CERIS
ISTITUTO DI RICERCA SULL'IMPRESA E LO SVILUPPO

Via Avogadro, 8 - 10121 Torino - Telefono (011) 5601.111 - Telefax (011) 562.60.58
Corrispondenza: C.P. 1381 Ferrovia - Partita IVA: 02118311006
E. MAIL TO 1001 @ ITOIMGC.BITNET

Working paper N° 4/1994

FIAT AUTO: A SIMULTANEOUS ENGINEERING EXPERIENCE

Giuseppe Calabrese

CONSIGLIO NAZIONALE DELLE RICERCHE

This paper is based on research carried out in the context of the international research project on «Product Development and Production Networks: A Comparison of Countries and Sectors» coordinated at the Science Center of Berlin (WZB).

FIAT AUTO: A SIMULTANEOUS ENGINEERING EXPERIENCE

Giuseppe Calabrese

First draft: March 1994
Revised draft: August 1994

1. Introduction

The major challenge Fiat Auto has resolved to win in the '90s is the achievement of the Total Quality project, within which the most important aim is the Time to Market (T.T.M.) system, that is the satisfaction of those customers to whom "the right product at the right moment" should be offered. An instrument suitable for reaching T.T.M. is Simultaneous engineering (S.E.) through which the following goals would be attained:

- reduction of project development time/cost, as activities are carried on "in parallel" instead of "in sequence";
- reduction of product costs, because more alternative techniques can be analyzed in shorter time;
- reduction of investments, because "Design for assembly" is developed only if the industrial functions of the company work with known and shared purposes;
- improvement of quality and reliability levels of products, because all the other goals depend on the achievement of quality purposes.

2. Management organization

Five operational platforms have been arranged - one for each product range - for the concept, planning and management of changes of Fiat Auto's new products. Within platform C, which is going to be analyzed in this study, there are the following motor vehicle models:

- the future "Tipo C" model
- the new Lancia Delta
- the new Alfa Romeo 33
- the recent Fiat Coupé

The development procedures of a new product must comply with the guide lines described in the so-called Product Range Plan (PGP). This plan is drawn up by the central management of Fiat Auto; it outlines the launching times of new products, their main characteristics and the funds allocated for their execution. The only essential and definite element to be strictly observed is the starting date of commercialization, as any delay could cause negative effects on the introduction of other new products, since the sales of certain types of motor vehicles are seasonal (e.g. Fiat Coupé); in other cases, commercial launches carried out with too shorter intervals in between do not benefit from complete and immediate exploita-

tion of market potential buying opportunities.

The current PGP has been drawn up for the period of the '90s (10 years in total) and globally arranged for the planning of 50 new models.

The development process of a new product has been divided into 4 macro-phases with a global Time to Market of 48 months. Fiat has declared she intends to further reduce the time necessary for the productive launch of a new model.

- The first phase concerns the product concept up to the final approval of the new model. For each of the three makes represented by Fiat Auto (Fiat, Lancia and Alfa Romeo) the intention is of maintaining those peculiarities and characteristics which have always distinguished each of their own particular style. In fact, the design planning centres (one is usually in Fiat and the other two are external) must comply, for every make range, with certain statements Fiat considers indispensable. In order to protect these peculiarities there are three internal testing and style departments, one for each Fiat marque, and some of them are located outside the district of Turin.
  For achieving this phase twelve months have been allowed, even though Fiat believes that especially in this phase it is possible to obtain most savings in time. Fiat aims at spending no more than nine months for the product outline evaluation. In this phase strategic marketing plays a major role for transferring upstream customer's (VOC - Voice of the customer) and sale network needs (VOD - Voice of the dealer) and comparing them with the guide lines set down by the 'ownership' in the Product Range Plan (VOO - Voice of the owner).
  The determination of quality levels the product should have to improve the company image and to be highly competitive is paramount in this phase. An internal Board (Quality control) makes proposals and checks whether the aims previously fixed are in agreement with the other functions of the platform.

- During the second phase the following operations are carried out: product planning development, industrialization process analysis, technical reliability check, implementation of the first pilot production. All technological aspects concerning these operations are tackled. All the interfunctional teams are also set up: their task is that of looking after the whole project, the feasibility of the product in all its aspects and the changes which will be introduced to adapt the product to new market

requirements. They could also deal with the impossibility of respecting certain project aspects. In every team representatives of each function are present. They are: Technical direction, Production, Marketing, Purchase and Quality Control.
In this phase suppliers could also be involved, according to their degree of reliability.
Twenty-one months are devoted to the product planning; during this time economic analysis and the approval of the development programme are also performed.

- In the third phase the pre-series production is executed together with the check of quality levels fixed in advance. Six months are devoted to achieving the technical, product and process resolution.

- During the last nine months production starts, commercial areas and networks are involved, prices are settled and mass-media informed.

Once a month meetings are held among the different platforms for exchanging information and solutions adopted on the different models.

But, within each platform, meetings concerning the progress of work, are held weekly.

As a consequence of concentrating the planning of the three different makes in one site, which only deals separately with the style centre and check tests, the risk is that of standardizing procedures too much without safeguarding the characteristics of each make.

3. Simultaneous engineering

In Fiat Auto the S.E. system was applied for the first time in the project development of the Punto.

Each company, according to its commodity field, to its culture and organizational evolution, to the historical moment of competition it has to face, has given a different - though only slightly - definition of Simultaneous engineering. Fiat Auto gave the following one:

"S.E. is the methodological, regular and organizational approach towards the integration of the various company functions during the product development cycle which goes from pre-engineering to production start. S.E. requires the passage from a project development system characterized by consecutive activities to a process development system in which the same activities are performed in parallel. This is possible if the product

aims are all known and shared from the beginning of the operational activities."

Technical problems can thus be faced taking into account the needs of all functions at the same time. A correct outline and the coherent development of the project are then possible from the beginning and they represent the source of remarkable quality and time efficiencies which can be achieved.

Every decision has ensued from an interfunctional process with the right level of delegation and responsibility. Thus the project revision cycles have been left out, in which, in the traditional development process, functions examine the work carried out by the function upstream. If they do not agree upon it, they ask for corrections, then examine the modified project again and only if they agree upon it do they let it be examined by the function downstream.

Interfunctionality has been granted through the creation of working groups composed of specialists coming from company functions (Planning, Production, Purchase, Marketing, Accountancy and Control) and coordinated by a "core team" which has followed the project from outlining to production consolidation (mass-production).

