

March 2010

## **The Chronoprogramme – Capital budgeting and motorway construction**

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*Abstract*

This study analyses capital budgeting practices where ‘matters of concern’ condition capital budgeting decisions involving a particular category of investments, that of motorway building projects. Here, a central mediating instrument is the chronoprogramme which visualises the geography of ‘matters of concern’. These ‘matters of concern’ engage with the critical issues of the motorway construction and seek to develop, envision, and project its emerging possibilities. Through this lens capital budgeting investments are bundled of both economically complementary assets where one investment increases the value of another; and of compliments consisting of non-causal investments that are socio-economic investments that are loosely coupled to the investment object. The study thus shows that capital budgeting involves strategizing and organizing. In particular, capital budgeting for advanced construction technology which has a social relevance, such as the Italian Apennine motorway named “Variante di Valico”, is a matter of managing socio-material compromises and negotiations. The Chronoprogramme is analysed as a mediating mechanism enabling this accomplishment.

## **1. INTRODUCTION**

The Chronoprogramme is a mediating instrument mobilised to frame investment decisions with many interests and long time-space extension. It mediates capital investments by monitoring not only the progress of a complex capital investment project but also more importantly by monitoring relations between matters of concern, responsibilities and social groups. It is a central mediating instrument used by Autostrade in the construction of the “Variante di Valico.”

The role and format of this instrument adds generality to but also extends the roles of mediating instruments such as the technology road map well described and discussed by Miller and O’Leary (2005a, 2005b, 2007). It is not surprising any more that capital budgeting activity comprises more than the financial valuation of projects; there is also an emerging definition of the project. Capital budgeting is centrally involved in figuring out the project, managing it, and not least linking it with others such as subcontractors, users, public administrators, and local politicians. Capital budgeting has been described as appraisal via Discounted Cash Flow (DCF) techniques (Graham and Harvey, 2001). Such techniques express expectations and risks about the future via a single number. However, they pay only little attention to the problems facing managers when framing, developing and valuing capital budgeting projects (Chen, 2008, Jensen, 1993, Miller, 1991, Miller and O’Leary, 1997, 2005a, 2005b, 2007). They treat the project as a matter of fact whose properties can be evaluated financially. However, empirical research suggests that the capital budgeting process is more an emerging set of matters of concern and its design involves mediating possible futures still to be found out: complementary resources have to be found; sceptical audiences have to be persuaded; and numerous surprising facets and aspects each of which will involve an effort of varied parties have to be mastered. Part of the process is to learn about the relevance and realism of the project. The research

question is how a mediating instrument will be able to manoeuvre such heterogeneous concerns? How does the *chronoprogramme* mediate matters of concern?

Through these questions, it is possible to develop an account which adds empirical weight to Miller and O’Leary’s argument by describing processes involved not only in making decisions but also in developing decisions that have to be decided about. It adds new nuances, however, since the empirical situation is one that compared with Miller and O’Leary’s technology roadmap involved mobilisation of a more divergent set of actors since the motorway was an intersection between various private and public matters of concern.

The empirical domain of the paper is the development of an Italian piece of motorway (the “Variante di Valico”). It affirms that DCF calculations never stand alone but are combined with other calculative techniques (such as traffic and transport forecasts, technical calculations for the assessment of engineering structures); but it also shows concerns of a quite different order within a network of public and private actors who mobilise different matters of concern. The mediation between such matters of concern happened via an instrument for aggregating multiple claims and assigning purposes across a range of actors – this was the *chronoprogramme*. It is presented in section four where the empirical material concerning the construction of “Variante di Valico” is presented. The remainder of the paper is organized as follows: Section two outlines the method used in the analysis and its theoretical groundwork. Section three contains a discussion of relevant literature. Section five highlights the power of mediating instruments and the role of visualization in the process of designing and building a complex infrastructural asset. Section six outlines conclusions.

## **2. APPROACH**

The paper draws on data from a field study of Autostrade, a private company that under an Italian government licence managed and built the motorway network, and the many actors who intervened in shaping decision processes. The research site was the set of actions and actors constituted around the “Variante di Valico” motorway, one of the most important infrastructural works realised in Italy. According to Autostrade’s Managing Director:

“The ‘Variante di Valico’ is more than a great infrastructural work: it is a commitment that Autostrade has undertaken with millions of travellers who every day use our network and who want efficient roads to meet the needs of the growing traffic of people and things in our country. The ‘Autostrada del Sole’, the main motorway linking not only the North and South of Italy but also continental Europe with the Mediterranean basin, is in fact the backbone of the entire Italian road network system and the tract between Bologna and Florence has a strategic role. This is why the realisation of the “Variante di Valico” is one of the priorities of the modernisation and development program that we are currently actuating and which includes a considerable investment in terms of financial resources, men, technology and means. We have undertaken an analogous commitment with the

inhabitants of the areas affected by the works, with the institutions which represent them and with the economic entities that operate in those areas.”

“Variante di Valico” linked parts of Italy, and favoured connections between Italy and its neighbours but it was also a sacrifice during its construction. Speedy connectivity was the justification to local residents and users to accept the inconveniences and discomforts deriving from the works of “Variante di Valico”.

Investigating the development of the “Variante di Valico” drew on various sources of data including on-site interviews with senior managers, plant engineers, accounting and control system employees, representatives of local institutions and government ministries who participated in the so-called “conference of services” where collective decisions were taken. A total of sixty four in-depth, semi-structured and unstructured interviews, lasting from one and a half to four hours, were conducted. The interviews focused on how capital budgeting decisions regarding motorway building processes were taken, on the network of collaborative agreements covering the design and building of a new piece of motorway and on the actions of other actors who shaped the capital investment decisions.

It is possible, via these empirical materials, to develop an account of motorway construction understood as mediation of matters of concern (Latour, 2004a, 2004b, 2005). Latour contrasts matters of concern with matters of fact and suggests that when considering a situation as matter of fact we have closed it from its relations. It is possible to suggest that a DCF of so-and-so many Euros can be considered a matter of fact to the extent that the object under investigation is stable. Here, the project can be described finitely in its consequences and therefore it is a bounded object. This matter of fact is true in the sense that the calculation is true. Uncertainties pertaining to risk and cash-flows are there, but they are understood to be due to lack of precision in forecasting rather than lack of precision in the properties of the project being forecasted. When understood as matter of fact DCF substitutes the efforts of managing by a calculation which presents itself as a decision. This version of decision making, makes sense when forecast information is trustworthy (Dixit and Pindyck, 1994; Magni, 2008, Trigeorgis, 1993; Brennan and Schwartz, 1992) and known (Adler, 2006, Chen, 2008). This is where matters of fact can override matters of concern.

However, matters of fact rarely override matters of concern. In contrast, matters of fact often turn into matters of concern. Latour (2004a) provides many examples hereof. One example is the fact of the spacecraft Columbia which turned into a matter of concern when it tragically became burning debris. The solid object suddenly turned into a multiplicity of scientific, political, strategic, and economic concerns. Likewise, in a different area, Roberts and Jones (2009) show how the mathematics of finance was not seriously disturbed empirically and taken to be a fact before the financial crisis of 2008 but when it took off, it became clear that financial mathematics was not matter of fact. It became a matter of concern. A parallel in capital budgeting can be found when it turns out that forecasts are not factual presentations of the properties of the project because conditions are on the move (Adler, 2006, Chen, 2008) and courses of action can be represented only partly (Magni, 2008).

Matters of concern contrast with matters of fact since “while highly uncertain and loudly disputed, these real, objective, atypical and, above all, interesting agencies are taken not exactly as objects but rather as gatherings ... Matters of fact may remain silent ... but we are not going to run out of data about matters of concern as their traces can be found everywhere” (Latour 2005, pp. 114-115). Matters of fact may present themselves as objects that can be kicked about; matters of concern present themselves as gatherings of humans and non-humans – between people and technology – over controversies. The gathering – the parliament – is a place for dispute, a place for “making facts more visible, more risky, more costly, more debatable, more interesting and more publically relevant” (ibid., p. 115). Yet, the parliament is more than a mechanism for showing dissent; it is also a mechanism for developing the collective – the space where it is possible, at least for a while, to engage in unity or compromise from the controversies that the parliament requires in order to be one.

Matters of concern are a gathering and therefore they have uncertain boundaries. While the object of matters of fact may remain clearly articulated, the boundaries of matters of concern are unclear and have to be fabricated during the course of getting to agreement about the project under consideration. This lens requires the study to be concerned with the multiple propositions about the empirical project in question but always with a search for the mechanisms that at least for a while may bracket the barriers to its progress. Politics is part of this, but not only in the conventional sense of unbridgeable interest; politics is also about the construction of decision opportunities that can give roles to multiple parties.

Studying mediating instruments through the lens of matters of concern provides an opportunity to analyse how such instruments contribute to the development of the collective. It makes possible the search for mechanisms that relate actors and collective. In the case of motorway construction there are many diverse actors, as will be demonstrated below, and this will influence the operation of the mediating instrument. In Miller and O’Leary’s analysis of the roadmap, as a mediating instrument it is concerned with framing collective effects of individual investments and the coordination taking place is a work of motivating others to bring complementary investments in place. In the case of “Variante di Valico” to be accounted for below, the mediating instrument, the chronoprogramme, was a direct mapping of matters of concern by making visible the actors that were in need of coordination rather than the benefits as in the case of the roadmap.

