PROJECT MANAGEMENT AND NEW BUSINESS DEVELOPMENT: REUSING OR RENEWING RULES? EVIDENCE FROM A CASE-CONTROL STUDY BASED ON HISTORICAL CASES

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Track H. Radical product/service innovation

ABSTRACT

Innovation projects are actually a place where two contrasting logic are conflicting: on the one hand, project management can be oriented towards the efficient reuse of competences for new business development; on the other hand it can also be considered as a favorable arena to renew the usual rules. How does project management combine exploration and exploitation when dealing with new business development? Is it an antagonism, as it is described in organizational learning literature? (March 1991). Or are there ways to fruitfully combine rule reuse and rule renewal?

This question has actually received a strong attention in the last decades. We are today very knowledgeable on the different management principles of exploratory projects. However there remains to propose an integrated model combining these principles and able to relate to the new business development performance.

Based on the literature review we will propose a synthetical model with two main factors: the management principles that correspond to a logic of rule-reusing (reuse as much as possible the existing rules) and the management principles that correspond to a logic of rule renewal). We will then test this model based on a case-control study of 46 historical projects, 26 leading to new business development, 20 not. On this sample we will show that our measurement model, based on rule-reuse vs. rule-renew principles, has a good fit and we will test that the rule-reuse principles are independent of new business development whereas rule-renew principles are positively related to new business development. This will lead us to discuss the different combination of rule reuse and rule-renew in our sample . We conclude on the managerial implications of this work.

INTRODUCTION

In the "hall of fame" of innovation projects, the invention of nylon stockings by Du Pont de Nemours is one of these exemplar projects that led to new business development (Hounshell and Smith 1988). Another example is the Manhattan project, that appears as the matrix of the post-war giant defense projects (Lenfle and Loch 2010). Hence innovative projects appear as the vector of new business development.

Still if an expert in project management would have audited Du Pont Nylon project or Manhattan project, he would certainly have badly assessed the project management: missing expertise, unclear list of specifications, no integrated team, no planning, no budget control,… Hence our research question: how can an innovative project be a relevant vehicle for new business development?

Innovation projects are actually a place where two contrasting logic are conflicting: on the one hand, project management can be oriented towards the efficient reuse of competences for new business development; on the other hand it can also be considered as a favorable arena to renew the usual rules. How does project management combine exploration and exploitation when dealing with new business development? Is it an antagonism, as it is described in organizational learning literature? (March 1991). Or are there ways to fruitfully combine rule reuse and rule renewal?

On such an issue, it is important to underline in which way our perspective differs from other approaches: a) the question is *not* whether a project is "intrinsically" innovative or, on the contrary, intrinsically non-innovative (for such a question see for instance the synthesis made by (Lenfle 2008)). We consider the project as a place where management principles are set to reach a certain object. If the goal is to develop a new business, *what are the preferable principles used in the project to get this goal?* b) the question is *not* whether the change of organizational routines is possible or not, impeded or promoted. Our question is on the *how*. We intend to show *what are the (project) management principles that helps to develop a new business and what are the management principles that don't relate to new business development*.

This question has actually received a strong attention in the last decades. One of the main results is that project management doesn't always consist in optimizing the use of resources to orient them towards a clear objectives. In many dimensions of project management (process, resources, coordination, value management…), authors have unveiled original practices and principles that lead to renew the rules and routines. For instance project process doesn't only consist in planning, control and reaction to external events but the process can be organized to maximize the exploration of the unknown in order to identify new risks unidentifiable at the beginning of the project (*unk unk*) {Loch, 2006 #10}. We are today very knowledgeable on these new practices and principles of project management. But there remains to propose an integrated model combining these principles and able to relate to the new business development performance.

Based on the literature review we will propose a synthetical model with two main factors: the management principles that correspond to a logic of rule-reusing (reuse as much as possible the existing rules) and the management principles that correspond to a logic of rule renewal (part 1). We will then test this model based on a case-control study of 46 historical projects, 26 leading to new business development, 20 not (see part 2 on the method). On this sample we will show that our measurement model, based on rule-reuse vs rule-renew principles, has a good fit and we will test that the rule-reuse principles are independent of new business development whereas rule-renew principles are positively related to new business development. This will lead us

to discuss the different combination of rule reuse and rule-renew in our sample (see part 3). We conclude on the managerial implications of this work.