In S.E. a continuous and coherent flow of information has arisen, originating from the individualization of customer needs. These were outlined through surveys led by marketing specialists, who use accurate and reliable recognition and identification techniques of the voice of the customer (VOC) together with suitable check procedures of correspondence between the product, at its development stage and customer's desire. In this way Fiat has safeguarded herself against any changes of product contents after production start which would not only be expensive but would endanger the achievement of quality aims.

Marketing information has been changed into project contents throughout the drawing up of various technique/technological alternatives, all coherent with the innovation strategies of product contents and process technologies and the strategies of execution of product reliability and quality excellence objectives.

In the analyses of project alternatives a major role was allocated to the supplier system. The change has involved not only the company internal processes but also the external relationship process which regulates the relationships with suppliers.

The activities with suppliers were performed in Codesign, whose connection with S.E. is briefly shown in figure 1.

As for the execution of a widely extended strategy aiming at reducing vertical organization, suppliers were not entrusted with a merely executive task. They were actually asked an optimization contribution far more important than in the past. In other words they were asked to bring peculiar know-how, highly innovative, competitive and capable of integrating with the new way of working.

Suppliers have thus participated since the outlining of the Product Detail list, in order to use their know-how about innovative trends, in the best possible way.

During project development suppliers have participated full-time in the various work teams in order to supervise the employment of their components, always sharing the general aims of the motor vehicle system (Figure 2).

The choice among the different project alternatives drawn up by the interfunctional team has been supported by Accountancy specialists who have integrated and achieved the project alternatives after evaluating costs and investments relative to the implementation of each alternative.

The final choice of product configuration mostly tends to:

- meet customer's need;
- improve the intrinsic technical, technological and qualitative level;
- guarantee the maximum reduction of development and execution costs.

As S.E. keeps into account the competitive advantage of the product from its concept to production and continually checks its development, Fiat Auto believes S.E. is not only a new way of working, but also a strategic instrument to guarantee great success to the company.

4. Changes introduced by S.E. in the development of the new motor vehicles

The transition from a sequential to a progressive approaching development has involved radical organizational changes which started in 1990 with the first performance of progressive strategy on the Punto project and are still in progress. It turned out that Fiat Auto's desire of recovering its competitive position and its hope of achieving this result, also with the introduction of S.E., has been supported by the effort of performing tests on new organizational mechanisms, the adoption of advanced operational procedures and the strengthening of management instruments. Even though they are still not completely consolidated, together with their allo-

cation to major projects, with ambitious aims to pursue within the renewal strategy of Fiat Auto.

In summary, the various aspects of change can be described with different labour organization and with the new operational and management instruments.

4.1 Labour organization

4.1.1 Organizational structure

Fiat Auto organizational structure, under the central management, is made up of three staff bodies (Organization, Industrial Relations and Management and Resource Development) and of three functional and operational supporting bodies (Production, Technical Direction and Commercial Area).

As far as planning and restyling of new products are concerned, the Fiat Auto organizational model derives from the Technical Direction and consists of a double structure both with leading and managing elements relating to each other.

In the upper level the organizational model is the matrix where one part represents functional units and the other technical direction bodies. In each intersection the different project teams are shown, in which the experts of each function come together. It is important, however, to point out that within these interfunctional teams the Technical Direction body has partly maintained a predominant role. It is not by chance that all but one team project leaders come from this body.

The matrix structure develops following the product lines corresponding to the various market ranges:

- Segment A - Commercial vehicles, foreign market and electric vehicles (Fiorino, Ducato, Panda Elettra).
- Segment B - Small-sized vehicles (Cinquecento, Panda, Y10, Uno e Punto).
- Segment C - Medium-sized vehicles (Tipo, Alfa33, Delta, Coupé).
- Segment D - Medium/Large-sized vehicles (Tempra, Dedra, Alfa155).
- Segment E - Large vehicles (Croma, Thema, Alfa164)

Within Fiat Auto the intersections of functional lines and of product are called "platforms".

The team which coordinates platform activities is permanent and -

consistently with the matrix model - does not monitor hierarchically any of the people assigned to it, except for the secretarial staff.

Moreover, the bodies specialized in technique do not manage current productive processes, they are rather professional groups of specialists, permanently allocated to the various platforms. In other words, the aim of functions is that of maintaining and developing existing know-how (shelf-engineering), of providing the human resources necessary to develop new products, thus favouring the transfer of know-how from one platform to the other.

In each platform there is an exponent of the functional areas (R&D, Tool design, Controlling, Procurement, Marketing, Personnel) and one for each new car project.

Starting from each new car project responsible there is an under-structure organized by projects involving the creation of provisional bodies; each of them is responsible for the execution of particularly complex activities involving the engagement of several people coming from different company functions. Project leaders have hierarchical authority towards the people who belong to the project team. These people depend on two different bodies but not simultaneously: that is, during the project execution they depend on the project manager, while for the rest of the time on functional bodies.

The number of teams varies according to the complexity of the model, but generally amounts to 19, 16 of which are for specific parts (e.g. side panels, suspensions, etc.) and 3 for the so-called virtual parts (e.g. the body). The teams' working method is simultaneous engineering and to take part of them is considered an opportunity of professional enrichment and a good way of implementing job rotation. It is to mention, however, that at the beginning simultaneous engineering was considered an operational procedure falling within the competence of technical direction only. After three years spent on testing the structure organized under platforms, completely dissimilar personal points of view have emerged. At the end of the project each worker can become very anxious because he does not know whether he goes back to his functional area or he is allocated again to platforms.

4.1.2 Co-location

When S.E. was employed for the first time in Fiat Auto the Company Management decided about the co-location of specialists of various functions who, with different responsibilities and discipline know-how are

usually asked to contribute to the organic development of a project.

The execution of co-location has involved a remarkable organizational effort because some hundred people were physically moved together with their work instruments, from the place where they used to work to the place where the new project is to be carried out. This move has had a highly emblematic and motivating meaning because it has marked the fall of barriers, even physical ones which during the traditional motor vehicle project development had always defined the areas where the above mentioned Company Functions worked.

When starting co-location, particular attention was given to the specification of problems which could ensue. Problems concerning in particular human resources, went from mere space difficulties resulting from the move to the new work site, to far more complex relation problems with the functions to which workers belonged. The "head quarters" of these functions were still on traditional sites, not in co-location.

Management's task was to establish suitable channels to perceive the organizational climate, the emerging problems, to prepare the instruments for short-term solutions and to study definite organizational solutions of the new structure.

Vocational training, mainly aiming at team working techniques, has been fundamental to quickly overcome opening difficulties.

A peculiar characteristic of co-location in Fiat Auto has been that of supervising the project in the site where it was being implemented.

Interfunctional teams, whose number of participants and quality depend on the project development phase, worked within Technical Direction during the planning and testing phases, then moved to the Pilot Plant for the Process Check. Finally they went to the Production Plant during the pre-series and production start phases.