### **3. CAPITAL BUDGETING AND COMPLEMENTARITY**

Capital budgeting has had considerable attention in the literature investigating the extent of use of methods and techniques in the assessment and selection of investment projects (Aggarwal, 1980; Segelod, 1998; Sangster, 1993; and Mukherjee and Henderson, 1987; Brounen et al., 2004; Hermes et al., 2007; Baldenius et al., 2007; Chen, 2008). Survey based research (Klammer et al., 1991; Kester et al., 1999; Lamminmaki et al., 1996; Pike, 1996; Trahan and Gitman, 1995; Graham and Harvey, 2001, 2002; Verbeeten, 2006; Truong et al., 2008; Chen, 2008) and qualitative research making use of field methods

(e.g., Carr and Tomkins, 1996 and 1998; Collier and Gregory, 1995; Harris, 1999; Van Cauwenbergh et al., 1996; Guilding, 2003) typically focus on the presence of techniques more than on the decision processes that arrive at a project. This research often pays only little attention to the complexity of capital budgeting practices that often recognise and account for flexibilities associated with the project (Stout et al., 2008, Verbeeten, 2006). Miller and O’Leary (2005b) point out the abundance of studies relating flexibility to corporate investment programs, but also the shortage of analysis of how such flexibility is managed. Such research focuses on capital budgeting decision making when DCF calculations are substituted by or combined with other calculative techniques and with concerns of a quite different order (Jensen, 1993; Miller and O’Leary, 1997, 2005a, 2005b, 2007).

Because of significant complementarities among the system of assets, DCF techniques meet obstacles. Miller and O’Leary (1997) describing capital budgeting practices at Caterpillar show complex relations between the firm’s transition to modern manufacturing and “sets of diverse but mutually reinforcing assets (‘investment bundles’).” Miller and O’Leary (2007) suggest a linkage formed by mediating instruments that relate the efforts of various parties. They show how a particular instrument, the road map, was able to guide the investments of different agencies in a field around the development and application of new computer technology. They see the technology roadmap as a formal coordination mechanism for complementary investments. The road map is a mediating instrument because it forms its own centre from which coordinating effects occur even if actions are devised and decided, in principle, by autonomous agents.

The research on “Variante di Valico” adds empirical evidence from a setting much different from the semi-conductor industry. Will complementarity be different in motorway construction? To Miller and O’Leary (2005 a; 2005 b; 2007) capital budgeting analysis refers to investment decisions in *a new computing technology* (the post-optical lithography). This semi-conductor device can be identified as a particular category that Henderson and Clark (1990) and Brusoni et al. (2001) call ‘multitechnology product’. That is an artefact “made up of components and embodies a number of technologies”. The different product components are physically and functionally distinct portions of the product and are linked to each other via a set of interfaces defined by the product architecture. Miller and O’Leary study a particular industry, that of microprocessors and related devices, which is characterised by large scale production. The end product is differentiated into many dimensions and is made up of a multitude of components which cannot all be produced by the same firm. Complementarities concern such interactions among components and mechanisms, and how these interdependencies align capital investments to potentially diverse organizational environments.<sup>1</sup>

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<sup>1</sup> Complementarity concerns “resource interdependencies” (Stieglitz and Heine; 2007), “task interdependency” (Simon, 1976), “knowledge that is both related and diverse” (Teece, 1986), and according to economic theory (Milgrom and Roberts, 1990) assets or activities are mutually complementary if an investment in one asset or activity increases the productivity of another asset or activity.

This kind of complementarity is organised by the product's modularity and by the subsequent integration among modules within a design-architecture. Miller and O'Leary (2005b) understand complementary assets as "integrated and mutually reinforcing systems of assets". Since the values of complementary assets are interdependent, they constitute 'investment bundles' (Miller and O'Leary, 1997) which require integrated capital budgeting decisions and strategies. None of the elements in the bundle would have autonomous use value outside the coordination that builds it.

Motorway constructions offer a different type of complements namely political and strategic complements. A motorway is a socio-material entanglement where complements exists when between two (or more) parts there is a mutual delegation to complete processes via activities undertaken by the other part or a direct delegation for the entire process. In the case of "Variante di Valico", actors had different institutional roles. Political consensus and social legitimation of actions were more important than technological optimum and financial efficiency. The problems facing a motorway operator may sometimes justify inferior technological and financial solutions dictated by politics or by socio-material constraints. Autostrade pursued a coordination strategy that aimed at aggregating consensus around a capital investment which had to be shared among a multiplicity of actors.

#### **4. "VARIANTE DI VALICO" AND THE CHRONOPROGRAMME: CAPITAL BUDGETING PRACTICES IN MOTORWAY BUILDING**

Planning and constructing "Variante di Valico" was a complex undertaking which required decades to be accomplished and in many of the tracts which constitute it, works still have to be finished. It involved several private and public actors, and it had to mind nature via an entanglement of bridges, tunnels, or viaducts. In this network of actors, there was not only reinforced concrete, asphalt and optical fibres but also compromises, consensus, contrasts, claims, dreams, hopes, menaces and conflicts. These were the human and non-human elements out of which the motorway was composed. This undertaking was important for the magnitude of expenditure, long-term costs and benefits, and for public service delivery and achievement of socio-economic objectives. So complex was the situation that one final calculation did not convince of the appropriate actions to pursue and there was a requirement of different technologies of managing. Specifically, a particular mediating instrument, the chronoprogramme, was used to manage the project' complexity and to address relations among activities suggested and carried out by a multiplicity of agencies.

This empirical section is organized in several subsections. First, the description of a meeting with people tasked to organise an assemblage is presented in order to see the chronoprogramme in use and the emergence of controversies that constitute the matters of concern. Then, the chronoprogramme is described and it is characterised as a visualisation. This is followed by a presentation of "Variante di Valico" which is understood to consist of a series of concerns including geology, economics and politics. This politics is then described around the so-called Conference of Services that arrives at collective decisions about the "Variante di Valico." . These elements form an empirical

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movement between the mediating instrument – the chronogramme – and the concern – the “Variante di Valico”.

#### *4.1. Mediating and organizing the mobile assemblage*

The conversation presented below offers an illustration of the purposes served by the chronogramme. It shows the CEO and the Work Division Manager attempting to imagine a capital budgeting strategy which had to be suggested to the meeting of the board of directors scheduled for the next day. In 2005, right in the middle of the “Variante di Valico” ‘s design and building stage the problems linked to the definition and advancement of this complex investment project questioned the progress of the motorway.

In a room on the silent and stern last floor of the glass building, in an afternoon of June in 2005, the silence was broken by the following dialogue:

“W. Why are our times changing?”

G.J. Many criticalities that lie in problems of sharing our works with the territory slow down the progress of our programmes and the times set during the planning stage are no longer appropriate...

W. Then, when is “Variante di Valico” expected to open?

G. J. You know that the activities where we dominate times are not independent but rather linked to other activities which must be completed before these activities.

W. We have to concentrate our efforts on these bounded and propaedeutic activities. We need to press forward with the works of “Variante di Valico”, and to know, with a reasonable level of certainty, when it will be possible to open this motorway tract to traffic.

G.J. Yes, but the ever more exorbitant requests from the territory, which often are not directly linked to the development of the motorway axis, risk paralysing our activities. We were not able to conclude the procedure of the Environmental Impact Evaluation at the Emilia Romagna Region, which was started last year, due to the requests put forward by some municipalities for additional works to be realised external to the motorway tract and not part of the Convention ...

W. We must keep a close eye on times, on costs but also we must try to preserve good relationships with the territory. We need to gain the consensus of dissenters and dampen down contrasts which could have much more serious political implications. We will look at the possibility of an alternative motorway tract which could be discussed with the Emilia

Romagna Region's Environmental Impact Evaluation Department and the local bodies during the Conference of Services ...

G.J. On the North Florence- South Florence tract (lots 4-8) we have criticalities linked to the hydraulic authorisation which do not permit a normal development of the works of lots 7 and 8 and the entrustment of works in tracts 4 -5 and 6, where the call for tenders is currently in progress. The Province of Florence and the Regional Office for Territorial Protection have issued the requested hydraulic authorisations, with the exception for the discharge of the platform waters and the road work site of lot 6. In this case, the attribution of competence between the two local actors is dubious.

W. We urge a clarification amongst these Bodies in order to find an agreement as to who has to do what. We have to mobilize all our resources and capabilities and obtain the necessary authorisations in the shortest possible time. We have to intervene on the purple and red areas and try to dominate time. »

How were problems suddenly purple and red? The complexities of the debate ended in a fairly simple conclusion – we have purple and red problems. This translation was derived from the chronoprogramme which literally coloured matters of concern (see Figure 1). The colours visualised concerns, awareness and perspectives. . The red and purple areas were populated by actors which, having a relevant power of veto, could block the advancement of the Variante di Valico' project. The differentiation between red and purple areas separated different actors who were related to different concerns. The purple areas represented a wider gathering compared with the red ones. They assembled the multiplicity of actors participating to the conference of services (Ministries, local bodies, Regions, municipalities, mountain communities and so on). The red areas represented activities which required the intervention and authorization of the final actor (ANAS- the National Authority for Roads). These areas constituted a problem because without the consensus of these actors the project would have been stopped.

Here, concerns about time domination, costs control and the possibility to reach agreements among a multiplicity of actors who produced different claims and concerns overlapped and followed one another in a complicated sequence. These concerns did not have fixed and definite boundaries. They were deeply entangled: more consensus could mean more time and more money at the outset but also less time and less money in the end of the process. The price of concerns could not be established a-priori. To reach an agreement among different actors required sacrifice of other matters which then raised other concerns. These were difficult to assess and define a-priori because the lack of consensus could imply even more time and money.

