fitting the data.

The charts show $F = N(t)/\overline{N}$ in the linearized form: $\log (F/1-F) = at + b$.

$\overline{N}$ is given in parenthesis; it is called the perceived potential in the text. ΔT gives the temporal spread of production: the time to go from 10% to 90% of $\overline{N}$; it represents a more intuitive way of expressing a. The parameter b is a time cursor locating the pulse in calendar time.

FIGURES 1 - 4

The production of well quantified geniuses is reported in cumulative form and fitted with a logistic equation.

The asymptote or final potential is given in parenthesis. Usually, the person dies when 90-95% of his potential has been expressed. This is true for Humboldt (90 years) or Mozart (35 years).

The fitting is usually excellent. The extra play in Shakespeare's chart is actually a fake. Mozart seems, however, to have overworked during the last couple of years.

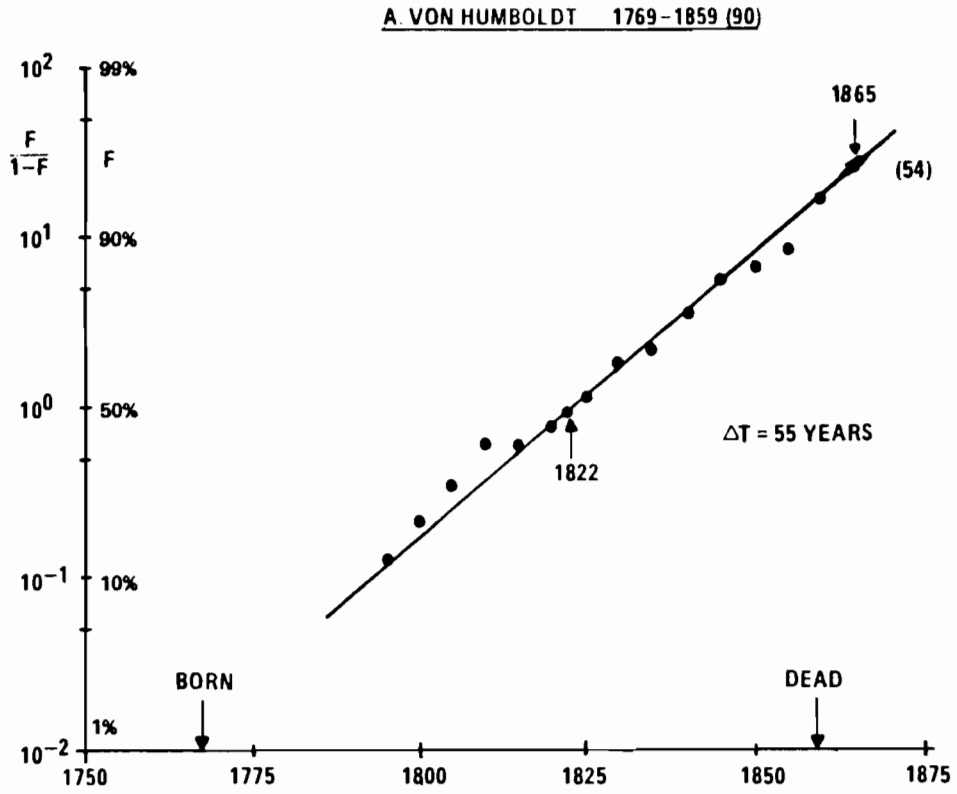

Figure 1

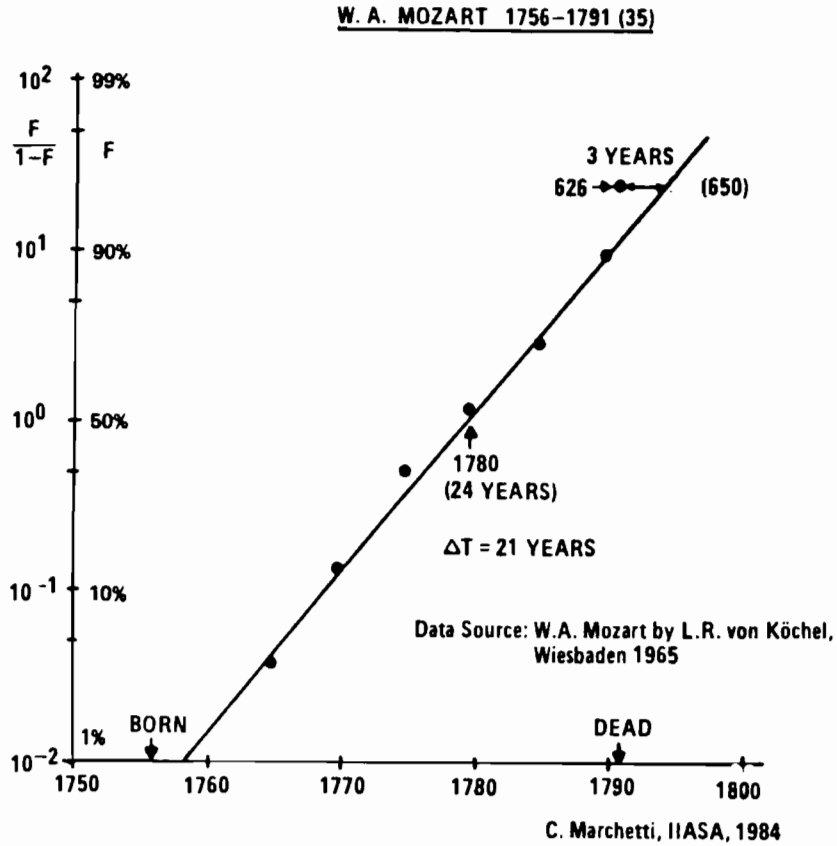

Figure 2

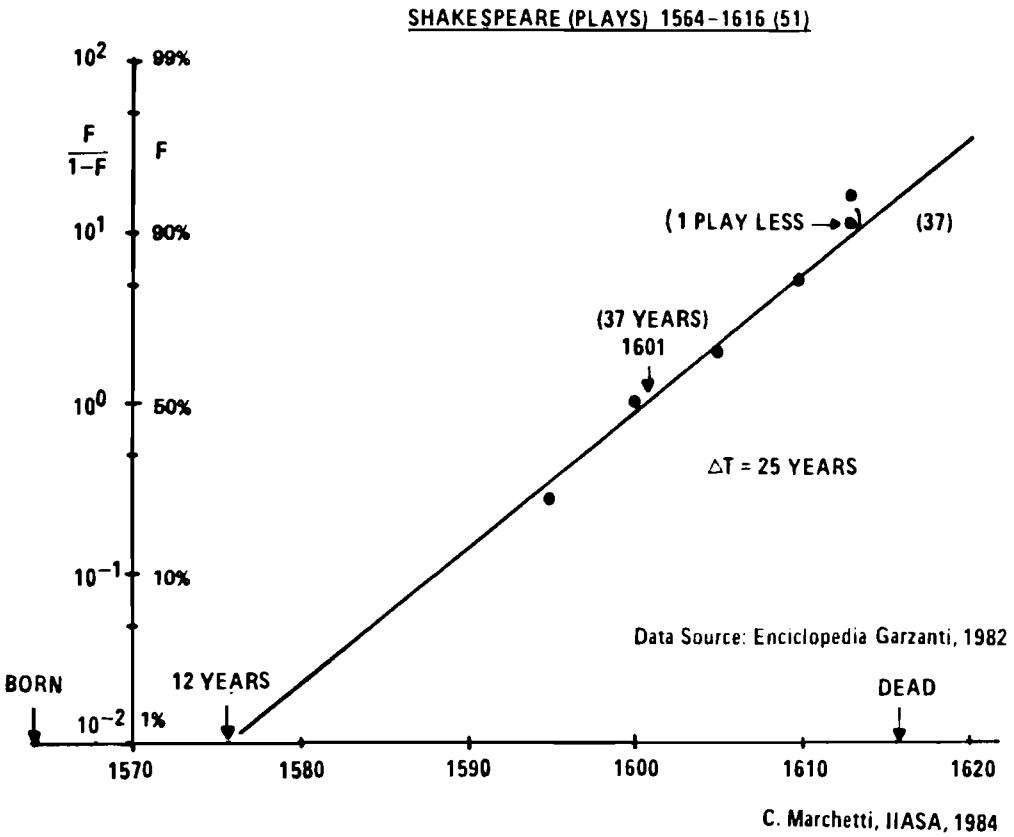

Figure 3

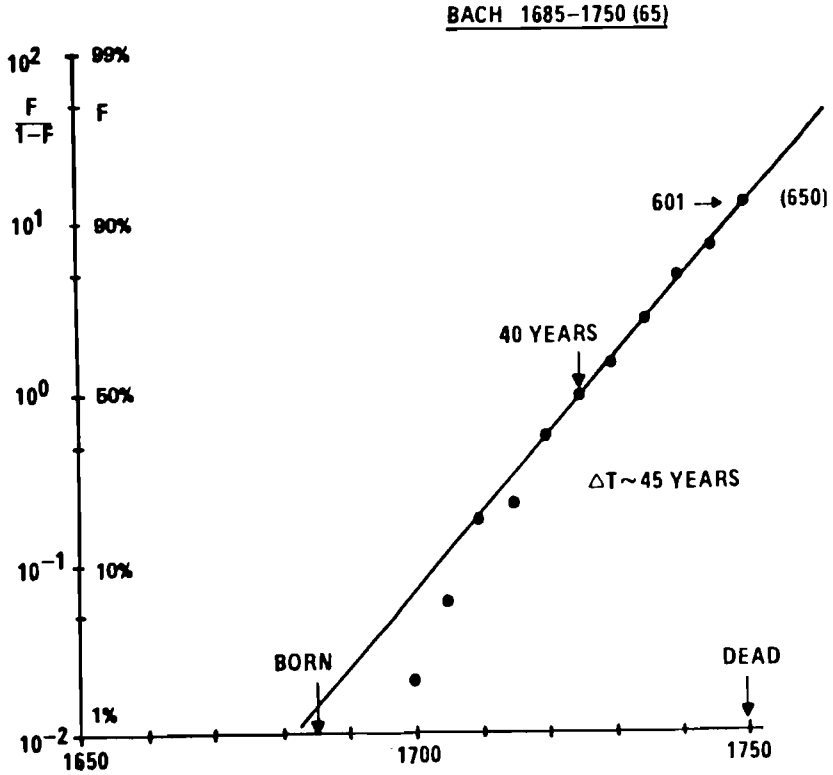

Figure 4

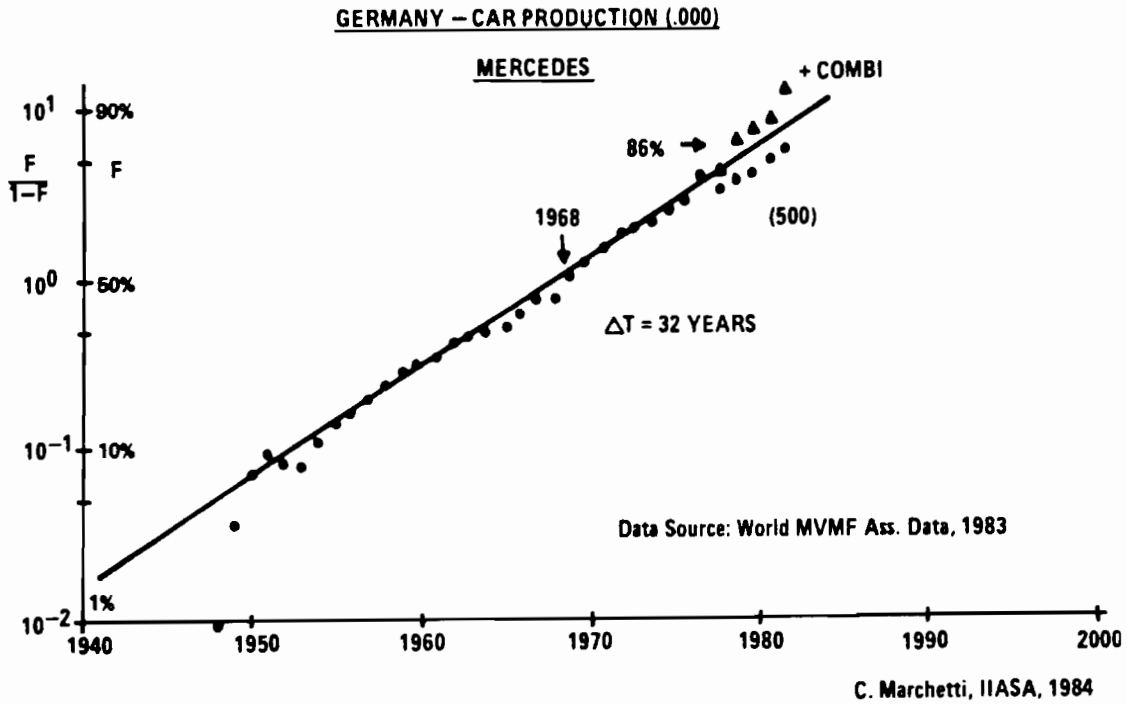

FIGURE 5

A company, like an individual person, gets an equation for life. I.e., the three parameters, a, b, $\bar{N}$, seem to stay the same at least during the growth period. When the size of the company, expressed through its output, reaches 85-90% of $\bar{N}$, it usually breaks loose, going into an oscillatory pattern (fibrillation). Mercedes is the only exception I found to date.

FIGURES 6a and 6b

Car population in Italy is here reported as log F/1-F, and as N. The number of registered cars follows very precisely the growth equation, without energy prices or economic fluctuations influencing it in the least. The system appears to be endowed by a form of very efficient homeostasis, reabsorbing external influences. This is a quite common characteristic of such systems. E.g., the influence of the oil price increase on the world air traffic (ton km/y) has been less than 1%, as referred to the fitting logistic.