In this way, during the consecutive development phases, continuity of component and of motor vehicle subsystems improvement was guaranteed by the regular presence of the same skilled-workers.

The number of workers within co-location varies according to the development phase. As regards Punto (figure 3), whose project was recently achieved, it is possible to point out the human resources flow in co-location during the whole cycle.

4.1.3 Setting up project interfunctional teams

This task was performed by the Company Management which, at all levels, has allocated to human resources of the various platforms different

tasks which involved the will and necessity of achieving results coherently with the logic of interfunctional development of the project.

The crucial moment of this change aspect was represented by the step-by-step widening of the "Cross allocation of goals" and of the "Cross evaluation of performances". This means that all the workers of Fiat Auto, belonging to all the levels involved in individual allocation of objectives of the annual accounting period and in the following performance evaluation, have taken part in both these interviews. In the previous work organization, these interviews were traditional meetings between chief and employee in which they examined objectives, performances and related facts together with their hierarchical chief and with the functional leader to whom workers had to refer.

Resources allocated to platforms have been organized in various project teams; each of them is in charge of developing a specific subsystem of the motor vehicle.

During Punto manufacturing, for example, at the beginning of colocation, some 28 active teams were set up on the subsystems singled out by the core-team.

After the development of the Punto project Fiat Auto has achieved the rationalization of the vehicle development process. The new projects have been divided into 16 basic teams working on three physical subsystems (suspensions, dashboard, etc.) and in 3 other teams. Their job concerns typical performances and characteristics of the full vehicle system. The number of interfunctional teams varies according to the project. For Tipo-C, for example, 21+9 teams were set up because since the beginning 4 different versions (5-doors, 3-doors, station wagon and cabriolet) were foreseen. In figure 4 basic team configuration is shown.

4.1.4 Codesign

In the introduction we have already described the new strategic role played by suppliers. The percentage of components developed in Codesign is higher than 50% of the total value. The group of suppliers was made up of resident-engineers who contributed, by introducing the right skilled workers into the different phases of project development, to the optimization of the use of their own component with regard to the optimization of the vehicle system.

In figure 5, relating Punto, it is possible to deduce the trend of the presence of the Resident engineers in Codesign.

4.2 Operational instruments

4.2.1 Cae-cad extended use

S.E. is undoubtedly simplified when some basic conditions are satisfied:

- working in an atmosphere where there is a relationship of professional exchange among technicians from different cultures;
- work programming is carefully studied in order to exploit all possible parallelism of activities involving simultaneously all the characters of the process;
- the use of CAD-CAE extended techniques capable of analyzing a variety of technical aspects linked to the product for the execution, through 3D simulation and models, of virtual objects which resemble very much the aspect of the real product.

Simulation techniques, in particular, lead the team operating in S.E. to work in a virtual reality which allows them to anticipate the problems of testing.

Potential critical points can be analyzed from different technical points of view, finding optimized solutions more easily.

Another important advantage of this kind of approach is the possibility of achieving, through quick prototyping techniques physical images of virtual objects, allowing for a series of project checks and set ups.

Though the CAD model has been widely adopted, a table is always available for drawing the simplest components in the traditional manner.

The adoption of simultaneous engineering implies that data are released during procedure development, not only at the end of the procedures. Moreover, since some of these activities are carried out in parallel, continuous updating is necessary.

The results obtained with CAD are transferred to the following areas by means of models for surfaces, volumes and lines with 'raster' technology.

The first tests on computer aided drawing have been achieved by software experts within Fiat Auto. The subsequent purchase of CAD programmes from skilled companies initially implied the research of compatibility between existing know-how and external software. For this reason total compatibility with software for numerical control, quality control and robot setting does not exist yet, even if its execution is in progress.

An Operative Plan (Master Plan) has been drawn up for the gradual diffusion of the CAD model which will end in 1997. In a very synthetic

manner the introduction of CAD in Fiat can be analyzed from two points of view.

- The technological aspect.
  Until 1991 only three-dimensioned Computervision work-stations had been adopted. Such a work-station has proved to be in many cases much greater than specific needs and with an unsatisfactory costs/benefit relationship. For this reason later on also 2-D CAD models by Autocad have been used. CAE procedures are employed for simulation activities: these procedures are particularly important since they can forecast any possible defect on prototypes and so reduce testing costs.
- Penetration level
  Within Fiat, CAD is considered a strategic choice of vital importance through which it is possible to adapt or detect new organizational structures. The results of the introduction of computerized procedures in the field of product planning and concept are so important that it is extremely difficult to make ex-ante remarks on probable benefits. Fiat chose CAD without previously carrying out careful analysis on investment return.

At present CAD has been introduced for the activities concerning simultaneous engineering in R&D (600 workstations) and in tool design (100 workstations). According to the programme all internal bodies will be involved except for the operations relative to style definition. In this case more sophisticated equipment is necessary, as similar as possible to that of manual modelling.

4.2.2 New testing plan

The new Testing Plan has been drawn up as an efficient device within S.E. because it involves teams from the first steps of the project up to the final checks, in a field which in the past was committed only to vehicle testing. Its concept and effectiveness are strictly linked to the adoption of other work instruments typical of S.E., but above all to the existence, in the initial stage of the project, of a firm, articulated and reliable computing structure which can give a sort of ante-deliberation, starting from the first draft of the project.

When the Testing Plan is drawn up within the team each component undergoes analysis and according to its origin (component or new one, or total carry over or partial carry over) and to calculation supports which are available about it, a decision about what the experimental iter (which should certify its validity) will be taken.

The aims achieved with this new work device/instrument are:
- involvement of the team, thus of the skill of each participant as regards deciding what to do and when to do it and as a consequence waiting for the positive result of check;
- time and cost efficiency as the longer tests are carried on only when absolutely necessary and on peculiarities deemed remarkable by the team for the development level reached.

4.3.1 Managing devices

4.3.1 Integrated programming

In 1990 this important managing device was being studied by one of the groups working on the subprojects of Fiat Auto Total Quality Plan.

In order to allow Punto core-team to employ the above mentioned device not yet perfected, the development of the programme was accelerated and the purchase of hardware and software necessary for its employment was anticipated.

Integrated programming logic is aimed at supplying the core-team with a control and programming device covering the whole of the intervention development process. This would allow both feasibility checks of time objectives of each plan phase and an effective monitoring of each activity development.

The objectives that such an instrument should reach are the following:
- managing the project both in a transversal and functional way;
- managing priorities:
- managing development costs throughout time-cost trade-off analysis;
- budgeting support;
- managing human resources also according to labour quantity within each Company function;
- managing critical paths and what-if analyses in order to overcome emerging critical situations and to reduce any possible delay.