The concern to control time was not independent, but it was linked to requirement to establish good relations with the territory. Compromise had to be attained. When time changed by extending its effects and it postponed the opening to the traffic of the

“Variante di Valico”, it was never easy to define how much time was possible to sacrifice and how much money and time were worth spending in order to reach consensus.

“Variante di Valico” arose from such matters of concern and evolved through them. The chronogramme operated within these matters of concern and helped organise seemingly disparate components and activities. It extended “Variante di Valico” from a fixed object to a heterogeneous project whose boundaries were under construction. Through the chronogramme, “Variante di Valico” was engaged with a series of inherent contradictions and controversies and to detect how many participants were gathered in this socio-material entanglement. The chronogramme helped to visualised conditions, forces, and potentials. Contexts were multiple.

#### *4.2 The chronogramme: an instrument to visualise the motorway’s actors and investments*

The chronogramme was a technology of management traditionally used in the road yards of Autostrade to monitor and account for the time and cost of advancement of activities constituting the building process of a piece of motorway. In its classical and original configuration the chronogramme was a detailed and articulated accounting tool which compelled managers to do certain things in a certain sequence to perform tasks. It consisted of several pages composed into dossier. As an accounting technology endowed with tools and signs to make accountable people working in motorway yards, it closely integrated the time management process with the financial accounting data base in order to relate costing and timing. This data created time modules based on the sequence of activities. The system supported the application of numerous business rules associated with the details of the time data processing. Time articulation formed the specifications for the financial valuation of performed works. The results of each calculation were stored in clusters to allow reporting of each motorway sub-section. This storage scheme also allowed for automatic recalculation of data changes that impacted timing and costing.

A project manager of the New Works Division explained the use of the chronogramme on the road building sites as follows:

“The detailed chronogramme that we use on the road building sites helps us to understand sequences, interference between the diverse activities, which micro-activities can be carried out contemporarily and which are instead sequential. Understanding sequences helps not only Autostrade who having commissioned the works must control the conformity of the activities to the project and their advancement, but also aids the designer who develops the project of a motorway work. The planning phase, which is an activity of the chronogramme, influences the chronogramme itself because while the project is developed we know more and we are better able to formulate hypotheses on times and links. These detailed chronogrammes, articulated

in a multitude of micro activities, permit us first and foremost to understand how works have to be done”.

The chronogramme was part of the planning process but rather than stipulating only the end of the motorway object it also engaged the project by defining a procedure of interaction and decision making. A works manager added:

“The chronogrammes in the first phase are simply draft designs which subsequently evolve as knowledge is gained and gathers around the project. When the first chronogramme is developed we rely on experience due to the fact that estimating times is not simple for any of the macro phases – planning, entrustment of the works, work execution – with which the building of a motorway work is articulated. We design the preliminary project which is no more than a sketch and which must be approved by national authority for roads (ANAS). When the process – the so-called Conference of Services – comes to an end, contemplating the received inputs, we must develop the final project which includes the architecture of the work as agreed with the territorial authorities. Finally, we develop the executive project which also contains the calculations. Approval by ANAS must be gained at each stage of project advancement – preliminary, final, executive”.

Due to the importance of synchronisation of activities, the chronogramme was a main mediating instrument of the process of motorway building. Nevertheless, the modularity of this technology allowed for different forms of mediation. It had the mediating power to transform existing mediations and produce new forms of mediation intervening in future situations. This explains how the chronogramme was not only a means of accountability at the level of the operations, where it helped organise the road yard works. As an accounting tool, through a process of aggregation of elementary accounting data concerning the timing and cost of a multitude of yard activities, was moving from the management of the operations to strategy formulation. However, in a different capacity, it also worked as a mechanism to support strategy formulation. In this capacity the chronogramme had a configuration which is shown in Figure 1.

*[Insert Figure 1 about here]*

The chronogramme visualised the sequences of activities to put in place over time, and its colours designated relations between various parties and “Variante di Valico”. It is colourful and each colour represented (the power of) a social group. The chronogramme drew interests together while forming the motorway.

The first observation is that the chronogramme was a timetable which visualised the progress of the motorway summarising activities to be carried out. It singled out obstacles to the progress of the motorway by signs and symbols analogous to those that would be used on roads to signify road construction such as road signs, stop signs and semaphores signifying danger, slow speed and extra care because of impediments, obstacles and constraints.

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The second observation is that these activities were visualised in different colours; each colour was a relationship between different types of actors and expressed different possibilities and levels of time domination.

The green areas were executive activities (i.e. executive projects) under the control of Autostrade and whose duration was predominantly linked to the Autostrade's will. The purple activities required efforts from other institutional actors who participated in a Conference of Services, such as e.g. Municipalities, Authority for catchment basins, Ministry for Environment protection, etc. These were activities such as environmental impact assessment which institutional actors had to carry out so that a motorway project could be shared and integrated with the territory and the landscape. The red colour zones were phases in which the agreement of the national authority for roads (ANAS) had to be acquired. The yellow areas were subcontractors' work execution and implementation and which Autostrade supervised. Here the duration, even if it is not exclusively linked to actions undertaken by Autostrade, could be oriented and directed via programming and vigilance actions. The blue areas were procedures for the entrustment of works to subcontractors. These activities, which in previous versions of the chronoprogramme were green, were now blue because, as sustained by Autostrade's staff, "these are activities in which we do not dominate time". The duration of these activities depended to a great extent on ministerial committees which had to issue permissions and mandatory advices.

The system of colours was a statement on the status of relationships between actors. . The red and its shades denoted obstacles, impediments: in the semaphore convention people have to stop in front of the red signal. In this case, red suggests prudence and it invited people to reflect on. But red also is the colour of the passion and red and purple activities required more involvement of Autostrade in terms of capacity to seduce actors, to enrol them into the "Variante di Valico" and to apposition them in this big socio-material matter of concern.

Rather than presenting financial calculations such as DCF to make all activities commensurable, the chronoprogramme focused on uncertainties related to the conduct of social groups. The road signs, stop signs and semaphores visualized impediments, obstacles and constraints which were also briefly described in the chronoprogramme. There was a graduation of intensity among those signs which suggested different modes of intervention in order to remove impediments: the semaphore was indicative of a slackened situation but not so difficult to be resolved or which was being resolved; the danger triangle highlighted a highly risky impediment which required substantial resources ; two danger triangles represented even a more serious impediment arising from different actors; the stop sign symbolised stagnation and paralysis which required actors' substitution (such as in the case of sub-contractors which had to execute works) or a significant change in the project's design.

The third observation is that integrated in the visualisation there was also a meek KPI, namely the 'carried out %', an indicator of the progress of the works of the project. This quantitative indicator, occupying only a little space of the visualisation, was a tremendous

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amplification of the progress of the motorway as it produced a very limited but highly communicable version of performance.

The fourth observation is that within the chronogramme there was also accountability in the sense that explanations were articulated about the character of the barriers facing progress. All these explanations referred to permissions to be given by others. Barriers were not proposed about the difficulties of the works of the motorway but more about the permissions to be given to advance the motorway. These permissions explained barriers to progress by social conditions; people had to make up their minds about acceptable courses of action; they had to delegate permission to carry out the promises associated with the motorway.

For Autostrade, the chronogramme visualised the state of advancement of various investments. In one page commitments were aired, and it formed a discussion agenda within the Works Completion Committee, a subcommittee of the Board of Directors, which met on a monthly basis and which, in a detailed way, focused on investments. It was attended by the CEO, by other general managers and by some directors of the board. This was where future actions were discussed and where proposals to be presented at the Conference of Services were shaped, where many different concerns organised by the different colours were expressed. In an interview, a top manager explained the role of the chronogramme as follows:

“In the chronogramme we report the different activities necessary for the realisation of a motorway tract, the connections between the different activities and the time required for each of them. The hypotheses on the connections and on times are at the basis of the construction of the chronogramme. It is a way of representing and visualising connections, times and boundaries among activities which have a sequential nature. We indicate not only how much time was needed to do things, providing a picture of the history, but we also give an explanation of why times change. Behind these symbols there is the chronohistory of a problem and its evolution. The danger signs alert us. This history helps us to envisage future scenarios and to reflect on future actions to be undertaken.”

The visualisation was constructed against time, but it developed a narrative – a sequence not only of actions but also of actors – by introducing colour that explained roles taken by a multitude of parties to the construction.

In the capacity of framing the construction, the chronogramme moved and developed interests so that a proposal could be made collective and approved by many. Later, though, the chronogramme had yet a role namely of that of summarising the development of increasing detail and of addition of roles to be played in the construction:

“Once the planning stage has been finished, the call for tenders for the selection of executive subcontractors is opened. Even in this phase of entrustment of the works there are no certainties with regards to times. Timing largely depends on how many enterprises participate in the call for

tenders and how long the technical commission takes to evaluate whether the discounted cost indicated by the competing enterprises, in comparison to that cited in the call for tenders, is technically feasible. When the company which has won the tender opens its road yard, the Works Management Division has sixty days to develop the detailed chronoprogramme which includes all the micro activities. This thus becomes the tool used to follow and monitor the works. Here the objective of the chronoprogramme is to prevent delays and help the management of the operations. On the road yards we use the appropriate software for the construction of chronoprogrammes which reach high levels of detail. Here we have weekly meetings based on the chronoprogrammes. The chronoprogramme is the principal tool used by the Works Management Division, our technical body, in order to control the execution of the works realised by the subcontractors.”