RESEARCH BACKGROUND AND HYPOTHESIS

Innovative projects are considered as a powerful means to provoke the development of new business, in a so-called ambidextrous way (Tushman and O'Reilly III 1996). They can help organizations to change the architecture of their products and their core competences, i.e. to adapt to various forms of major innovations (O'Connor 2008). It is even considered, as a consequence of the mirroring hypothesis (Henderson and Clark 1990), that the success of this kind of projects should not only lead to major changes on the product/services but also to strong organizational shifts (invention of new kinds of structures, forms of coordination, new partnerships,…). But beyond this general view, how does project management relate to business creation and non-adaptive organizational change? What are the factors that could explain that some projects lead to new business development?

To begin we have to clarify the notions of new business development. By "new business development" we understand a new family of products related to some "major innovation" (O'Connor 2008). We recognize by the fact that there is a lineage of products sharing common properties, a kind of "dominant design" (Abernathy and Utterback 1978). Some of these properties makes that the products of this family are considered as a major innovation, compared to the existing one at the beginning of the lineage (new features, new business models, new competences, new architectures,…). Moreover this new lineage can correspond to a new organization (new business unit or even, in an historical perspective, invention of a new organizational actor like the invention of the corporate research lab at Du Pont). These criteria are consistent with the two main criteria used by (Leifer et al. 2000), new to the context and misalignment: the new business development leads to products which are new to their context and these products were so "misaligned" that they require a new business line for themselves.

Which factors are described in the literature? A first series of factors are given by the classical project management success factors. Literature (see for instance the synthesis in (Brown and Eisenhardt 1995)) has long established a list of critical success factors of project management: clear initial vision and clear problem to solve (Imai et al. 1985) (Clark and Fujimoto 1991) (Wheelwright and Clark 1992) (PMI 2004), careful planning, uncertainty front loading to avoid late discovery and surprises, integrated teams with relevant competences and clear work division (Myers and Marquis 1969) (Cooper and Kleinschmidt 1987, 1993) (Zirger and Maidique 1990) (PMI 2004). One will characterize these factors as "rule-reuse", in the sense that they are all based on well-known routines. Surprisingly enough, these factors are not self-evidently related to new business development: by contrast, new business development is said to require learning, exploration, risk taking, evolving teams and commitment and dynamic competences (Van de Ven & al., 1999; O'Connor & al, 2008). It is considered as a process that is incompatible with the existing routines. One could even wonder whether traditional project management success factors are not contradictory with new business development, in so far as they tend to re-use existing routines instead of revising them. This leads us to our first research hypothesis:

H1: the above-mentioned set of variables, corresponding to a rule-reuse factor (RR), are actually independent of the success of new business development.

The literature on innovation and project management helps to identify another set of critical factors for successful management of exploratory projects:

1- beyond the logic of robustness to unexpected events and risk minimization, innovative projects have to identify the unforeseeable uncertainties (or unknown unknowns) (Loch et al. 2006; Sommer et al. 2008); they can even maximize the exploration of the unknown on a certain issue, for instance identifying the options that maximize variance (Fredberg 2007; Lenfle and Loch 2010; Adner and Levinthal 2004)

2- beyond the logic of validation, the exploration is based on creative but rigorous methods that help to break critical design rules, either through fuzzy-front end phases (Koen et al. 2001; Reid and De Brentani 2004) or by systematic investigations (Tidd et al. 1997; Verganti 2008) or by launching strongly deviant explorations, often described as "moon-landing" initiatives, to let be surprised by the results, in an organized "reflexive" way (Schön 1990; Le Masson et al. 2011a; Sutton and Hargadon 1996; McGrath 2001);

3- beyond integrated team with clear work division, the innovation project team is also able to connect, involve and commit relevant stakeholders over time (Akrich et al. 2002; Van de Ven et al. 1999) or even to create in its ecosystem a disruptive community that will support the development of the whole business (Le Masson et al. 2011b)

4- beyond the clear list of requirements and well-defined specifications, the innovative project might require a capacity to "make sense" from different value perspectives (Thiry 2001) or it can even require a value management (Hatchuel et al. 2005) (Gillier and Hooge 2012) that manages multiple, interdependent exploration alternatives to create multiple, varied, types of values (Elmquist and Le Masson 2009; Loch et al. 2006; Lenfle, 2008; Van de Ven et al. 1999)

This second set of factors is more oriented towards learning and creation of new competences and values, instead of using rules for known performance criteria. It can even tend to intentionally break the rules. We call it "rule-renew" factors (RN). These factors are more easily related to successful organizational change. This suggests a second hypothesis:

H2: the above-mentioned set of variables, corresponding to the rule-renew factor (RN), positively impact the success of new business development.

If H1 and H2 are true, this raises an interesting issue: we should find successful projects that combine rule-renew factors and rule-reuse factors. How can one combine these factors?

RESEARCH METHODOLOGY AND EMPIRICAL MATERIAL: A CASE-CONTROL STUDY ON 46 WELL-DOCUMENTED HISTORICAL CASES.