All these actions should be accomplished in accordance with "transparency" towards all the Bodies involved in the development process and with "coherence" among the various levels of business programming.

4.3.2 Design review

In this case as well, a considerable acceleration has been given to a Total Quality project the development of which was already in progress.

We can say that - though not yet refined - this instrument turned out to be precious and irreplaceable in order to achieve the pre-settled following aims:

- complying with keeping planned times;
- complying with settled product contents.

The logic of Design Review is that of identifying, at the higher level as possible, the achievement or deviation from the goals by means of:

- use of know-how of all the functions called in to co-operate in every moment of the development process;
- measuring of the process 'intermediate' product with Supplier/Customer logic;
- check of activity execution with the expected quality level in the respect of a programme.

The Design Review structure is based upon two check levels/moments:

- M.S.D.R. (Management System Design Review): programme and system checks. Check moments are connected with the phases of development T.T.M. programming of the project. For each phase there is a M.S.D.R. The nine identified M.S.D.R. check that the primary objectives, connected with Marketing requirement fulfilment (VOC) and with the respect of company constraints, are constantly under control and that any countermeasure could be identified in time.
- O.D.R. (Operative Design Review): checks of content applied to operational scopes. The two check levels are connected with the sharing of aims which, in the end, must always guarantee customer's (both internal and external) requirement fulfilment.

5. Main results

5.1 Times

The interviews performed concerned a project in progress from which it is not possible, at present, to draw performance indicators, except for evident hope expressed by interviewees. In development times of the Punto project, however, the results obtained with S.E. introduction in Fiat Auto are evident. When the new strategic intervention was decided to be applied to project development, standard T.T.M. had planned the new

vehicle launch for November 1994. The first intervention of S.E. resulted in a nine month saving followed by, after one year, another three month saving thanks to time and quality unexpected results obtained with S.E. In figure 6 are shown: T.T.M. according to the old standard, T.T.M. planned after S.E. introduction and final T.T.M. representing the Punto commercial launch which took place in November 1993.

5.2 Costs

Punto development costs do not show yet remarkable reductions compared with the costs of other previously developed correspondent model. The only reductions are those intrinsically due to shorter development times. It is necessary to note, however, that Fiat Auto had taken into consideration the hypothesis of not reaching all possible efficiencies with S.E. introduction simultaneously and since the first performance.

As regards Punto, time reduction goal was paramount. As far following developments are concerned, since organizational mechanisms and technical instruments had been set up and improved, we can say that the aim of development cost of a following project of motor vehicle in S.E. is about 10% less than the traditional development cost of the same project.

5.3 Quality

Quality and reliability aims allocated to Punto, the achievement of which has just been certified, are represented by values attained at present only by certain similar products by European and Japanese competitors.

6. Conclusions

S.E. is a strategic instrument for the success of Companies because it guarantees their competitive benefit.

The first performance of S.E. in Fiat Auto has had, as already stated, a highly emblematic aspect because it marked the fall of professional barriers which, in the traditional process of project development, had always defined competence areas of the various Company Functions. At first workers were confused about their new role, their relationship with original functions which, apart from S.E., still existed and operated on other projects and about the identification and use of their new task.

Their initial discomfort was quickly overcome thanks to the competence of co-location specialists who spontaneously provided for the lack of procedures, starting to work 'across' traditional Functions.

In this connection it is important to point out the professional growth of resources who have benefited from know-how exchange, from the transfer of information allocated in special areas other then theirs, contrary to what happens in the traditional sequential process of project development.

S.E. is a non-return phase in the evolution process of Company organization from Functional to integrated. Specialists involved in S.E. would never go back to sequential work with strictly functional goals.

Finally, S.E. has been the promoter of the introduction of organizational mechanisms aiming in particular at the integration of Company Functions, of accurate and analytical management instruments. It also strengthened the use of technologically advanced operational instruments.