The chronoprogramme was a visualisation functioning as a mediating instrument, a technology of managing, which developed times and spaces, a chronology of the motorway, a distribution of roles, and a framing of the concerns that the motorways was to make real. It was built to reflect concerns, resources and ambitions clearly beyond the focal firm – Autostrade – as it by colouring contemplated not only the projection of promises; it also developed promises and delegated permission to execute activities. It both promised and permitted and therefore it projected the motorway in time and space.

#### *4.3 “Variante di Valico”*

The “Variante di Valico” is an adjustment project of the Apennine motorway tract between Sasso Marconi and Barberino di Mugello. With a length of 58 km, the Variant crosses two regions (43 km in Emilia Romagna and 15 km in Tuscany), two provinces (Bologna and Florence) and eight municipalities: Sasso Marconi, Marzabotto, Monzuno, Grizzana, Castiglione dei Pepoli, S. Benedetto Val di Sambro in Emilia Romagna; Barberino di Mugello and Firenzuola in Tuscany). The route is composed of 45 principal works, 23 viaducts (totalling 10 km) and 22 tunnels and galleries (totalling 30 km) (see Figure 2).

*[Insert Figure 2 about here]*

The motorway tract had traffic peaks of 90,000 vehicles a day, triple the volume envisaged in the Sixties, the epoch of the construction of the so called “Autostrada del Sole” – Sun Motorway. The cruising speed expected at the time at 80 – 100 km per hour, had been reduced to 60 km per hour for light vehicles and 40 km for heavy vehicles thus increasing travel times substantially. The accident rate in this tract was 70% above national average and maintenance costs were treble that of the rest of the Italian motorway network. The existing tract, with 3-3,5 % slopes, 85 bridges and viaducts and 25 galleries, was deemed inadequate for the then current volume of traffic in addition to being a threat to safe, fluid and fast mobility.

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“Variante di Valico” included both improvement of the then existing tract as well as construction of a new tract of approximately 38 km, permitting a 40% reduction of the altimetrical drop in comparison to the then current route. In addition, the project envisaged the construction of new junctions and motorway tollgates. The “Variante di Valico” was a strategic infrastructure; it was expected to be completed by 2011, to employ over 5 thousand workers, to cost a notable 3.2 billion euro, and to have a high level of innovation adopted in the project choices and the construction techniques.

There were engineering uncertainties since “Variante di Valico” was located in one of the morphologically and geologically most complex areas of Europe and the related technical problems had delayed the completion of the work. The “Variante di Valico” investment choices were the result of a complex design and approbation procedure which began more than twenty years previously and which had had to take into account various socio-administrative problems which had involved a considerable stratification of decisions, displacements, departures from previous envisaged plans and adjustments.

The realisation of Autostrade’s investment plan required, under the then present legislation, a complex and long, environmental and urban authorisation phase involving Ministries, Regional, Provincial and local governments, Communities. This accounted for delays and subsequent increase in cost. Unexpected technical and geological problems, possible financial difficulties facing executing companies and the continual updating of regulation could lead to further delays. However their impact was considerably inferior to that determined by authorisation delays that could last for many years – e.g. over 8 years for the “Variante di Valico.” A manager of the technical services told:

“In the advancement of new works the most difficult thing is finding agreement and reaching a solution in accordance with the needs of the territorial communities. Even if it may seem to be a paradox, it is actually easier to mediate with the living than with the dead. We have had to notice that it is more difficult to move the dead than the living. This we have managed to do, we may have wanted to demolished and rebuild housing, but when along the planned route, we have come across a cemetery or an archaeological site we have been forced to stop and to deviate from the optimal route of the motorway”.

No technical calculation or study for optimising the trajectory of a stretch of motorway would hold up in front of the symbols of a collective memory. The engineering calculation supported by the financial numbers offered an optimal route but it could not stand up to the strength of myths and symbols or to politics. Therefore, calculations rarely provided a solution to issues but suggested a perspective from which contemplation and problematisation would happen:

“Sometimes technical calculations help us to gather together consensus. With regards to the realisation of lot n. 8 of the “Variante di Valico”, when the local communities asked us to move the hairpin bend of the link road which should have connected the old motorway to the new motorway, we were able to document with our experts, following technical calculations and geological verifications, that

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such a change would have involved excavations which were so deep that they would have put at risk the stability of the slopes” (an Autostrade’s project manager).

Calculations helped to engage social and political groups and sometimes influenced actors’ goal setting. In construction processes, many mediating instrument shaped relationships (financial calculations for cost estimation, investment budgets, traffic and transport studies, engineering calculations and building parameters and standards, consensus platforms, chronoprogrammes). However, they were rarely end-states of an analysis and more understood as developing context. A manager from the new works division explained why cost analysis here was not a solution but a parameter among many other parameters:

“An analysis of costs generally neglects other factors which often constitute the real critical element in the management of these projects. I am referring to the costs of the management criticalities of the project which during the realisation phase produce a series of inconveniences and burdens on the lives of the population affected by the works, near but also afar, which nevertheless are transformed and translated into costs of the collectivity as a whole: time, petrol, delays, chaos, tension and so on”

And again:

“The cost-benefit analysis is used as an instrument of debate, more than that of decision making. Someone undertakes a study, introduces the hypotheses and uses parameters which he considers to be correct. Finally, on this basis, he offers his own assessment with regards to the feasibility or not of the considered alternatives”.

Financial calculation was part of dialogue but could not determine it as an informant from the New Works Division explained:

“A small piece of motorway has to interface with Town Councils, Provinces, Regions, State property office, environmental associations, and agencies for the protection of water. It is never easy to reach a solution which all these actors can agree upon. Often we organize tables of arrangements with the participation of experts and technicians together with political representatives of the various institutions. These meetings, organized with the aim of favouring a dialogue between the interested parties and reaching an agreement more quickly, do not always lead to the desired results because a council or a mayor only has to change to put the whole project into question”.

From 1985 to 2001 “Variante di Valico” had undergone over twenty modifications and calculations helped outlining the object of decision making temporally and spatially. They contributed to defining the objects of a public debate and the time horizon of the decision making, but they did not end dialogues. An operation manager said:

“The argument “it costs too much” normally is not used by us as a means for reaching an agreement because it is not very convincing. “It costs too much” also implies the definition of “with regards to what?” and “for whom?” For whom does it cost too much? For the collectivity or for a private investor? The subject who here faces the burden of the cost is a private company which has been given a task by the State to realise a public work. The private company gains private benefits from the realisation of a work of public utility”.

Calculations became meek objects of problematisation. The construction of a new piece of motorway unfolded in a very long span of time – sometimes tens of years. These activities would require taking on risks time of realisation and costs associated with the extension of the time period as time was involved in determining the production cost. From the preliminary project to the final one and to the feasible one there was an increase in costs. However, costs and the uncertainties of calculations did not seem to be the main concern here:

“The overrunning of the cost of an infrastructural work is not one of our principal worries. What interests us most is time. It is true that with regards to time, money also comes into question; however the financial loss is watered down and rendered more tolerable by time. What I want to say is that the fact that money is spent later in time includes in itself the financial benefit of the delay in payments. In addition the exceeding of the cost is diluted over such a long temporal horizon for investment works that it does not scare us. The dynamics of the costs is not so impacting over longer periods of time because interests, projects and people change too. But the damage in terms of image and reputation resulting from a two year delay in the opening of a tract of motorway, even if not quantifiable in economic terms, is extremely high.“ (A manager of the New Work Division)

The main concern here was time but time was not money – it was something else. Time went towards gaining social legitimacy. Time allowed more interaction between actors and reinforced relations, and these would paradoxically make it possible to end the dialogue with something that has at least some degree of consensus. On this an informant from the administrative division commented as follows:

“Investment decisions are sometime taken based on agreements between us and different administrations without the support of an economic assessment. On a whole, a process logic based on a consensus platform prevails rather than that of the result such as the realisation of a work determined by costs. The indications stemming from accounting rules at times create sometime “perverse” effects on the decision process, pushing towards an acceleration of the decision for financing, even when the content of the decision in itself does not present the adequate project requirements necessary to ensure the subsequent realisation in the times and with the costs envisaged”.

In these cases, financial calculations were inputs to debate but did not privilege financial results per se. They were considered one element in the gathering which produced the

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building project. Other elements participated in developing the matters of concern that envisaged the motorway.

#### *4.4 The conference of services*

The conference of services was a meeting-place where alternative choices were articulated and evaluated:

“Fundamental to the success of the conference of services is the involvement in the planning phase of the entire territory with regards to determining infrastructural choices. Otherwise all the requests, needs and objections which are not clarified result in the interruption of the conference of services which then becomes the only occasion of confrontation between the various interested parties. It is therefore appropriate that the political composition of the various parties involved takes outside of the conference. Therefore the planning and project phases need to be opportunely disciplined to avoid the definitive project of a public work which can lead to the blocking of the implementation procedure.”  
(Managing Director for Territorial Development Policies – Ministry for Infrastructures and Transports)

The capital budgeting decision process unfolded throughout the entire duration of the project, from its conception via preliminary design through to the definitive design and implementation.

The conference of services gathered and synthesised propositions about the motorway articulated by prospective users, mayors, resident populations, local administrators, central regulators, companies involved in the design, building and management of the motorway some of which mobilised interests of lands, mountains, and rivers. The norm was that the conference could only close proceedings when unanimity among actors prevailed. The logic was that an infrastructural work such as that of a motorway required sharing of territory. While single citizens were weak as they could undergo expropriation of their property for reasons of public interest, the municipalities and all the communities which had a legal statute such as mountain communities, water catchment basins, provinces and regions had the blocking power of veto. With the absence of veto the General Management for Territorial development of the Ministry of Infrastructure and Transport would emit the so-called “final measure” substituting all previous authorisations, concessions, or agreement acts of the participating administrations or of those invited to participate. Each modification of the project after the closure of the conference would require the opening of another new conference and the whole process would begin again. This procedure conditioned the development of “Variante di Valico”.

