FROM RESEARCH TO REALITY

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Summary

Research plays a major role in the development of a big services company like SNCF, particularly in the present context of Regional Public Transport, where:

- the opening of the markets and the competition between transport operators is intensifying,
- but where also the political will to obtain complementarity between carriers is increasingly being expressed in order to gain market share against the private motorcar.

Finding new customer services has become a major stake to SNCF's Passenger business in its drive to win over new customers, to win customer loyalty and to gain market share against the car. The car is indeed a very challenging competitor because of its simplicity of use and its high utility to users.

The SNCF Research Department has always been the source of important technical innovations for the company.

The smart card-based automatic fare collection (AFC) project is a new development derived from basic research carried out by SNCF and its partners. This paper analyses the process by which the project evolved from the state of research to an operational embodiment and to concrete deployments of the new technology in the field in recent years.

The concept of Knowledge Management takes on true meaning during the transition from a research project to one or more operational projects. It is a matter of maintaining the competencies inside the company and being able to use them and that requires taking into account the constraints attendant to the career development of the staff, to the company's ability to integrate in-house competencies that were hitherto brought in from out-of-house, to the company's ability to ensure a fair and even distribution of those competencies, to provide each staff member with at least equivalent responsibilities or perhaps superior ones and to maintain a simple and efficient overall decision-making chain.

The technical accomplishments in the context of a research project are subject to different constraints and objectives from those of a project to put the product of that research into widespread use. Once a project goes beyond the research phase, the company gives more consideration to the lastingness of its investment and the quality of the developments than previously. The result is that the developments made must often be re-designed and modified. The developments, furthermore, are compared with other company projects which may be ranked higher in priority. Lastly, industrial and/or intellectual property rights and their application in the context of financial contracts or patents must absolutely be investigated in order to protect the company from extra cost and possibly find possibilities for financial gain from previous investments.

A research project is focused on the technical aspects and is often granted dedicated funding and resources. The transition to the operational embodiment requires more than ever to organise the communication and circulation of information about within the company in a coherent way. The object being to spread the knowledge to the entities that will be asked to implement it. The need for continuity of communication also becomes more pronounced.

Closing out the research phase of a project is likewise not an obvious matter. Mastering the specification and design of new services is a tough challenge. The researcher is not necessarily always a good project manager for an operational project. What's more, electronic ticketing is not arising in a commercial and marketing desert. It must fit into a more comprehensive, already existing offering (distribution, pricing, loyalty building) and must be understood by the new decision-makers. Although it is more difficult to achieve this in the short term, it is necessary to integrate the research teams into the existing corporate divisions such as Marketing. This strategy helps to win in the medium-to-long-term by enabling the standing divisions of the company to acquire, to defend and later to promote the services invented by the research phase.

The impacts of electronic ticketing on the different trades and on the organisation itself are considerable. They should be investigated upstream, with the future users, so that the latter can express themselves about the new tasks and procedures, on the ergonomics of use of the new equipment. Since research concentrates mainly on chip card technology and its related technical tools, it is absolutely necessary to organise a rigorous management of job changes. After all, the new e-ticketing system must be accepted by the company's personnel if it is to be really successful with our customers.
In 1989, the national agency to generate revenue from research (ANVAR), a government organisation, examined the technical possibility of using the new technology embodied in the microprocessor card (smart card), a French invention, in the context of public transport.

At that time, the smart card had only a single communications interface, via contacts (pin-outs), which made it necessary to insert it into a reader when you wanted to use it. However, the ANVAR study clearly highlighted the security aspects of the smart card and the extensive data storage potential afforded by its memory chip.

SNCF decided then to assign to its Research Department to make a survey of the new smartcard based technology and to develop a card equipped in addition with a communications interface not requiring electrical contact and thereby allowing the card to communicate from a distance with stationary equipment on the ground. This new direction of research had become essential if the card was to be used by the customer easily on a daily basis, especially when stations were closed in the Paris context. The project team studied the different means of communication available at the time (infrared, longwave and UHF radio, etc….) and considered them from the standpoint of the railway environment and its special electromagnetic constraints. The advantages and drawbacks of each system were set out in a report on the comparative study along with the outlook for the different types of transmission technology.

In 1994, the conclusions of the study proposed using a new smart card technology based on a microprocessor and featuring two communications interfaces, one conventional, contact-based and the other contactless, remote-acting by radiofrequency transmission at 13.56 MHz.