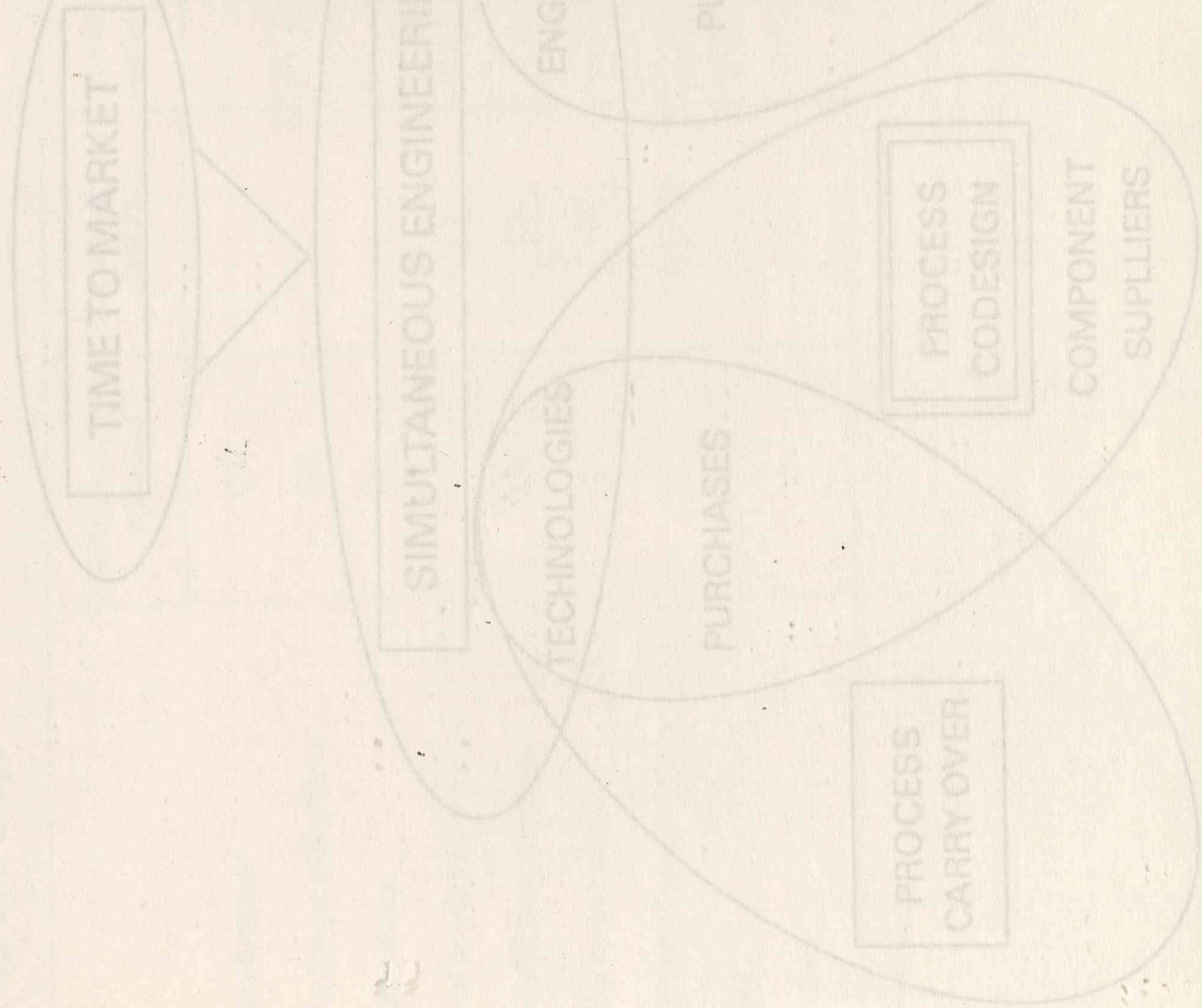


FIGURE 1 - EXTENDED AND FULLY INVOLVING ACTIVITIES

FIGURE 1 - EXTENDED AND FULLY INVOLVING ACTIVITIES

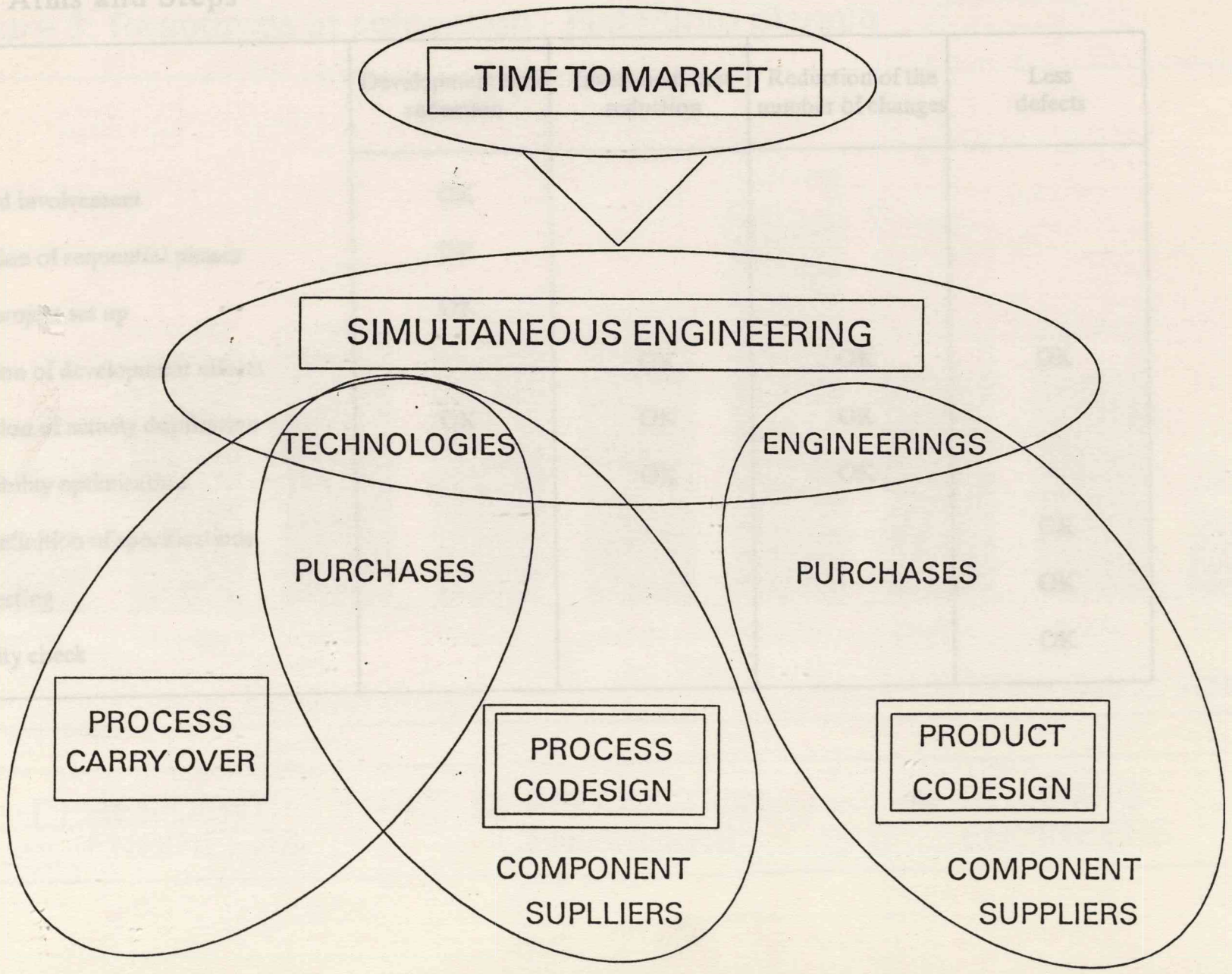


FIGURE 7 - EXTENDED AND FULLY INVOLVING ACTIVITIES

Figure 2: Aims and Steps

	Development time reduction	Investment cost reduction	Reduction of the number of changes	Less defects
Advanced involvement	OK			
Elimination of sequential phases	OK			
Speedy project set up	OK			
Integration of development efforts		OK	OK	OK
Elimination of activity duplication	OK	OK	OK	
Compatibility optimization		OK	OK	
Better definition of specifications				OK
Better testing				OK
Reliability check				OK

	Development time reduction	Investment cost reduction	Reduction of the number of changes	Less defects
Advanced involvement	OK			
Elimination of sequential phases	OK			
Speedy project set up	OK			
Integration of development efforts		OK	OK	OK
Elimination of activity duplication	OK	OK	OK	
Comprehensive optimization		OK	OK	
Early detection of exceptions				OK
Early testing				OK
Continuous check				OK