The chronoprogramme helped the conference of services to arrive at conclusions by summarising multiple information signals, claims and ambitions from different actors. “Variante di Valico” required support and commitment from a multiplicity of actors each of whom would approach the task differently and whom had to be persuaded to perform its role. There were several significant political actors.

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*Ministries* regulated the tenders for adjudicating works to subcontractors and they supervised the project. The *Ministry for infrastructures and transports* promoted motorway building for economic growth and development. The *Ministry for environment* assessed the project in terms of the digging materials produced, pollution, noise, water-bearing strata, landscape etc. The task of the *Ministry for cultural heritage* was to ensure that the project would not conflict with pre-existing works of cultural interest. The *Defence Ministry* ensured that the motorway tract would not interfere with military installations.

*ANAS (the National Authority for Roads)*, managing the public Italian road and motorway network on behalf of the Ministry for Infrastructures and Transports, supervised the execution of licensed building works and the management of the motorways. It developed laws and norms safeguarding roads and motorways, traffic and road signs.

*Autostrade*, the private concessionary building and managing the toll motorways, operated a 3400 km network of motorways in Europe. It was the largest private investor in infrastructures in Italy.

*Municipalities* were local bodies primarily concerned with safeguarding their territories and their citizens. In addition to their right of veto in the conference of services, their role in road-building was mediated also by the more frequent so-called “operative roundtables” between them, Autostrade, and the companies undertaking the works, where compromises were made and consensus and commitment were built. For the most part, consensus building was undertaken prior to the conference of services which thus became primarily a moment of synthesis, of coming together, of orchestration and formalisation of various propositions. A series of agreements between Autostrade and the various actors were often produced prior to the conferences of services.

This is what the Mayor of Barberino di Mugello, the municipality which was heavily affected by the works of the “Variante di Valico” in the Tuscany tract, had to say:

“At the beginning of 2008 we underwrote with Autostrade an agreement which included verification on the progress of the works of the “Variante di Valico” and which analysed the current situation, declaring our respective duties in order to speed up the works respecting the safeguarding of territories and local populations”.

The Mayor further added:

“The face to face meeting between the municipality and Autostrade confirmed the importance of supplying clear, continual and specific information to the community affected by the works in order to ensure the safety of those who are for years forced to cohabit with the inconveniences resulting from such large infrastructure works. Clear and correct information is important to create participation. It is not possible to build the “Variante di Valico” if public opinion does not perceive the importance of its realisation. The

sacrifice of the territories affected by the passage of this viability of a national character has also to be valorised. We have reached with Autostrade an agreement for the realisation of a packet of initiatives in this sense”.

The “Variante di Valico” envisaged numerous interventions in favour of local bodies whose territories were directly affected by the road yards of the works. These works were outside the motorway axis and were requested to mitigate the eventual possible inconveniences caused by the works. They were works of environmental rebalancing and socio-economic recovery. Sometimes such works would improve integration between the motorway, territory and other transport modalities. A manager from the Work Division commented this issue as follows:

“We call as ‘non-cause effect’ interventions all those investments which are not directly linked by a causal nexus to motorway’ project, but which are necessary in order to permit and facilitate its existence”.

Among the works undertaken by Autostrade in favour of the territories affected by the construction, these “non-cause effect” interventions were distinguishable from so-called “cause-effect interventions”. The latter works included the environmental protection motorway such as anti-noise barriers, green areas, cleaning up of structures and worksites no longer in use and they were all conditioned by the motorway. The “non-cause effect” interventions were, in contrast, aimed at the development and promotion of the territory such as optimization of the waterways, recuperation of historical-cultural assets, park interventions, environmental and landscape upgrading, slope stabilisation, technological network completion, requalification of viability and urban centre structures within the various communal territories. Rebuilding communal roads, realising fluvial parks and building new social services compensated Municipalities for the impact of the works on the surrounding territories. The non cause-effect interventions were added even if they had only limited direct relation to the motorway; they showed deference to local communities. Civil works requested by the local authorities increased the sum originally set out in the financial plans. The complexity of the “Variante di Valico” was such that the environmental protection interventions envisaged along the tract and on the territory were estimated at approximately 30% of the total cost of the work.

*Authority for catchment basins* were public law bodies transversal to communal, provincial and sometimes regional territories responsible for the defence, safeguarding, requalification and government of land and water resources and related environmental systems. They were to mitigate against hydro-geological risk (landslides and floods), to develop hydraulic and hydro-geological balance, to monitor, use and government of water resources, to limit soil pollution, to prevent territorial instability related to mining activities, to defend and safeguard the agro-forestry patrimony, and to evaluate environmental impact and the costs-benefits the envisaged interventions.

*Mountain Communities* had statutory autonomy and were responsible for the promotion and development of the territories which fell under their jurisdiction as well as monitoring the socio-economic development of the life conditions of the mountain populations via

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both the execution of their own direct functions and those associated with communal functions. "Variante di Valico" cut across an important mountain community, that of the Mugello, made up of the municipalities of Barberino di Mugello, Borgo San Lorenzo, Firenzuola, Marradi, Palazzuolo sul Senio, San Piero a Sieve, Scarperia, Vaglia and Vicchio. The definitive project of the tract number 14 of the "Variante di Valico" which, from the bridge on the Santerno (at Castro San Martino) and crossing underground the Futa's pass, would join up with the new A1 at the new turn off at Poggiolino required huge geological and hydro-geological studies in order to demonstrate the compatibility of the works with regards to the safeguarding of waterways.

After various preliminary projects, the joint solution elaborated with the municipalities, envisaged, in contrast to the previous solutions, a highly winding tract at a higher altitude, always 500 metres above sea level, such that it assumed the characteristics of a mountainous road. This solution did not interfere with the environmental and natural resources of the territory. The presence of the mountain community added attention to environmental effects. The manager of the New Works of Autostrade:

"In order to satisfy the needs of the populations of this territory it has taken 15 years of studies and at least six elaborated project hypotheses before reaching a definitive project. There were undoubtedly more requests, but any other solution – even a more suggestive one – would have been dangerous for the delicate environmental balance and in particular with regards to hydric resources. The current project is the best possible compromise and we are satisfied with the work undertaken".

A mayor of one of the municipalities underlined:

"This tract of the road is the realisation of a dream which enables the various communities to come out of their isolation in order to improve the development conditions of the territory. This is the only possible path to permit our territory to be "put into the network" of large viability in addition to averting the risks of possible damage to our waterways."

*Regions* encompassed the territories of many municipalities and provinces and synthesised local concerns. In contrast to other local actors, which had the right of veto, regions also controlled the regulatory power over the regional territory. In the case of "Variante di Valico's" two Regions involved (Tuscany and Emilia Romagna) have different norms for urban spaces. As stated by the Councillor responsible for mobility and transport for the Emilia Romagna Region:

"During the long procedure which led first to the decision to realise the entire Variante, then to the authorising phase and currently to that of the realisation, the Emilia-Romagna Region has worked intensely in order to reconcile the often contrasting needs of Autostrade, the enterprises and the Municipalities. If on the one hand, in fact, it was necessary to insure the efficiency of the road building sites and the works, on the other hand it was equally important to minimise the

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inconveniences and the environmental and territorial repercussions. With this objective in mind, problems related to the disposal and storage of digging materials, the individualisation of service viabilities and the mitigation of dust, vibration and noise impact were dealt with.”

He continued:

“In addition, the Region, together with the Province of Bologna, has played the role of mediator, by co-ordinating and giving support to the various municipalities and helped them in dealing with the consequences stemming from the suspension of the works by sub-contractors and their recession from tender contracts. When the enterprises which had been adjudicated the works suspended them, the Region committed itself to creating the conditions for a rapid systemisation of the safety of the abandoned road building yards and exercised pressure on the competent authorities to ensure that the repercussions on the local economy and inconveniences felt by the local municipalities affected were dealt with and resolved in a short space of time.”

The regions were directly involved in the promotion of the socio-economic development of the geographic areas which fell under their jurisdiction and this was favoured by interconnectivity with other territories. This was proposed by the Councillor for Infrastructures of the Tuscany region:

“The realisation of the “Variante di Valico”, a central node of the enhancing of the so-called Apennine corridor, is one of the priority interventions in the framework of a national and European infrastructure programme. Among the specific regional objectives, there is on the one hand the completion of the High velocity/ High capacity system and on the other hand the enhancing of the motorway corridor which includes the completion of the “Variante di Valico”, the realisation of a third motorway lane from Barberino di Mugello to Incisa, and the completion of the Tyrrhenian motorway and the links with the ports of Livorno and Piombino. The help of a logistical regional system would give Tuscany a privileged role in the commercial platform of exchanges between the west and east. The Tuscan cities (primarily Florence) would return as a centre as it would be integrated into European infrastructural corridors with the North-South Corridor 1, and the Lisbon – Kiev Corridor 5 as well as via their ports and sea routes”.

Among the priority objectives of the territorial Plan approved by the Tuscany region there was precisely the link between the Tuscan city and the infrastructure networks. Hence the completion of the “Variante di Valico” would eliminate then current criticalities of the existing tract, which was too small to meet the requirements of the levels of traffic of this road artery in addition to enhancing the principal North-South link axis of the nation.