The Paris Mass Transit Authority, RATP, meanwhile had itself driven some successful industrial developments. SNCF’s Ile-de-France Department, which is in charge of transport business operations in the Region of Paris, being interested in the proposal, decided to let a contract jointly with RATP to the manufacturer SGS Thomson and the design firm INNOVATRON (the latter founded by Roland Morenau, inventor of the smart card), to develop a Transport application on a contact and contactless smart card.

The detailed development of the solution (solder mask and component) required the fabrication of a new microprocessor integrating both communications interfaces from the start which, when achieved, was a world premier. It took two years – 1996 and 1997 – to design the chip.

It was in 1997 then, that the product named CD97 for "Carte Déplacement 97" (1997 Travel Card) came into being and was manufactured in quantity.

A trial of the card, called the "Francile" trial for the Ile-de-France region, was organised in the Paris Region. This ended in 1999 and the analysis of the customers' and railway staff's reactions confirmed the appropriateness of the company's forward-looking approach. It also confirmed the technical and commercial potential of the new product.

In 1998, SNCF's management in charge of its business activities in the region, Direction du Transport Public Régional et Local, also became interested in the potential of the new product. The DTPRL had already been involved as a partner for several years in various European projects, such as GAUDI and Stradivarius, aimed at defining new services based on smart card utilisation.

To ensure operational implementation, the company decided to transfer staff members from the Computerised Ticketing division of the Research Department to the Business departments, considering that it was no long dealing with a research project proper and that it was now up to those departments to lead future projects.

Electronic ticketing translates for the customer as the possibility of storing on his/her card the equivalent of fare vouchers and discount rights valid on SNCF and on the networks of other operations, both urban and intercity. The personalised card also allows customers to pay for purchases through automatic debits of their bank account and later will allow payment from an electronic purse stored on the same card. The electronic ticket smart card also accommodates the customer's frequent traveller points. The smart card can also host other applications such as access control.

At the time, we had a certain pride in asserting that electronic ticketing was the customer revolution equivalent to the design, development and implementation of the very-high-speed (TGV) train. It was henceforth a project to be managed by the company's Passenger Business people.
COMPETENCIES, MANAGEMENT AND HUMAN RESOURCES

The "Electronic Ticketing & Information Systems" division of the Research Department, in charge of electronic ticketing developments, consisted of a single team of men and women with the appropriate technical background, that is they were all either electronics or computer engineers. It worked with about 15 outsiders who were either SNCF staff from other departments, consulting and computer services contractors and engineers-in-training.

The team was multi-skilled and extremely competent in the technical aspects relating to computer hardware and software as well as in the technical aspects more directly related to the topic under research, namely microprocessor cards. The hierarchical line of the team was straightforward (only 1 level), so responsibilities were quite clear.

SNCF's decision to put electronic ticketing under the Business Departments provoked a major change. Each SNCF staffer in the team has to face the following questions:
- To which sales/business department should I move?
- What future career opportunities will I have there? What responsibilities?
- Do I feel like continuing in this speciality or is this a good opportunity to reorient myself?

Knowing that career development at SNCF grants a lot of importance to an employee's geographical and professional mobility, the pressures to change jobs could be strong.

For the outside consultants or computer services staff, the choice of options was narrower:
- The budgets allocated to the Research Department had been consumed and would not be renewed.
- The Business Departments might not be able to continue the same level of funding or to renew the more technical contracts.
- The new work locations were farther away, geographically, than those of the Research Department.

As a consequence, most of the service providers (70%) went on to new horizons. The remainder were finally directly recruited by the Railway, which allowed to keep some precious capabilities in-house.

The different occupational choices made by each and the distribution of the staff in the Business Departments had the inevitable consequence of diluting the competencies by spreading them thinly. Whereas the multi-disciplinary team within the Research Department was made up of experts that complemented one another, the break-up into several teams reduced that multidisciplinarity.

The transition was nevertheless rather smooth. Only two of SNCF’s staff quite the electronic payment field. The decision to recruit part of the outside contractors' staffs was certainly a good one because it allowed to continue the process on its own momentum. The Railway's overall capability in the field was basically maintained, even though the detailed capabilities of each new team were less.

The hierarchical line of the electronic payment division of the Research Department was simple. The whole team reported to a single manager. It was therefore easy to provide co-ordination of the different thought processes and investigations over a period of at least 5 years – 5 years during which each team member was able to find his/her place and appreciate his/her responsibilities.