Figure 3: Resources in colocation - Fiat Punto plannig

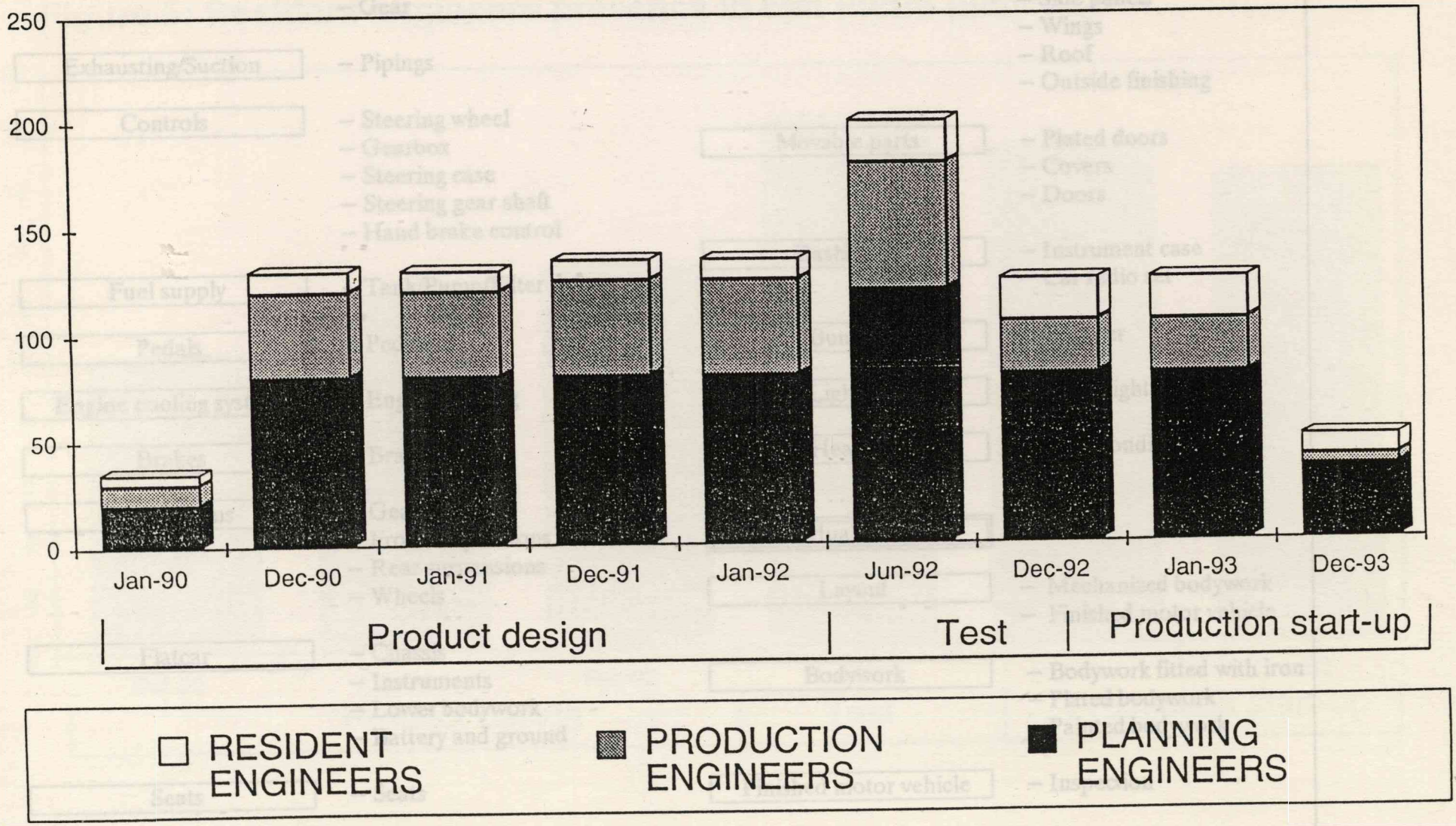
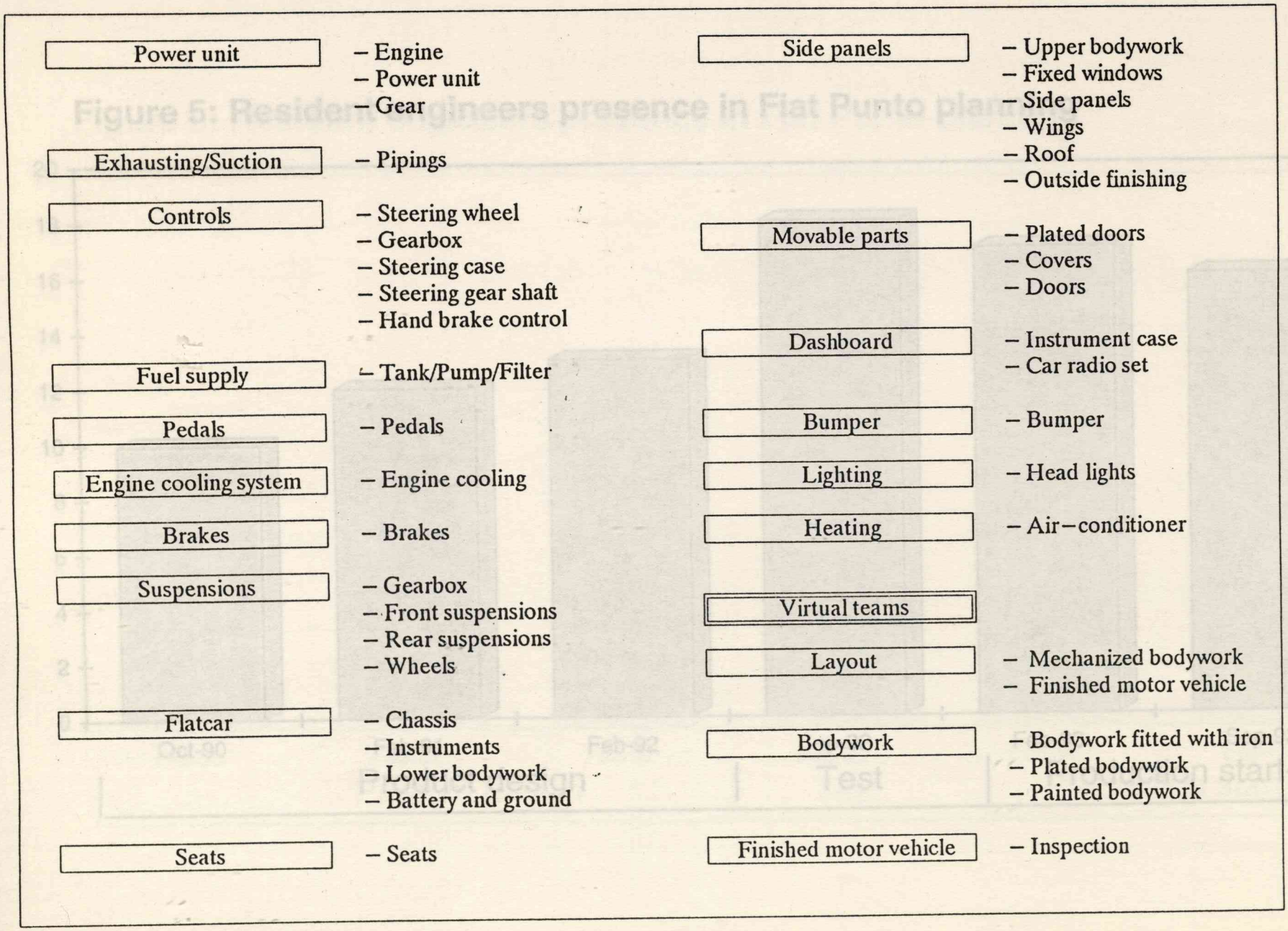