As the construction works of such an important route which spread over numerous territories impacted on the environment, on the socio-economy and also created disturbances to the local inhabitants, the two involved Regions asked the Italian

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Government to set up two separate Environmental and Socio-Economic Observatories of the “Variante di Valico”, one for Emilia-Romagna and one for Tuscany, to monitor the impact problems resulting from the realisation of the work and to resolve criticalities during its construction.

*Provinces* encompassed the territories of many municipalities and constitute a share of the territory of a Region. They promoted and coordinated the local communities they represented.

*Service companies* supplied services such as electricity, water, gas, railway transport, and telephone communications and so on and participated in the conference of services. They had no power of veto but they influenced the process since such installations could interfere with the works. Their cooperation was important.

In all, “Variante di Valico” illustrated how such a decision process required the cooperation of many actors with functions and roles that often overlapped. The approbative procedure of the “Variante di Valico” had a turbulent history which only came to an end in September 2001 with a Services Conference held at the Ministry of Transport and Infrastructure. Physical construction followed with its own problems and traps; this slowed the project’s completion down. In fact the first road yards were only opened in 2004 because of elements such as changes in provisions and norms, selection and monitoring of contractors for the works, requests put forward by the territories crossed by the motorway, and the lack of availability of quarries and dumps. This also included new regulation as explained by Autostrade’s Operations Manager for the development of the Italian motorway network:

“Modifications to regulations are frequent in various matters which affect the realisation of infrastructures and which bring about situations of uncertainty which, in some cases, can cause the slowing down or the suspension of works. Very often works are not seen as a public asset but rather as a problem and an environmental hazard. Regulations which continually change often halt the work of road yards.”

The modification required by regulation involved critical re-examination and forced further technical and economic commitments for the realised solutions. For example, recent provisions regarding the depositing of diggings included verifying the possibility of reutilising digging material for the works themselves or other uses, which were defined via the project forecasts agreed between the different actors. The eventual disposal of the digging material could only take place once the impossibility to recuperate and reutilise it had been demonstrated. Hence the problem of finding a collocation to this form of materiality hindered the progression of the building projects.

4.5 Non-causal investments and the formation of “Variante di Valico” as a socio-political accomplishment.

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It is easy to understand that anti-noise barriers, technological networks, and works for the motorway' environment compatibility can be connected to "Variante di Valico." It is less obvious that so-called non-causal investments in a school, a kind garden, a technological incubator for new start up, an ethnographic museum, a library, an heliport, a cycle track, a horse track, a church of XV century, an aqueduct or some sculptures placed on the square in a village would be relevant investments for Autostrade. Never-the-less. Such investments were common. For example, the amount of financial resources came to 14,5 million € only for the municipality of Sasso Marconi and to 43 million € for the Mugello mountain community and the municipalities of Barberino and Firenzuola.

"Non cause-effect" investments or "compensatory work" could seem unorthodox from afar but they could be justified. The he major of a municipality explained:

"It is undeniable that the "Variante di Valico" considerably has affected the daily life of our people by giving them discomforts and troubles. It is as much true that the compensatory works repaid, almost partially, the sacrifices of towns. The case of Sasso Marconishows that big works such as "Variante di Valico" are possible to realise as long as one comes to single out and understand the needs and requirements of interested peoples...It is important that the project's course is shared with local authorities, municipalities and with people that for a long time have daily to come to terms with the presence of motorway yards and with the related problems of traffic, noises and environmental pollution."

In line with this idea, a district councillor said:

"What is of fundamental importance for "Variante di Valico" is a shared strategy which aims at reinforcing the relationship between motorway and territory and appreciating the sacrifice of the communities directly involved with the way of this national road network. People can accept to live together with the discomforts caused by "Variante di Valico" works but have to perceive the advantages linked to its realization."

"Variante di Valico" produced discomforts. Non-causal investments could alleviate these; they were not functionally and technically related to the motorway object. Yet they illustrate how the motorway was more than an object; it was a socio-material gathering which required collaboration from local communities and national authorities.

Some of these non-causal investments included helipads for helicopter rescue in the Mugello region, which were equipped with devices allowing the helicopters' night flight; they added health emergency and civil defence interventions. Yet, the heliport was not only for the protection of people and territories surrounding the motorway, it was also useful for motorway users who travelled through this geographic area because high seismic risk increased the probabilities of calamities, and heavy snowfalls could bar traffic flows.

Other non-causal investment involved a technological incubator in the Mugello mountain community, which could support economic development of this area. They involved preservation of traditions, habits and history via investments in Bruscoli's historical and ethnographic museum. And investments in sculptural collection placed at the entry of Barberino di Mugello aimed at representing "a place of encounters" among different peoples. Such examples illustrate that the motorway could be integrated with the development of local communities even if primarily it was developed to make traffic pass rather than engage with them.

## **5. THE POWER OF MEDIATING INSTRUMENTS AND VISUALISATION**

The chronogramme visualised and organised matters of concern which were linked with the accomplishment of "Variante di Valico". It defined time as a medium of problematisation, but time did not control the content of this problematisation. It tried to envisage costs, but costs were not independent from the timing of activities and, both time and cost, depended on the gathering of consensus around the Variante di Valico' accomplishment and so on the possibility to establish relations with the territory .

It was impossible a-priori to calculate the price of these concerns. "Variante di Valico" illustrates the concern to preserve 'good relationships with the territory' in spite of 'more exorbitant requests which are often not directly linked to the development of the motorway'. These non-causal investments needed to enrol territories but strictly only loosely coupled to the motorway. The range of matters of concern were not settled once and for all but kept developing. Additional works requested by the municipalities could push to concerns about time and influenced the construction even if they were, in principle, unrelated to the technology of the motorway. As object, the motorway comprised certain entities, while as project, the motorway would comprise even more entities. The empirical materials show how concerns developed around the schedule and the budget could be realised by added investments in relations that had to be developed and preserved; but relations were more than the motorway as an object; it was the motorway as a gathering where matters of concern reworked the operation of the motorway beyond its status as an object.

### *5.1 The chronogramme, its associated conference of services and the constitution of the motorway*

The chronogramme is connected with a procedure to constitute compromise. The instrument summarises many diverse events and makes visible to an audience found in the conference of services. The conference is so spread over time and space that it cannot oversee the effects of its dispersed propositions before they have been made available to it via the chronogramme.

As a mediating technology, the chronogramme sums up various dispersed propositions about the motorway. It does not sum up all aspects of the propositions but only those that involve time and requires coordination between social actors/groups. It focuses on time and interdependence; on progress and on politics. It therefore takes into consideration that

multiple actors interact over a long period of time. Given this extended framing of time, themes and concerns change over time and a detailed account of all types of ends, purposes, and compromises would be next to impossible to monitor just as the multiple relevant effects would be cumbersome to describe intelligently. The summary provided by the chronoprogramme is without detail; it has been generalised and made to account for multiple situations by highly generalised and amplified messages.

This resembles Latour's (1999) account of circulating reference where the continued simplification of multiple traces are organised in one or at least few amplifications such as the "carried out %" which illuminates the progress of the works, and such as the visualisation of parties in need of making a decision to make the motorway progress. The circulation is a procedure of organising multiple possible traits and simplifying them so that they can travel further and be meaningful there. This procedure omits many calculations such as DCF or even geological calculations that have been attended to through a process but not through explicit inscription in mediating instrument. The chronoprogramme amplifies social and political relations.

However, this account of the qualities of a mediating instrument neglects the travel back to the motorway; the amplification neglects circumstances and contingencies that are required to be taken into account when the messages are to be re-inserted into decisions about the motorway, the local communities and the transport corridor from South-North of Italy and beyond. The chronoprogramme amplifies a few traces of a complex world and creates overview understood as perspective; but it also creates overview in the sense of missing detail which makes its travel back to the motorway and the mountains less certain. It does not monitor the multiplicity of objectives and goals – only time and interdependence between social groups. The chronoprogramme is a massive simplification; it massively reduces contingency and locality but this cost has as benefit an equally massive ability to travel over time and space.

The conference of services, whose pursuits the chronoprogramme summarises, is a long and time-consuming procedure. It can take decades to arrive at propositions that bring the cooperation of all. Time is required to produce such propositions because the boundary of what can be proposed is ambiguous; not only "causal" but also "non-causal" propositions can be brought to bear; not only economics is brought forwards, so is socio-economics. The conference of services, which has the power to decide the project, makes the investment heterogeneous as it builds not only transportation and accessibility, but also local infrastructure and community resources. Time is required to produce so complex effects and here money is watered down because DCF does not factor in time as production of consensus. Participation is time consuming since the motorway in addition to producing traffic fluidity takes part in revitalising local communities just as it extends time-space into relations to other countries.

Together the chronoprogramme and the conference of services constitute the motorway; together they mediate between situations and actors and assemble promises, projections and permissions both across time and across social groups. They create promises and projections by situating construction activities in time and space but these are precarious

and provisional because only when permissions given by multiple social groups have been ratified, for a period of time it is possible to advance the motorway. Each permission is provisional, however, because it also changes the character of the promises that will appear in the future. When agreements have been made about the format of the motorway, for example, it changes into detailed planning and programming which suddenly includes new actors such as subcontractors. Such a change in the organisation of the motorway can also be seen in the colouring of the visualisation as changing relations of responsibility are accompanied by changes in colour. The chronogramme is inherently dynamic and reflects on the promises and permissions developed around and organised through it via the conference of services.

This empirical account affirms and adds nuance to Miller and O'Leary's important account of the role of mediating instruments. Its concern with a construction project is different from Miller and O'Leary's analysis of the IT industry since for the construction project not only economics but also socio-economics play a role. The social relevance of the motorway is different from the relevance of the IT component since the links between materiality and politics are much more pronounced. Relations extend to the fates of local communities, the power of cultural heritage and even the dead.