Change inherently and involuntarily creates a feeling of fear in people organisational sociology tells us. Organisational change forces everyone to put themselves, and their ways of working, into question. Each team member also has to report to a new supervisor whom it is necessary to learn to work with all over again, something which is not always obvious.
Moreover, instead of the singleness of management at the Research Department, each new team found itself under the authority of a different strategic policy as determined by SNCF’s wide range of Passenger businesses and markets: a policy of mass transport and urban concentration in the Ile-de-France network in and around Paris, multiple partners in the other French regions, public service vs. profitability issues, etc. Good co-ordination is therefore more difficult to achieve, just when it is most vital to the company to ensure pooling of development costs for the new tools required for the deployment of the new electronic ticketing/fare collection systems. All in all, it is necessary to provide a strong supervisory structure to ensure implementation of the enterprise’s industrial strategy, its corporate communication and the other, cross-cutting subjects that a business department cannot handle all alone.

The change however required a great amount of adaptability on the part of the persons concerned, to integrate the new organisational setting and practices.

**TECHNOLOGY AND TECHNICAL ASPECTS**

The validity of the technical and commercial concepts that emerged from the joint thinking by the Research Department and SNCF’s Passenger business departments was tested in trials (the Francile trial in the Paris region and Rennes in Brittany for example). To implement the new services, several items of SNCF equipment were modified to be able to read and write to the transport smart cards. Other equipment (validators, information kiosks, portable readers) was purposely developed for the trials.

These developments were subject to tough financial pressure, to a tight timescale and to very limited deployment zones. The technologies were not yet entirely stabilised in terms of specifications. The development processes for those technical tools were therefore quite specific, calling in support from either outside contractors, from among the known toll specialists (ASCOM, DASSAULT, ERG, etc.), or from SNCF’s own Information Systems Management Department through which the Railway often develops its own computer software.

With all these constraints, the results obtained adequately fulfilled the undertakings of the trials.

However, it became much more difficult, once the project had gone out of the Research Department, to fulfil the target developments. On the one hand, about 50% of the developments made for the trials could not be re-used. On the other, the technical choices made were overturned a few months later. Actually, when a trial involves only a few score terminals and for only a short time at that, priority is placed on low costs and meeting deadlines, not on reusability.

When electronic ticketing left the Research Department, the new decision-makers were not happy to spend their money in non-reusable developments. Their prime concern was to be able to use the equipment for a long time. So the development aims were quite different: long-life of the investment, possibility of choosing among several suppliers (multi-sourcing), maintainability of the developed products, higher performance and integration into the company's customary processes.

Moreover, the electronic ticketing developments and related projects found themselves in competition with other corporate projects (that sometimes had a higher priority), in particular, in the last three years, the introduction of the Euro and the new electronic payment standards, CB5 and EMV. Because the development resources are tightly controlled, trade-offs occur more frequently between them. So, the electronic ticketing software took more time than expected, so that their quality and lastingly could be assured, and also due to a slower responsiveness on the part of SNCF which, remember, is one of the biggest French corporations, with a headcount of 180,000 and overall turnover of about 78 billion francs, and an annual budget of just under 1 billion francs (about 150 million euros) in computer system outlays for the Passenger branch alone. These new constraints sometimes destabilised the teams in charge of the operational projects, who had not foreseen these problems when they were planning their projects.

As concerns the smart card itself, the Railway ran into the fast-moving developments of that technology. Card manufacturers were producing one new card every year on the average, not counting the upgrades and intermediate versions! Therefore, the decision to invest in any given card was more difficult to take.

A last, but important point, is that of industrial and or intellectual property rights on the research done. These rights had been set out by contract during the research phase. But when prospects for moving to widespread application arise, and hence better outlooks for financial gain by each party involved, the financial and legal aspects raise their head with unsuspected vehemence, especially since the smart card
is covered by complex, mutually-related patents. The business negotiations about these issues must be
dealt with most seriously to assure that the company will get a fair remuneration for its investments or
at least that it will not have to pay to use the smart card technology.

These contractual issues were very important to SNCF because one of its objectives was to disseminate
its electronic ticketing card to other transport operators such as to ensure the best possible
interoperability. SNCF's strategy therefore required allowing the toll system manufacturers supplying
ticketing systems to the transport operators to gain access to the specifications and development tools
for the CD97 card, under licence. A trade-off became necessary between obtaining a fair return on the
investment expenditures devoted to developing the product, via a suitable licence, and the will to spread
the product across the largest possible market.