Figure 3: Resources in colocation - Fiat Punto plasma

Figure 4: Team Correspondence



Engine
Power unit
Cost
Antique
Exhaust system
Control
Steering system
Body
Doors
Covers
Wheels base
Chassis
Suspension
Brakes
Transmission
Clutch
Engine cooling system
Fuel system
Electrical
Ignition
Battery
Lights
Instruments
Heating
Ventilation
Upholstery
Seats

Figure 5: Resident engineers presence in Fiat Punto planning

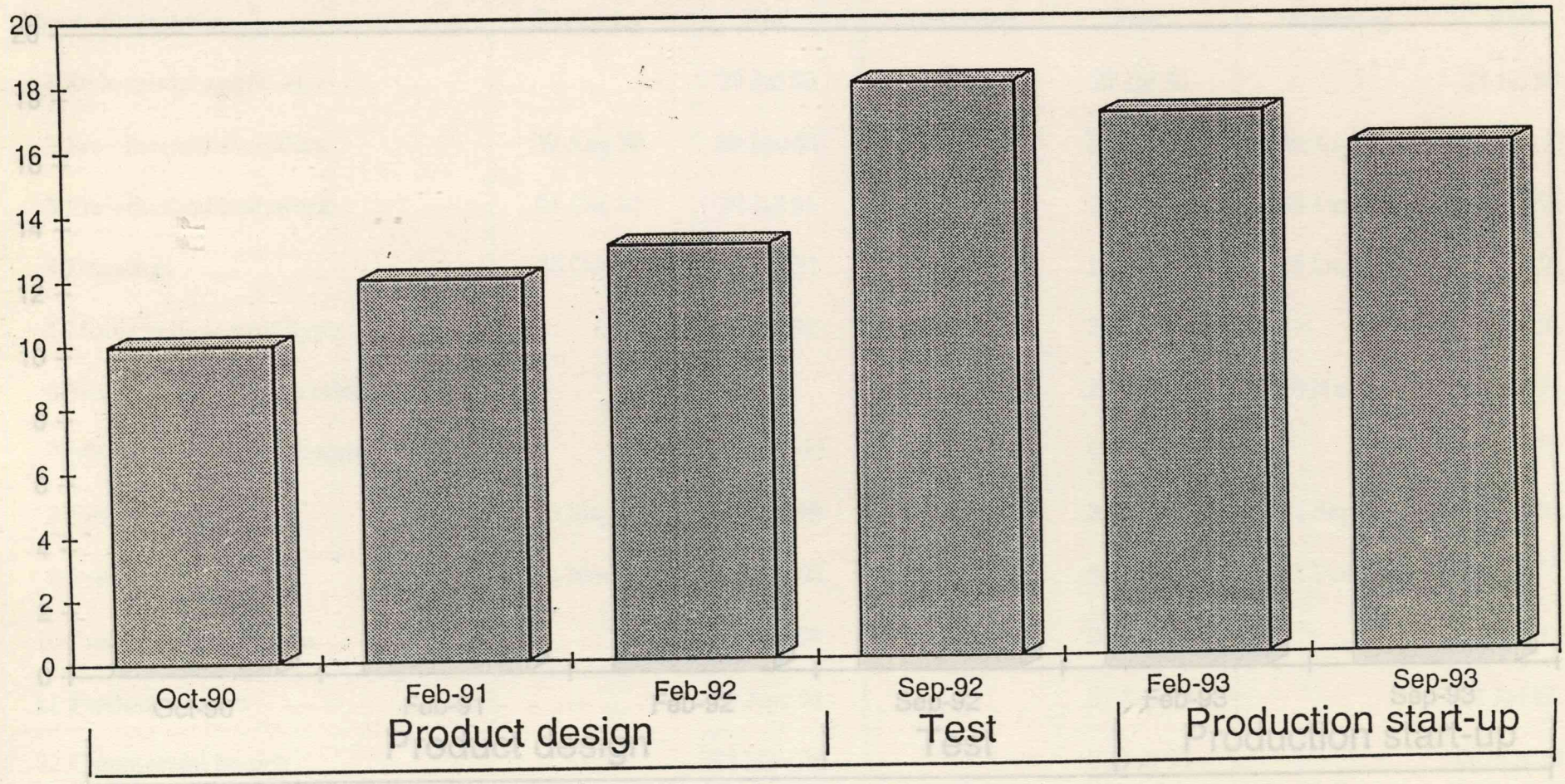


Figure 2: Research evidence presence in First Proto biomus

Figure 5: Resident engineers presence in Fiat Punto planning

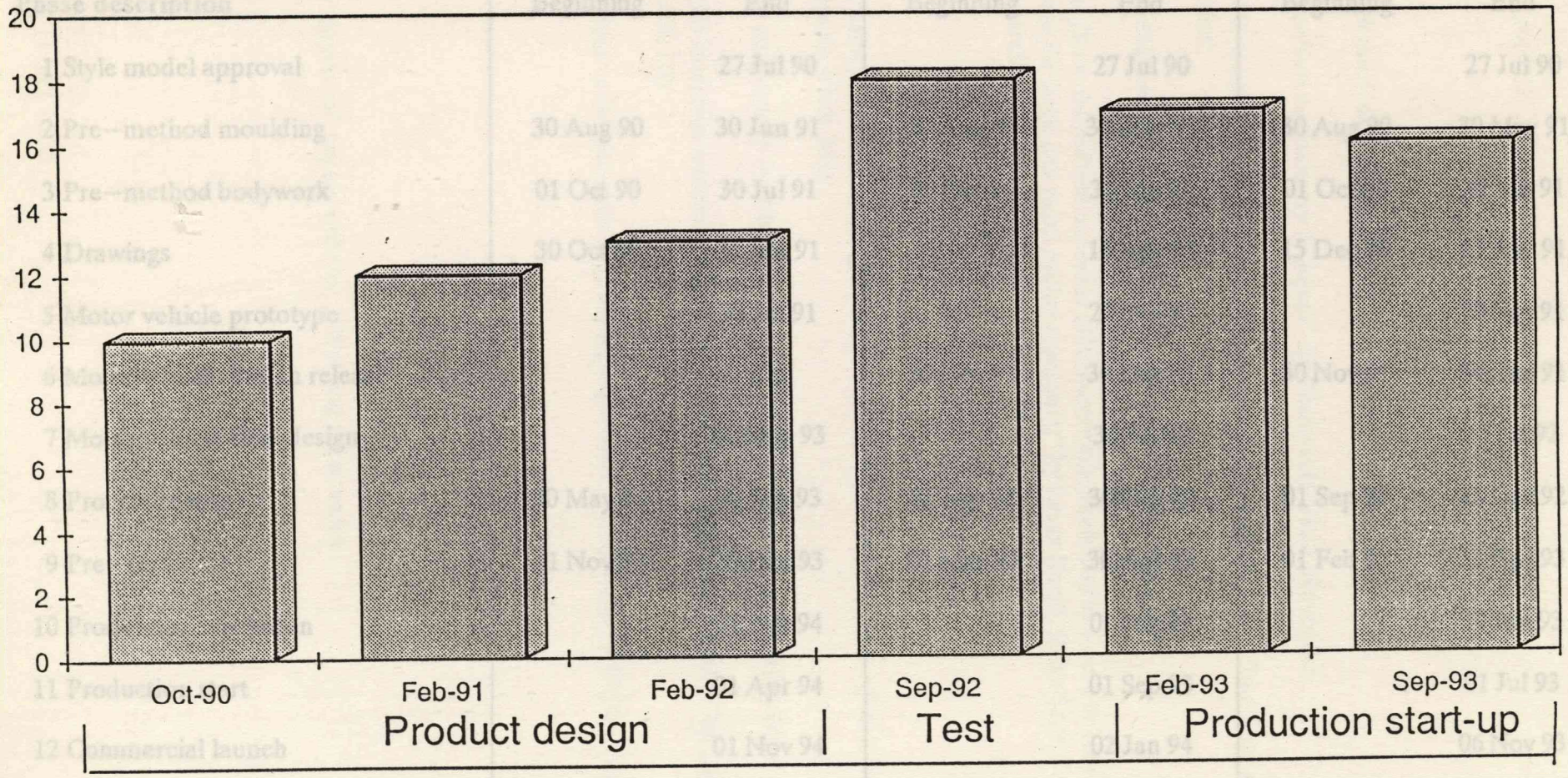


Figure 2: Realtent engineers prepare in Hat Bruno brainwind

Figure 6: T.T.M. Comparison

Phase description	Traditional method		Simultaneous engineering previously estimated		Simultaneous engineering final result	
	Beginning	End	Beginning	End	Beginning	End
1 Style model approval		27 Jul 90		27 Jul 90		27 Jul 90
2 Pre–method moulding	30 Aug 90	30 Jun 91	30 Aug 90	30 May 91	30 Aug 90	30 May 91
3 Pre–method bodywork	01 Oct 90	30 Jul 91	01 Oct 90	30 Jun 91	01 Oct 90	30 Jun 91
4 Drawings	30 Oct 90	31 Jan 91		15 Apr 91	15 Dec 90	15 Apr 91
5 Motor vehicle prototype		30 Jul 91		20 Sep 91		20 Sep 91
6 Motor vehicle design release		n.a.	30 Nov 91	30 Dec 91	30 Nov 91	30 Dec 91
7 Motor vehicle final design		01 May 93		30 Jul 92		30 Jul 92
8 Process checks	30 May 93	30 Sep 93	01 Sep 92	30 Oct 92	01 Sep 92	15 Dec 92
9 Pre–series lot	01 Nov 93	30 Dec 93	01 Mar 93	30 Apr 93	01 Feb 93	15 Apr 93
10 Production resolution		01 Feb 94		01 Jun 93		30 Jun 93
11 Production start		01 Apr 94		01 Sep 93		01 Jul 93
12 Commercial launch		01 Nov 94		02 Jan 94		06 Nov 93

Phase description	Traditional method		Simultaneous engineering previously estimated		Simultaneous engineering final result	
	Beginning	End	Beginning	End	Beginning	End
1 Style model approval		27 Jul 90		27 Jul 90		27 Jul 90
