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Memo for Mr. Kirschen

Questions for technological scenarios for cars.

1) Broadly speaking, the history of car passed through three major technological cycles (see Abernathy):

- a first cycle dominated by the Ford T model, up to the year '20;
- a second cycle characterised by the closed body car (up to the second world war);
- a third cycle characterised by the world market and the world car (convergence of European, American and Asiatic car characteristics with similar segmentation of the market. Market segments respond more to "status" than to basic car performances difference).

Each cycle develops according to a different "technological regime" which evolves and standardises along the cycle. At the end of each cycle the innovation process shows signs of saturation (increasing cost to obtain small innovations).

2) Are there signs of an incipient fourth car technological cycle?

The answer tend to be affirmative at least in the sense that there is an increasing gap between the demands adapt to the many different constrains (ecology, quality of life, pervasiveness of the Japanese market challenge) and the ability to respond (increasing inefficiency of R&D efforts typical of a saturated technological system).

The extend to which standardisation has been reached both in the design of the product and in the production technology, can be grasped if one considers that competition today is not much in term of product performance but on price and quality (in a given market segment).

It might be difficult for the experts engaged in the day-by-day innovative efforts to recognize this. Nevertheless the hypothesis of a new technological cycle deserve to be considered.

3) The technological achievements imbedded in today car, (in terms of performance, cost, reliability, etc.) are impressive. This notwithstanding, the user of car is finding more and more difficulties in exploiting the performance of the product, or even simply to "use" the car in certain conditions (saturation of traffic and other impediments and social constrains).

To assure that car continue to have value for the user, the car producer should more and more be preoccupied with "external problems" (infrastructure, urban design, etc.).

In the past, we have already seen an increase in the responsibility of the producers in assisting the users after he has bought the car (technical assistance, extended warranties, increased reliability and quality). In the future the involvement of the producer for the after sale phase will increase. New problems might have to be tackled by the car producer to sell the product. To give an example: it might have to help the prospective costumer to find a parking place, in case a future law will forbid to buy a car unless you have one.

The new car "concept" should therefore emerge from a systemic approach that considers *the need to integrate the car in the global transportation system (other modes, infrastructure, environmental impact)*. It will be reductive to consider that the only problems to face are those connected with the "air" environment quality.

4) The basic question to pose is: can we plan for the radical change to a new "technology regime"? The problem is a very difficult one. However the observation of past transitions tell a lot on the characteristic pattern of change. Can we use such knowledge to plan?

During the saturation period the innovation is well "channelled". The technological trends are clear. One can define the directions of R&D and set quantitative objectives for the innovation process. The research establishment of the leader enterprises (producers of the goods in the saturation phase) are all engaged in pursuing the "channelled" innovation activity. It is very difficult for them to give attention to alternative scenarios for the reason that the direction of needed innovation in the actual regime is so clear. Moreover, to respond to such clear R&D needs, an increased amount of physical and financial resources is required (because of the law of reduced efficiency of actions in a saturated system).

Nevertheless, for different reasons there are R&D efforts performed by someone following alternative scenarios. In the automobile case, the energy crisis of the year '70 has fuelled a lot of such search for new alternate routes.

Most probably, therefore, during the saturation phase a portfolio of ideas is being developed which will be the base for starting a transition phase to a new technological regime.

During such transition, many alternative routes are followed in a very inefficient and dispersed way. The comparison of new ideas with the current technology appears to be in favour of the latter in term of cost, quality, actual performance (even if new idea show higher "potential" performance). The technical "establishment" of the industries leaders of the current technology tend therefore to disregard the new technological routes.

When, after the transition period, a new leader technology (the one which survived many casualties) emerges, very often this is accompanied with the emergence of new enterprises. The history has proved to be so for automobile, for typewriters, for watches, etc. The above pattern shows therefore how to make an explicit plan to "ride" the transition scenario.

5) The most probable behaviour of the established leading companies in the business is therefore to assume that the future will follow a different pattern than in the past (departing from the above described transition path), or that we are not close to a transition to a new technological regime. If they will prove wrong, the transition will develop in an unplanned "eventful" way with new actors emerging.

An alternative decision-making route will be to take seriously the indications of the transition pattern and to plan accordingly. Since a basic part of such a plan will be to follow different technological routes - many of which later will prove not to be suitable - the effort cannot be done by a single enterprise no matter how powerful it is. Moreover, since the transition is only an hypothesis (and it will in any case take a long a painful course), one has to continue with the "channelled" innovation process to improve today products, to stay on the market while waiting for the new leader product to emerge.

A technology strategy to follow the transition hypothesis" can therefore only be done in a joint effort between competing enterprises. The rationale behind such joint venture is however different than that of "pre-competitive" research.

6) To make the transition hypothesis sound reasonable, we have to be able to describe scenarios of the future technological regime which will appear to be radically different of the today regime.

If we are really close to transition, the portfolio of research idea should already contain many indications both in term of the changing market need and of the technological answer.

An exercise to delineate such scenario (better, a set of different scenarios) is therefore the first thing to do.

7) Here are the outline for one such scenario.

The car market segmentation will be radically different of that of today. Basically, there will be two different car specifications: the short trip car and the long trip car.

They will have a common technological base. They will be able to communicate with an external network of information on traffic conditions and of guidance. Microelectronic will be extensively used on the car designed to substitute as much as feasible today "mechanically" performed information and control functions. Apart from these common aspects, the two cars will respond to completely different specifications and, accordingly, the design will differ.

The short trip car will have an electric or a hybrid power source, while the long distance one will have a thermal engine (most probably an internal combustion one) with the option of an electric power transmission. The short trip car will be designed to be compatible with an easy transfer to rail transportation for long distance displacement (limitation on total vehicle length). The long distance car will be amenable for automatic guidance on special roads. The short distance car will be very rugged, designed for ease parking, will have enough stored electric energy on board suitable for an average urban trip mission. In case of a hybrid solution, the engine will be very small and compact with intrinsically low gaseous and noise emissions (compact ceramic gas turbines?).

The long distance car might appear less radically different with respect to today power source, with the exception of the solution with electric power transmission. This solution will be favoured by a more extensive use of electronics and a "drive-by-wire" concept. The long trip car will assure a much comfortable ride than the short trip one, and it will use radically different materials and components than today.

8) The final question to be analysed before taking seriously the transition hypothesis is to make an inventory of today research activity and plans in order to ascertain how much of it can be classified as following the "channelled" innovation process or preparing a portfolio of new ideas to fuel the transition.

Here is a first quick reflection. Programs like *Prometheus* and *Drive* seem to follow new routes. In particular, they respond to the need of a "systemic" approach that consider the car development intrinsically tied with the transport infrastructure development, at least during the transition phase (before a new structure of the global transport system will emerge).

On the other hand, the R&D programs to push today technology to the limit to respond to the environmental (air, noise, energy) challenge, should rather be classified as following the channelled technological trends.

9) In conclusion, a strategic reflection on the R&D plan is needed. If such reflection leads to consider as plausible the transition hypothesis, then a major change in today prevailing R&D policy have to be planned. Basically this will mean to continue the effort on the "channelled" R&D activity while in the meantime a large cooperative effort among competing companies and public establishments should be launched to follow radically departing technological routes.