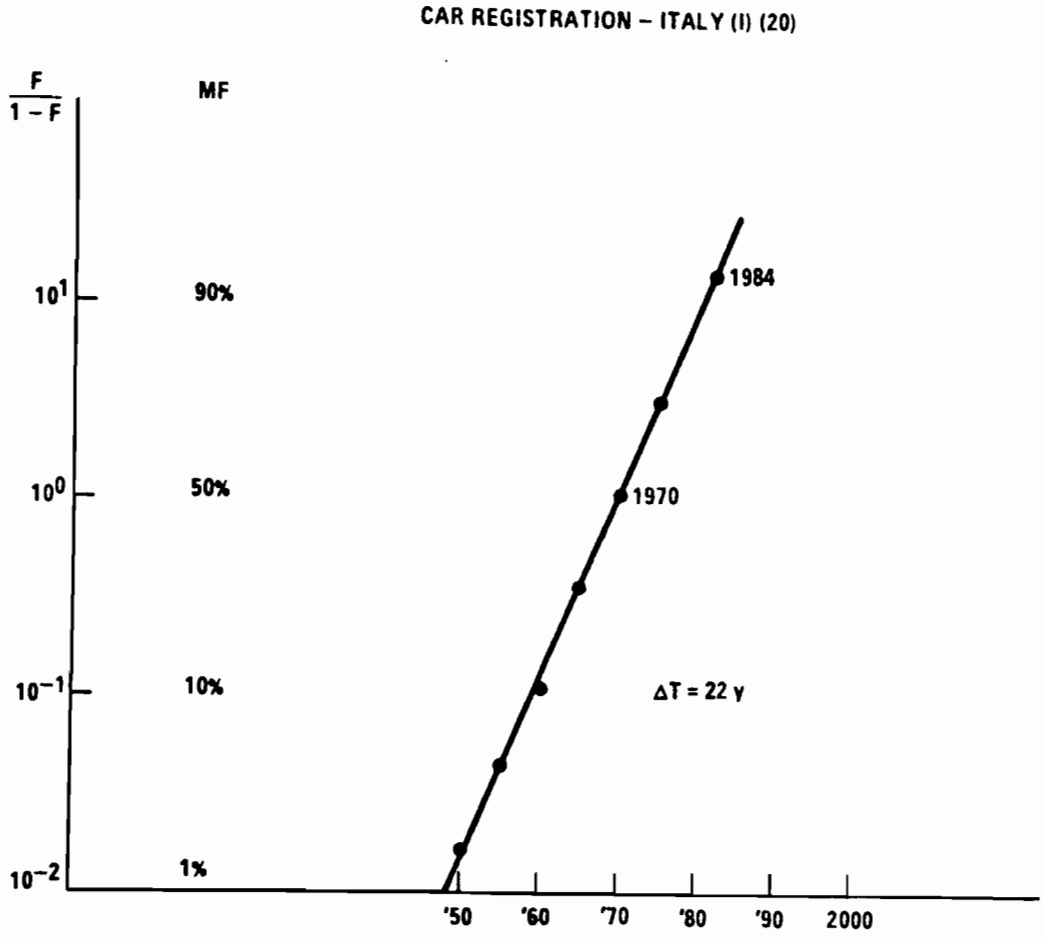

Figure 6a

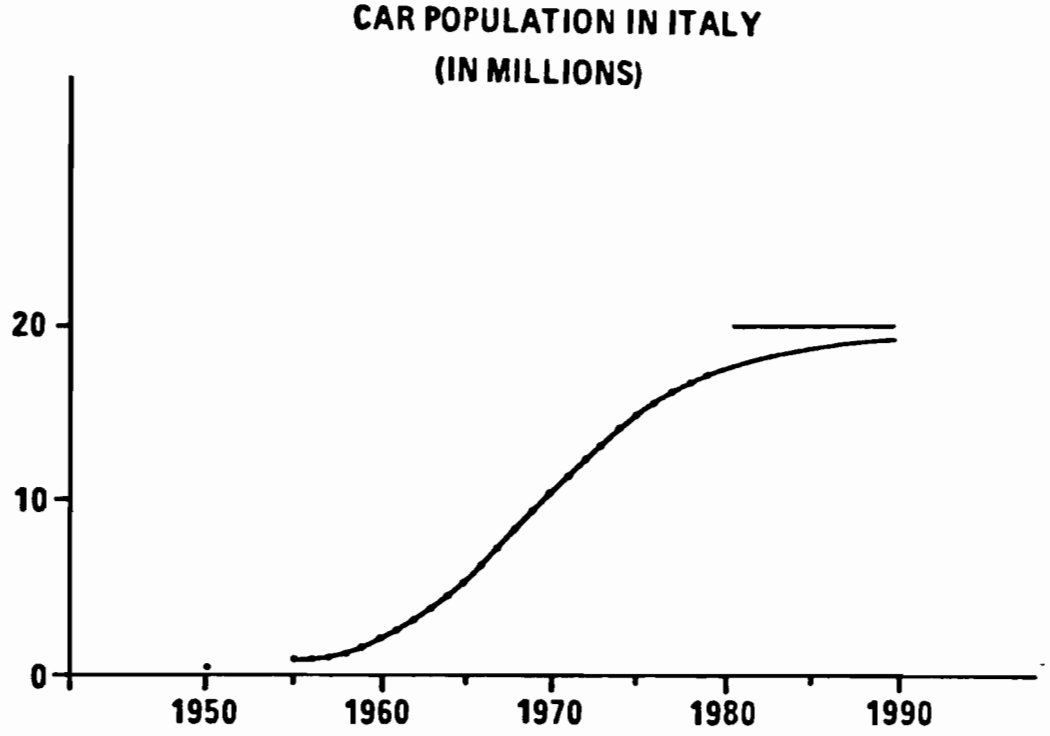

Figure 6b

FIGURE 7

As the construction of a cathedral may last for centuries, in order to grab a homogeneous quantitative indicator to measure the cathedral fever, I took the date of the laying of the first stone. It is an obvious indicator of the will to act becoming action. The number of first stones is counted every fifty years.

FIGURE 8

As in the case of the cathedrals, the state of the inauguration of the first railway stretch of a system finally becoming a network is taken here as the indicator of the starting point of the action. The about 40 railway networks actually operating are all reported here. No railway net was actually started after 1900, although most of them kept expanding after that date.

The period between the marks represents a period of boom in the long wave sense.