2 Pre-method moulding	30 Aug 90	30 Jun 91	30 Aug 90	30 May 91	30 Aug 90	30 May 91
3 Pre-method bodywork	01 Oct 90	30 Jul 91	01 Oct 90	30 Jun 91	01 Oct 90	30 Jun 91
4 Drawings	30 Oct 90	31 Jan 91		15 Apr 91	15 Dec 90	15 Apr 91
5 Motor vehicle prototype		30 Jul 91		20 Sep 91		20 Sep 91
6 Motor vehicle design release		n.a.	30 Nov 91	30 Dec 91	30 Nov 91	30 Dec 91
7 Motor vehicle final design		01 May 93		30 Jul 92		30 Jul 92
8 Process checks	30 May 93	30 Sep 93	01 Sep 92	30 Oct 92	01 Sep 92	15 Dec 92
9 Pre-series lot	01 Nov 93	30 Dec 93	01 Mar 93	30 Apr 93	01 Feb 93	15 Apr 93
10 Production resolution		01 Feb 94		01 Jun 93		30 Jun 93
11 Production start		01 Apr 94		01 Sep 93		01 Jul 93
12 Commercial launch		01 Nov 94		02 Jan 94		06 Nov 93

WORKING PAPER SERIES

1993

1 "*Spanish machine tool industry*" by Giuseppe Calabrese, November.

2 "*The machine tool industry in Japan*" by Giampaolo Vitali, November.

3 "*The UK machine tool industry*" by Alessandro Sembenelli and Paul Simpson, November.

4 "*The Italian machine tool industry*" by Secondo Rolfo, November.

5 "*Firms' financial and real responses to business cycle shocks and monetary tightening: evidence for large and small Italian companies*" by Laura Rondi, Brian Sack, Fabio Schiantarelli and Alessandro Sembenelli, December

1994

1 *"Una politica industriale per gli investimenti esteri in Italia: alcune riflessioni"* by Giampaolo Vitali, May

2 *"Scelte cooperative in attività di ricerca e sviluppo"* by Marco Orecchia, May

3 *"Perchè le matrici intersettoriali per misurare l'integrazione verticale?"* by Davide Vannoni, July

4 *"Fiat Auto: A simultaneous engineering experience"* by Giuseppe Calabrese, August

To request copies of papers write to: Working paper series

Ceris-CNR
Maria Zittino
via Avogadro, 8
10121 Torino, Italy

Tel. 39 11 5601.214
Telefax 39 11 562.60.58