Like Miller and O'Leary's roadmap, the chronogramme requires an underlying heterogeneous set of calculative techniques such as financial calculations for cost estimation, investment budgets, traffic and transport studies, engineering calculations and building parameters and standards. Also like the roadmap, the chronogramme is part of shaping and defining the contours of investments by relating multiple claims and information signals from actors across organisational boundaries towards purposes that are co-produced by all involved. As a mediating instrument the chronogramme is, however, more of an administrative tool functioning through one decision agency than the roadmap. The chronogramme aggregation of promises, projections, and permissions that are agreed between parties; the roadmap requires subsequent decision making to make its prediction true. The chronogramme requires flexibility through the dialogue which it summarises as it becomes more a list of promises than a prediction. As such it is a summary of the compromises made while the roadmap may be more of a prediction of collective and individual effects is all involved parties act according to the role they have been ascribed.

Both technology roadmap and chronogramme are mediating instruments for constructing the future via collective design decisions but the role of timing differs across the two cases. For the road map, timing derives from a matter of fact such as Moore's Law and synchronization is linked to product launches where different components have to be ready within specific deadlines to reach benefits. In Autostrade timing relates to matters of concern and shapes socio-material interactions across the phases of the construction process. For the chronogramme time is elusive as it is itself an investment to make compromise and consensus. It is a procedure for agreeing because time is to enrol others who have a veto. Time is social interaction which allows disputing actors to enter into contact over controversies. This makes the motorway a heterogeneous

object. There is attention to externalities many of which are positive as they strengthen the built environment beyond the requirements of the motorway.

### *5.2 Complements and investment decisions*

Some externalities are different compared with the complementarities developed around the road map. Complementarities are complements that fill out the technology and make it a product. It is concerned with causality dependent investments as one investment influences the value of another investment. This is complementarity in the economic sense that investment in one resource increases the productivity of another.

However, “Variante di Valico” identifies a nuance where a complement does not have to be complementarity but a compliment – an expression of gratitude or respect.<sup>2</sup> A compliment is a resource that adds value to communities and thus facilitates communities’ engagement with the motorway but it is not necessarily causal with it. Investments to upgrade local community services, built environment and houses are not integral to the motorway and therefore strictly they do not provide increases in productivity in motorway construction. They are not related to the productivity of the motorway, and yet they facilitate interaction with local communities and make the progress of the motorway faster. Complements as compliments rather than complementarity are relevant but non-causal.

Compliments fill out a socio-political space; the possible veto by a local community is a source of power and compliments may therefore to some degree be ‘kickbacks’. Yet, in the turbulence of the motorway it is also recognition of the variety of matters of concern that can be attached to it. These are heterogenous concerns that face the development of the different municipalities, regions and the state each of which experience different inducements to be made and contributions to be gained from the motorway. In order to somehow settle the distribution of strains and gains it may be that the number of ways in which the motorway can accomplish socio-economic development will have to be extended. Compliments may be productive if there is recognition that it is possible that the motorway as such may generate different inducement/contribution relations. This may be why everyone has a veto. There seems to be no trade-off between the concerns of different parties given the right of veto; but concerns can be re-negotiated and articulated as non-causal investments to level of the trade-offs. It is possible to make concerns variable; compliments work towards this.

This adds a point to literature that documents the embeddedness of investment decisions. The bundle of investments of which Miller and O’Leary talk can be extended to not only concerns about complementarity but also of compliments; this realises the complexity of matters of concern that can be attached to the capital investments. Attention to

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<sup>2</sup> Compliment normally refers to a form of salute where someone wishes to acknowledge an effort. However, it can also more generally be a sign of respect and gratitude. This latter interpretation is the one drawn on here.

complementarity induces concerns about the technical and strategic properties of technological interdependencies that make up a matter of fact; attention to compliments adds a layer of matters of concern that include attention to the variety of objectives that can be manoeuvred in one investment assemblage.

The stake in the technology road map is the compatibility of technological standards ‘rates of reduction in electronic feature sizes’ by lithography suppliers have to be combined with ‘rates of increase in wafer diameter’. For the chronoprogramme the stake is the matrix of socio-material relationships as the motorway rather than primarily being “integrated and mutually reinforcing system of assets” is a complex asset that has to be integrated in a social and geographical space. In the technology roadmap, consensus is formed and coordination realized via a matter of fact - a technological standard. In the chronoprogramme consensus concerns the assemblage of matters of concern.

### *5.3 Matters of concern and matters of fact: The role of visualisation*

The chronoprogramme is a visualisation; it is a mediating instrument that relates parties internal and external to Autostrade. More precisely, it is a visualisation that comprises things to be shared about the motorway as it holds the parties in place. This parallels Latour’s (1986) discussion of visualisation which is this two-dimensional inscription of a three- or four-dimensional world. The visualisation connects issues and concerns that are otherwise separated in time and space; it equips them with similar scales and sizes; and it presents heterogeneous materials next to each other. In this way the visualisation develops an account of the togetherness of things that are normally distributed and separated and suddenly it is possible to see links and makes relations where there were none before. The visualization orders things that occupy different spaces and times. The visualisation makes matters pertaining to a controversy visible; the visualisation presents its relations and entities.

Drawing on such insight, the chronoprogramme becomes less a system of matters of fact and more a system of evolving matters of concern that intertwine social ambition, technology, geology, history, economics and internationalisation. The heterogeneity of concerns is staggering and it frequently muses about the boundaries of the motorway. It is not strange that the motorway is part of the motorway, but why ‘causal effects’ oriented e.g. towards noise management, traffic safety? And, indeed why ‘non-causal effects’ such as heritage protection? Matters of concern traverse spaces and times as they help to define the boundaries of the things the motorway has to account for; they define the stuff out of which the collective is composed – motorway, traffic safety, community improvement, works of ecology and environmental safety, cultural heritage and the dead that cannot be moved from their burial grounds. Matters of concern change over time. New things are proposed as effects of the motorway and suddenly the unpredictable unexpected increase in traffic made a local community suddenly want to develop an express route to the motorway even if for years to have been disposed to prolong the procedure.

Such matters of concern cannot be surpassed by ‘matters of fact’ such as economic calculations found in net present value or calculations of geology and environmental

impact. They all may provide aspects of problematisation and structure debate; but they do not determine the process and outcome of such a debate. Such ‘matters of fact’ are quickly deconstructed and therefore they would not have any power in the chronoprogramme. ‘Matters of fact’ quickly turn into matters of concern. ‘Matters of fact’ are not the end of a procedure but a beginning of a procedure since strangely they annoy actors rather than make them confident. It makes actors ask new questions; they problematise. Calculations are inputs that develop the array of matters of concern rather than settle them.

The chronoprogramme is different from DCF calculations and engineering calculations. Even if it is related to economic and engineering calculations it visualises social relations. It shows who is dependent on whom; whose decision is a barrier to the progress of the motorway, who has to be persuaded to create a settlement for the project to be able to progress; who is critical in the development of the motorway. Thus focusing on the power of social groups in barring the development of the motorway, the chronoprogramme informs managers about their tasks to identify those that can make the project progress. The dependencies on social groups become the centre of management of the motorway. This strange translation where the technology of the motorway and the friction of geology and soil are made less critical than the interdependencies between social groups is noteworthy. This is, however, even more strange when realising that this is not a substitution of the material for the social; in contrast the chronoprogramme has amplified certain elements related to interdependence but the moment where the chronoprogramme starts to coordinate and organise it is clear that no social relation is present without various material relations. The social is integrated with geology and tarmac just as it is related to soil preservation and cultural heritage. The specific negotiation of interdependencies is not represented in the chronoprogramme, but the interdependencies that come out of negotiations are.

The chronoprogramme is thus an amplification that has left behind a lot of subtleties of the world; this is how it creates an overview – a panorama and perspective from which it is possible to navigate the interdependencies of the motorway at least in principle. During negotiation, the motorway strikes back and requires any social concern to also be a negotiation of technology, geology and culture. The visualisation creates overview not only in the sense of panorama and perspective; it also creates overview in the sense of lack of detail and realism which then come back to be part of yet new negotiations.

## **6. CONCLUSIONS**

This research reports an empirical analysis of capital budgeting practices for a project of motorway building and it focuses on a mediating instrument – the chronoprogramme – which intervenes to mobilise not only the evaluation of a project but also to develop its properties. This mediating instrument visualises social relations rather than economic effects by focusing on matters of concern of groups of people. This adds generality to but also extends the roles of mediating instruments including the technology road map.

The study illustrates the by now obvious idea that the DCF approach lacks a management dimension. Mediating instruments are more important in constructing capital budgets than in evaluating them. NPV is not strong as final arbiter of the relevance of a project. Instead capital budgeting is a process where matters of concern are organised and responded to in a socio-material space. The mediating instrument organises social encounters over time and seeks to gain consensus. The chronoprogramme develops time to enrol others; it allows disputing actors to enter into contact over controversies.

The matters of concern take precedence to technological interdependencies. Here, 'complementarities' become 'compliments' which fill out a socio-political space even if they are non-causal on the capital project proper. Matters of concern are mediated by the chronoprogramme by its ability to put diverse social groups into one assemblage. The chronoprogramme does not represent or copy the range of matters of concern. There are so many matters of concerns that they are impossible to describe properly because only few of them are causally related to the motorway. Many matters of concern are about issues that are non-causally related to the motorway and are related to the range of ways in which social groups can be compensated for them to acknowledge and avoid their veto for the motorway to progress. The chronoprogramme reports on the progress of consensus.