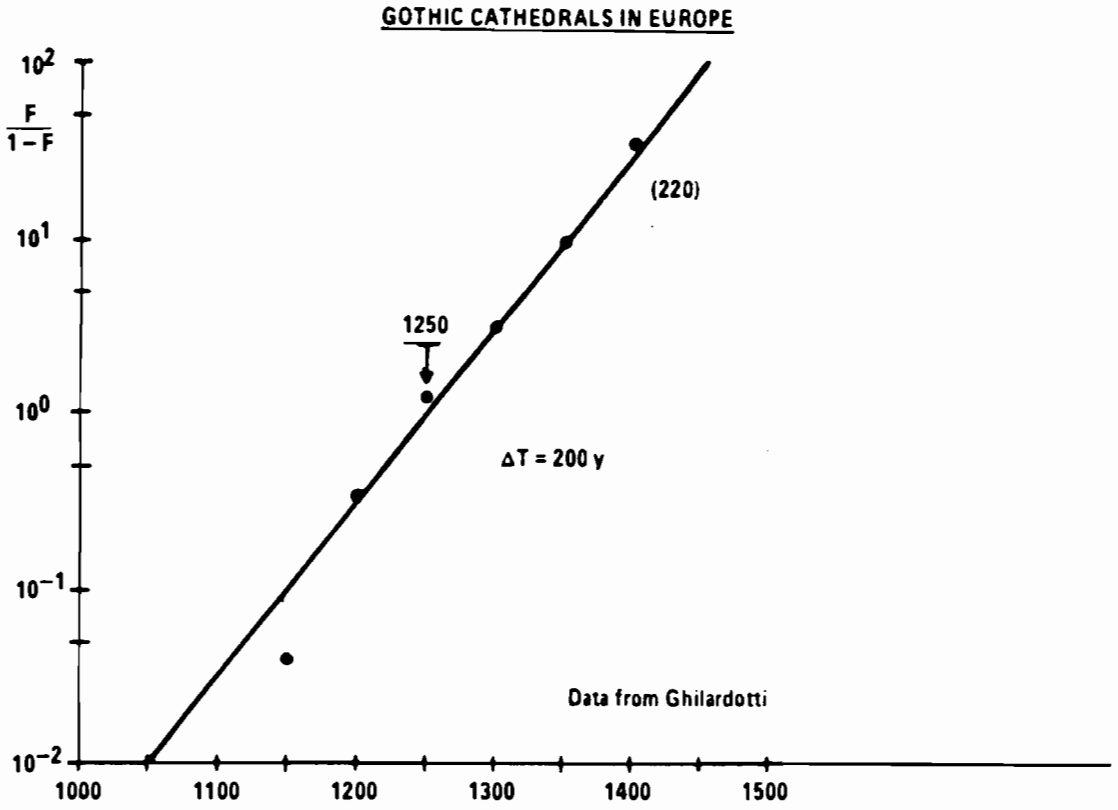

Figure 7

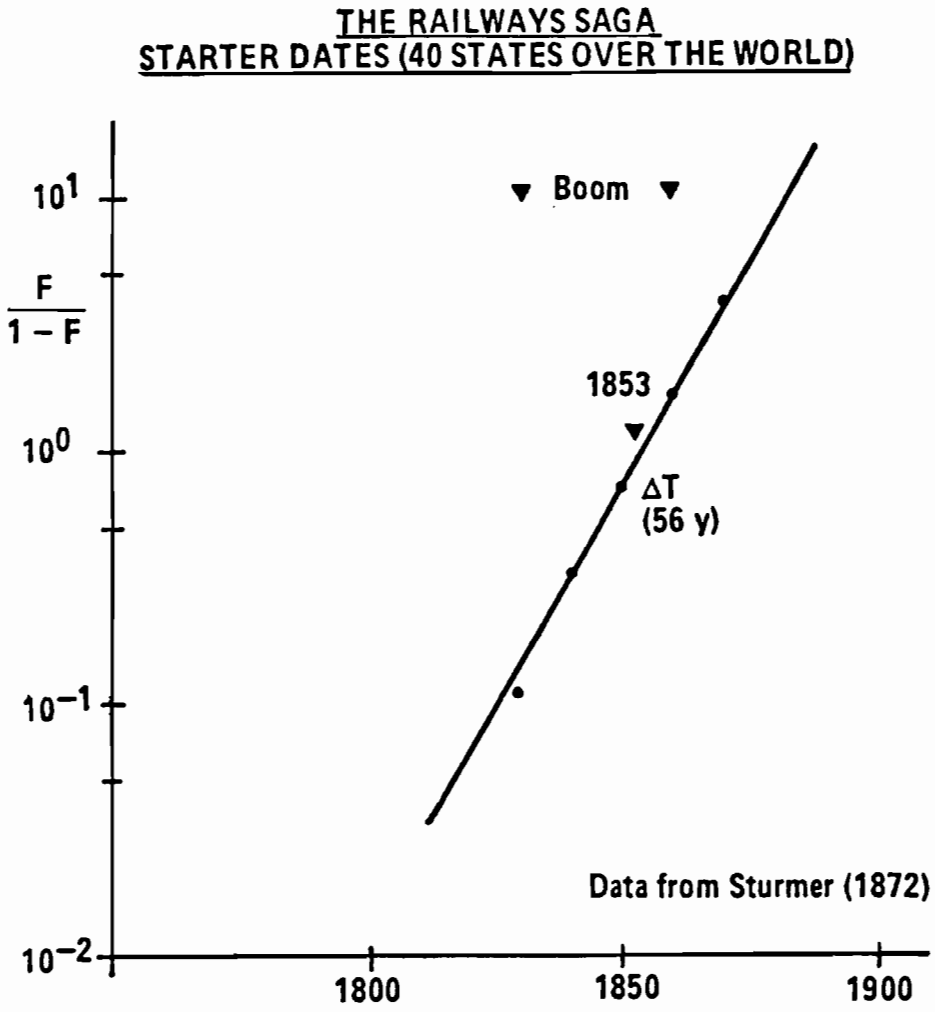

Figure 8

FIGURE 9

The data of Prof. G. Mensch on basic inventions and innovations during the last three centuries are organized here with the hypothesis that they are products produced in response to a system demand and filling a market niche.

The innovation waves are represented by the lines with an even number, the invention waves which preceded them by an odd number. Only inventions which generated an innovation have been taken into account, so, e.g., set n 1 and n 2 contain the same number of items.

Because invention and innovation basically conserve their order (first come first serve) to measure the time distance of a couple, it is sufficient to draw a horizontal line from the point of line 1 corresponding to the date of that invention, and find on line 2 the date of the corresponding innovation.