Industrial policy therefore quickly became the object of active involvement by the company. Being a
highly-specialised, cross-cutting subject, industrial strategy had to be taken over by an organisation
disconnected from the Passenger Business departments.

**INTERNAL COMMUNICATIONS**

The singleness of place and of management of the Research Department's team enabled rapid
development of the new technology. Communication among the different participants was virtually
instantaneous and natural. The communication between the research team and the commissioning
entity was good.

The transition to operational projects and the break-up of the initial team into several teams reporting to
different hierarchical commands had a substantial impact on the communication of information. Yet it
is vital to the company that information is accessible and can be easily shared and, possibly, kept
confidential for a certain amount of time.

How can such cohesion be maintained when the hierarchical lines are split and the functioning modes
differ from one entity to the other, when aims begin to diverge to follow different business strategies?

Institutional communication (from the company to the outside) can only be taken in hand by a cross-
cutting entity. The same entity must also be charged with circulating a minimum amount of information
to the other entities. It must also co-ordinate the exchanges and make a determination as to what may
be communicated and what must not.

Lastly, many entities and nodes of expertise had not been involved in defining/specifying the product
during the research phase. However, in the context of an operational implementation, those entities will
be impacted and will have to play a major role: some updating of all the entities is necessary to prepare
for their taking part.

**MARKETING AND SALES ASPECTS**

A research programme is often more focused on the technology and the technical aspects than on the
commercial potential for the departments who are its customers. Obviously, it is Research Department's
role to qualify the technical potential of its work and the Business Department's role to decide the
marketing features of the final product.

The end of a research programme should therefore translate into an assimilation of the technical
concepts and especially of their potential by the Business Departments, which must then concentrate on
the manufacturing of the final product that will be proposed to customers.

However, this last step is far from easy.

In the case of our electronic ticketing project, marked, you will remember, by a considerable technical
complexity relating to the smart card, the people from the Research Department found themselves sort
of pitchforked into jobs in the Business Departments. Yet they were researchers first of all. One
difficulty was therefore to halt the creative process or to confront it with the operational realities
(acceptance by the customer and the railway staff) and to set up a true operational project management.

As a first step, SNCF chose not to assign the teams in charge of electronic ticketing to the Marketing
manager of each Business Department, in order to ensure simpler functioning while maintaining a
working unit. Nevertheless, we soon realised that this stage could only be a temporary one, in the transition, as it did not truly allow to fully integrate the electronic ticketing concepts into an existing marketing operation and the ticketing could sometimes impact with a slightly different marketing strategy. Moreover, it was difficult for the marketing teams already in place to appropriate the new services. The later difficulty could create system dysfunctions in the internal decision-making process.

That is why, today, the electronic ticketing teams are under the responsibility of the marketing divisions of the Passenger Businesses (the Île-de-France passenger business, IDF, and the Regional and Local Public Transport Department, DTPrl). This organisation allows to fully integrate the offering of electronic ticketing services into the commercial development projects and to co-ordinate them with other projects, such as distribution and pricing. This also makes much easier the appropriation and dissemination of electronic ticketing knowledge.

Furthermore, the work aimed at precisely defining the electronic ticket commercial offering took longer than expected. Indeed, electronic ticketing/electronic payment, through its technical capacities can offer sundry service possibilities. The problem is to stay simple for the ultimate customer so the customer can readily take up the innovation. Reconciling functional richness with ease of use is a true challenge in the field of electronic ticketing/automatic fare collection. A researcher's dream can turn out to be a nightmare to the customer. Of course, the customer's dream can also be the engineer's nightmare.

**THE OPERATIONAL CONSTRAINTS**

The constraints on an operation project are much greater than those on a research programme.

In the context of electronic ticketing projects, far more people are involved than what is usual for a research programme: for each deployment project, at least 1 or 2 other transport operators, 2 to 3 Transport Organising Authorities (the General Council, the Regional Council and the urban transport authority, in France) together with their consultants and their respective approved manufacturers. This makes more complex the overall management of the joint project for new electronic ticketing. Decisions accordingly are more difficult and take longer.

In the research phase, the work concentrated on the front-office part of the electronic ticketing system (sale, information, validation, control) in order to research the staff-customer interfaces. The system back-office was highly simplified. But in the context of the operational project, the back-office part must be treated with the utmost care: the smart card, finally, is just one of the components of the whole system. However, electronic ticketing system back-offices cover some broad fields: accounts and financial management, security, customer relationship management, interface with the other operators' information systems, etc. It is highly complex.