Such a consensus is a complex matter and may not be equitable. Part of the complexity is that in each of the matters around consensus may be achieved the concern is rarely social. It is intertwined with not only interest, but also with relations between lands, orography, geomorphology and tarmac, viaducts, bridges, tunnels, trajectories, slopes, cultural heritage, etc. The concerns emerge from complexities that are both human and technological. Sometimes the slopes of mountain exhibit strong forces in making agreements about the position of the motorway but in other circumstances history, the dead and heritage make those forces. They are rarely social forces per se; they are also material – history, the dead and heritage all occupy the space via certain materialities such as houses, cemeteries and places. When it is possible to argue logically and forcefully about relevant non-causal complements it is exactly because the entire social is also material. It is possible to invest in cultural materialities.

The existence of non-causal investments adds to the knowledge about complements. The typical rendering of complements as complementarity can be extended by concerns with compliments. Compliments have to be paid to enrol the diversity of issues that can be attached to the motorway. These evolving matters of concern move people in their engagement with the motorway even if not part of it. The motorway as an object is different from the motorway as a project. The project is still an entity under formation and it challenges by inviting new and possible relations; at least it manages relations that were previously seen as outside its realm. As an object the motorway – the capital budgeting entity – is fixed and has clear properties. However, empirically the motorway – the capital budgeting entity – has many unclear properties; at least it allows surprises about matters of concern to emerge all the time; the motorways is a project rather than an object because it always surprises by the entities that it has to take into account. Thus the expansion of non-causal investments – the expansion of compliments.

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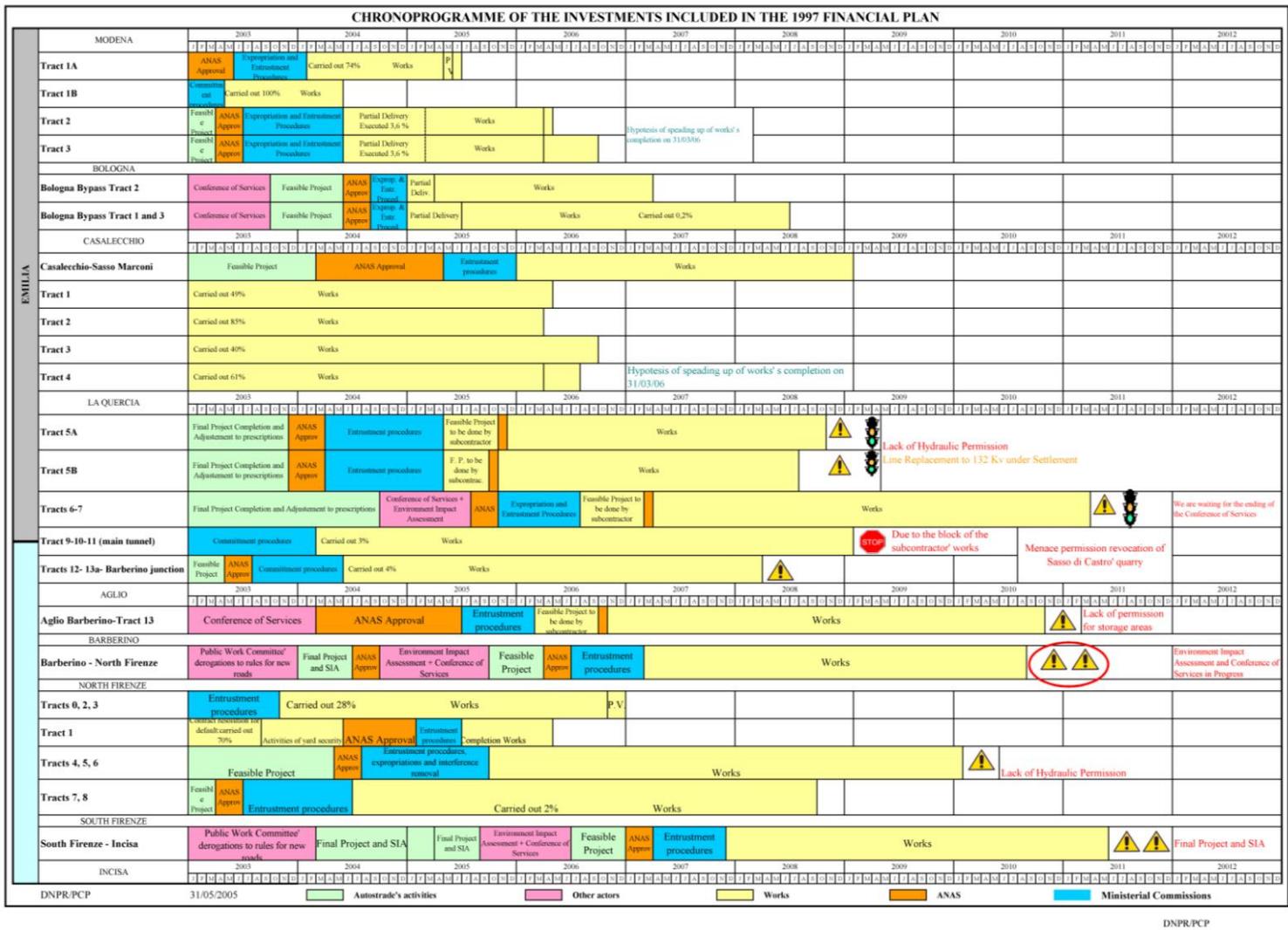


Figure 1: Chronoprogramme of investments in motorway assets envisaged in the financial plan for the year 1997

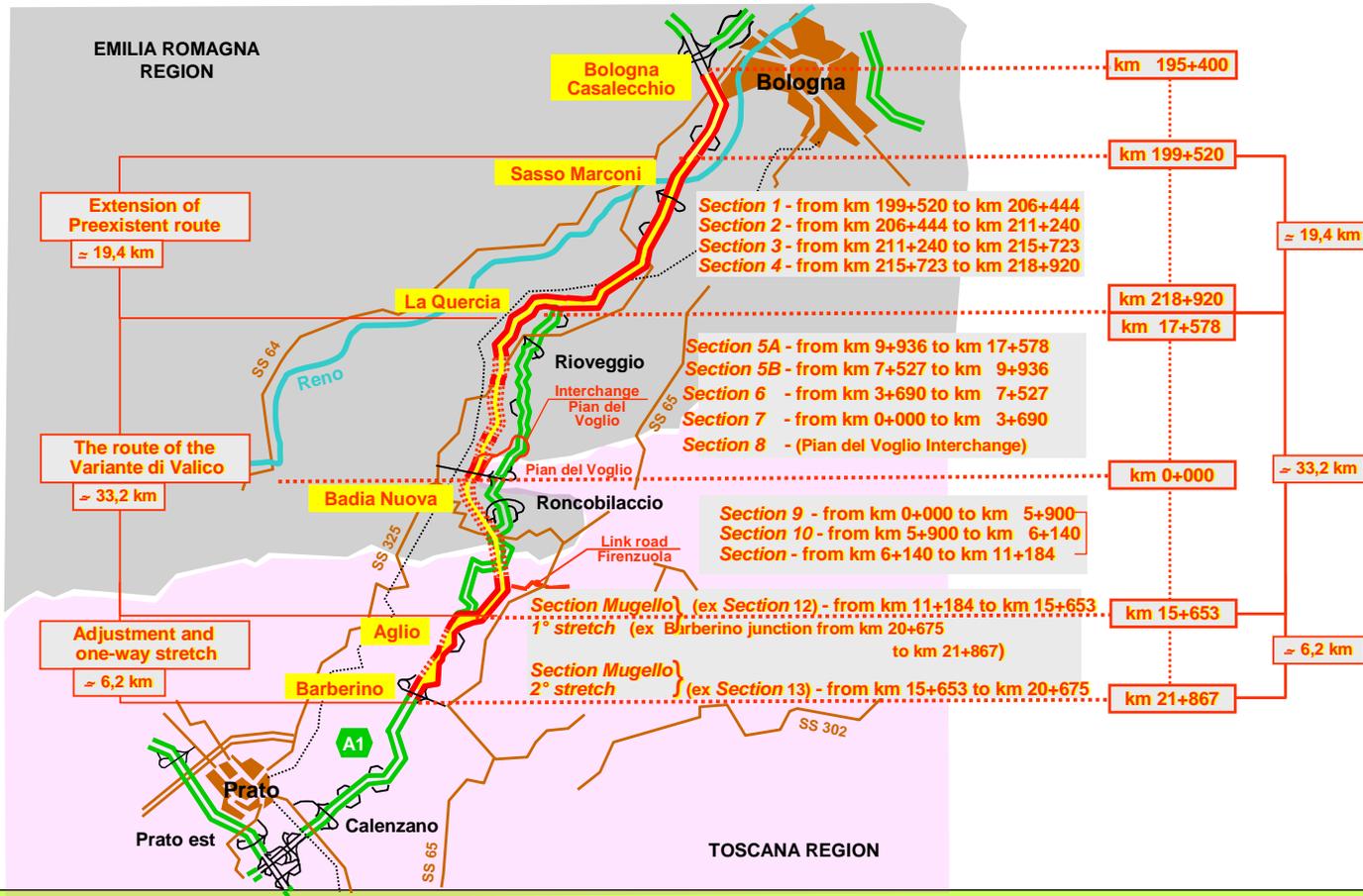


Figure 2: Autostrada del Sole (A1 – MILANO – NAPOLI): Development of the Apennine motorway tract between Sasso Marconi and Barberino di Mugello