Lines 8 and 9 have been calculated from the regularities of the first three waves. The idea, that the next ten years will see a strong wave of innovations entering the market, fits well the present perception of the dynamics of the economic system.

INVENTION AND INNOVATION WAVES – THE SECULAR SET

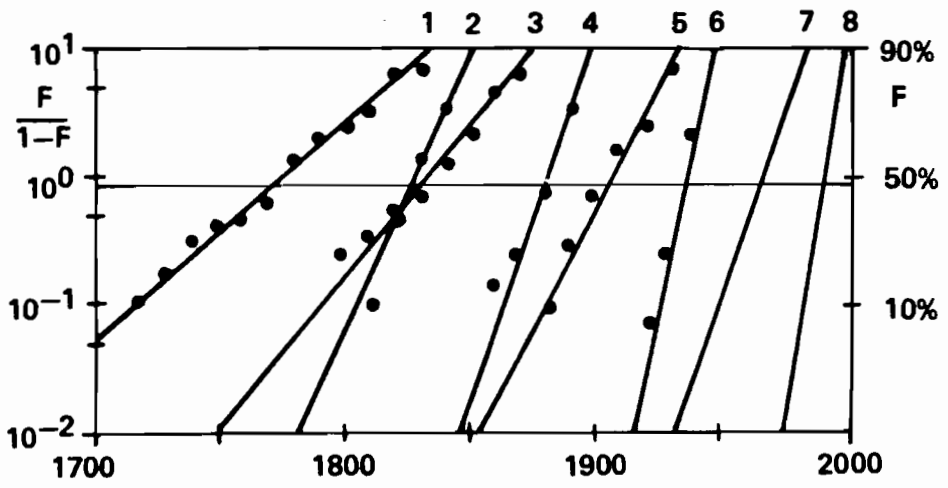

Figure 9

FIGURE 10

The distance between the center points of lines 2, 4, and 6 is 55 years, which may be cause or effect of long pulsations in societal moods and activity.

Socio-economic agitation can be monitored using electric energy consumption deviations from the historical trend (logistic!). The case of the U.S. is reported on top of the chart. The modulation is about 20%.

In order to test the moodiness and aggressivity of the American society, I took murders as an indicator. It has the advantage of credible statistical reporting. It has a modulation of 1:2, and is about 90% out of phase with the activity indicator (energy (o) and electricity (Δ)).

Still moodier is the ratio gun/knife, with a modulation 1:3, and the ratio women to men (victims).