Last of all, the electronic ticketing innovation does not arrive into an operating desert. A good many tasks have already been defined and specific departments are already in charge of them: booking/selling, after-sales service, information, etc. Electronic ticketing must fit into that which exists and not necessarily require new organisational structures for its exploitation in operation.

**THE SOCIAL ASPECTS OR SOCIAL RELATIONS**

Over and above their technical aspects, the innovations introduced by the electronic ticketing project will inevitably alter the tasks of the company's personnel, especially those who are in direct contact with customers.

The card is a medium which may be qualified as "opaque", that is that it does not provide direct, visual access to its content, in particular the characteristics of the fare voucher they represent. Also, the card comes with new rules for its utilisation that the customer must learn.

It is therefore necessary to equip the staff (reception, sales, ticket inspection) with new tools allowing to read and write data on the card, and then to train them to use those tools. This necessarily alters the procedures, the "trades" and the organisations within the operating department. It may also upset long-established equilibria between the trades.

In the research process, even though these aspects were taken into account as part of the trials whereby the electronic ticketing system was fine-tuned, they concerned only a small number of staff, and in
limited geographical areas at that. The long-term impacts on the trades could not, also, be researched. They were not among the main terms of reference of the research which was more oriented to studying the take-up by customers and electronic ticketing technology.

Once the project moves on to the more industrial and operational phase, the issue of managing change becomes much more important, in light, for example, of the number of staff affected (several tens of thousands). Besides that, every major project impacting the trades (job categories) must be submitted for scrutiny by Occupational Committees. The members of those committees include, among others, labour representatives. The questions raised in the committee meetings relate to modifications to the trades, work organisations and training needs.

Every major project likewise must go before an association of the Trade Union Organisations in order to identify possible hindrances and find ways to obviate them. This makes it necessary to devote resources to familiarise oneself with the project and for discussions with personnel representatives. As the subject itself cuts across the various projects to deploy the new electronic ticketing system, it may ideally be carried by an organisation going horizontally across the Business Departments.

Concerning the tools for electronic ticketing (sales terminals, card vending machines, control tools, card personalisation tool), the introduction of a new medium – the smart card – for fare vouchers and customer services deeply alters the ergonomics of their use. This makes it important to involve end users in their design, for example through a focus group. This approach helps to obtain fit-to-purpose tools that will be more easily taken up by the future users.

**CONCLUSION**

The end of a research programme is a stage that must be studied carefully and in detail, especially in the case of implementation new electronic ticketing systems. Such implementation is indeed very complex:

- from the technical standpoint, with the utilisation of a dual-mode (contact and contactless) card,
- from the trades standpoint, where new procedures and tasks are created and new ergonomics appear,
- from the management standpoint, where the expertise is rare and the number of partners involved is large (suppliers, transport operators, transport organising authorities)
- from the social relations standpoint, where the number of staff impacted by the project is great and where acceptance of the system by the staff is one of the conditions for success with the customers.

In the context of the research programme, these aspects, although they are sometimes taken into account, are not subjected to the same constraints as in an operational context.

There is a strong temptation, once the research proper is behind us, to expect quick operational implementation. However, an electronic ticketing system, as we have seen hereinabove, has important consequences for the customer relationship, the business offering, the trades of the personnel, etc. Each of these items needs to be studied carefully to prevent the problems that could arise in actual operation.
APPENDIX 1: ORGANISATION BEFORE – TRANSITION – TODAY

BEFORE

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<tr>
<th>Research Department</th>
<th>Ile-de-France Business Department</th>
<th>Regional Transport Business Department</th>
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<td>Information Systems Department</td>
<td>Manufacturers</td>
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TRANSITION PERIOD

- Special Officer in charge of project
- Ile-de-France Business Department
- Regional Transport Business Department
- Information Systems Department
- Manufacturers

E.T. Dept. | Marketing | Accounting

TODAY

- Deputy Directorship
- Ile-de-France Business Department
- Regional Transport Business Department
- Information Systems Department
- Manufacturers

- Deputy Director
  - Institutional Communication
  - Change control (trades)
  - Mgmt of cross-cutting tools
  - Smart Card and Security expertise
  - Standards and relations with industry

- Marketing
  - E.T. Tools
  - E.T. Projects