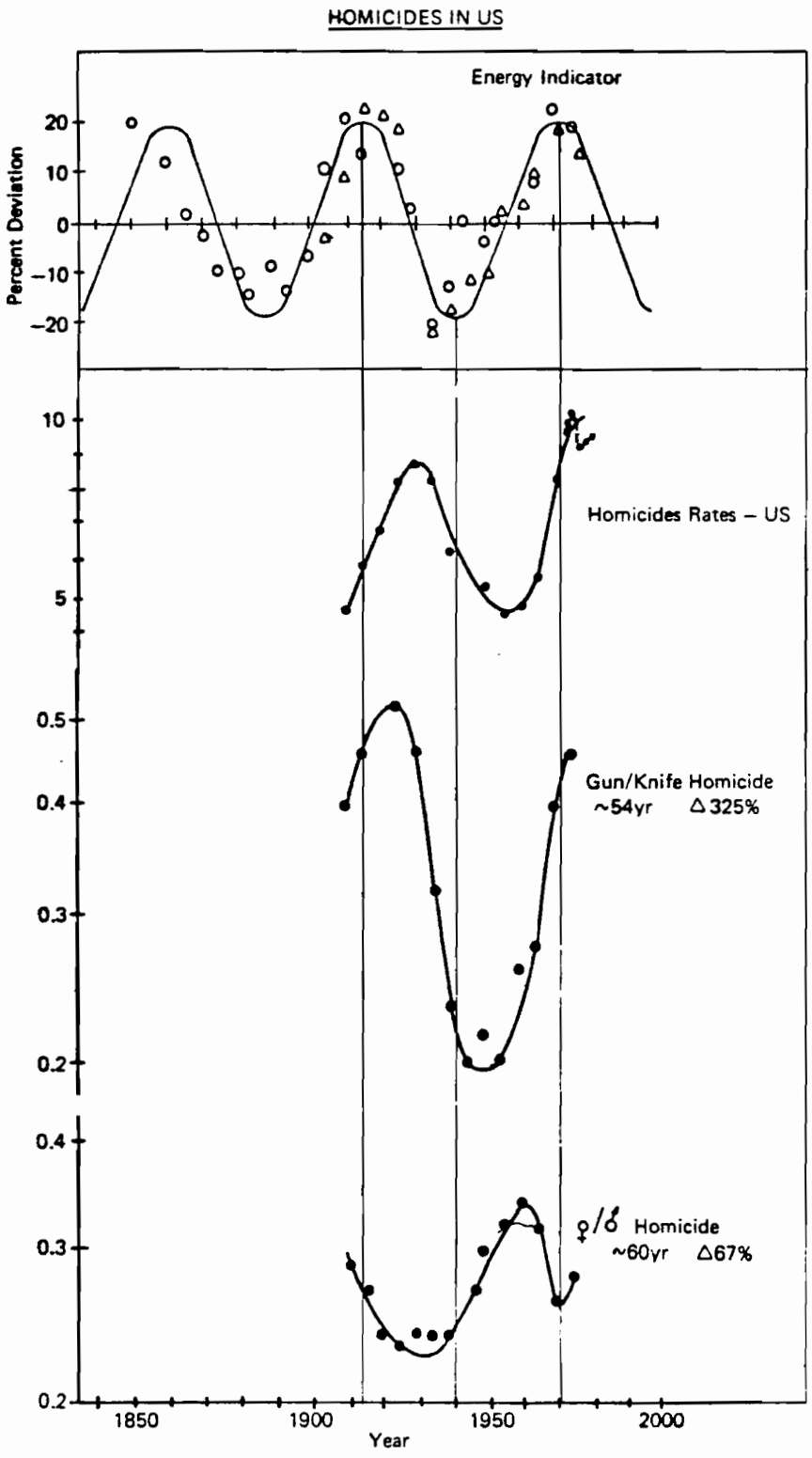
HOMICIDES IN US
Energy Indicator
Percent Deviation
20
10
0
−10
−20
10
5
0.5
0.4
0.3
0.2
Homicides Rates – US
Gun/Knife Homicide
~54yr Δ325%
0.4
0.3
0.2
♀/♂ Homicide
~60yr Δ67%
1850
1900
1950
2000
Year

Figure 10