The test of such hypotheses raise a strong methodological issue: we need rich empirical data on the project itself to analyze the management dimensions mentioned above (risk management, learning strategy, value management and organization) but we also need long term analysis to check new business creation. That's the reason

why, following (Kieser 1994; Pettigrew 1990), we favored historical data. Historical data have already been used on single innovative projects (Lenfle and Loch 2010). In this paper we try to generalize these single case results to a large sample of 46 well-documented historical cases.
We conducted a case-control study, with 26 cases of project leading to new business development and 20 control cases (project without new business development). This method has a good statistical power, given the fact that cohort studies, with which case-control method is often contrasted, must wait for a 'sufficient' number of 'case' events (new business development) to accrue, which would have been very costly in our situation.

Case selection
We selected 26 historical cases, where there were written detailed, available material and where each case combined two critical features: *there was a recognized development of a new business and this new business development was associated to a project*. We selected the 20 control cases with the following criteria: *there was a project and this project didn't lead to a new business development*.
To assess the existence of a project was an easy task since the authors of the cases themselves mention it carefully.
To assess the "new business development" variable we used two criteria: are there "descendants" of the initial project, i.e. products/services sharing similar functions, technologies and architectures. For instance the initial nylon stockings were followed by several derivatives that built a family of products, sharing common values (robust, light, fashionable,…) and common technologies (the nylon fiber and its associated technologies), progressively building a dominant design (Abernathy and Utterback 1978), with regular improvement. In each case we analyze whether a "lineage" emerges after the initial proposal. The second criteria is an organizational one: we check whether the new business is associated to a new business unit or even to new departments in the organization. In the case of nylon, a new department emerges, in charge of polymer products, and the new corporate research lab acquires such a strong legitimacy that it becomes institutionalized in Du Pont organization.
In practice, the three authors assess independently the variables, following a classical 5-level Likert scale (from -2 – strong disagree- to + 2 –strongly agree) (see detailed questions and assessment criteria in appendix).
Interestingly enough, these criteria led us to skip one case: Apollo. We initially selected Apollo as a relevant case, because of the apparently high descendance of the project (from Apollo 1 to Appolo 17). However careful investigations led to consider that there were only very few missions that followed the success of Appolo 11, they were all mainly a copy of the first one (except the Lunar Rover), without any improvement and any logic of business growth through improvement and variety. Moreover there were very limited transfers from the Apollo project to the following NASA projects (in particular the authors mention that there was no effect of Apollo on the Shuttle project). This is the reason why we finally didn't consider Apollo as a relevant case of new business development.

The above-mentioned criteria helped to deal with one critical issue when relying on historical cases: how long should one wait before one considers a case as an historical one? Should one fix a standard duration (eg "more than twenty years")? We prefer to consider that the relevant duration was made by the product development time specific to the lineage in question; e.g. in case of automotive innovation, innovations

like telematic services or athermic windshield are likely to be implemented for each new car development launched by the car manufacturer, i.e. approximately typically one or two every year for PSA. Hence after a couple of years it is possible to say whether a lineage is installed or not. This justifies that we will use relatively contemporary cases like Tefal or PSA, for which it was possible to assess lineage success.
Based on the same criteria we selected the control cases. We found these control cases in historical books. To ensure that these cases were *not* at the origin of a lineage of products, we had the same historical logic: follow on the long term. Moreover we were from time to time able to identify cases which were actually inside a lineage created by one of our "new business development" cases (see Saint-Gobain windshields) or in the same organization (see for instance Poseidon and Trident cases). We also relied on studies like (Clark and Fujimoto 1991) which made already powerful synthesis of several project management cases.

In such a process we had to take care of the observer objectivity. In quantitative studies based on questionnaires, it is today common to separate either the people making the study and the one making the analysis or, even, to separate the questionnaire into two parts, one on the dependent variables and the other on the independent variables, the part being administrated by two different persons (e.g. (Lichtenthaler 2009)). These methods are actually used because the results depend almost only on the data gathered through the questionnaire. The issue is often to triangulate the data with other sources. In our case we could strongly triangulate, since we rely on a much richer material than only the interviews since we could use complete history written by expert historians or in-depth case, comprehensive studies. Hence for each data point we had access to a quantity and quality of data that often far exceed the classical questionnaires.
On the other hand, qualitative study recommend to separate between data gathering and coding, on the one hand, and data analysis on the other (Yin 2003) (see for instance (Santos and Eisenhardt 2009)). We were able to follow the recommendation since we separate between the data gathered by the case historians and the analysis we made. Moreover the historical data we use are all published in English so that the reader can refer to the material if he wishes.
The list of cases and the published references are given in table 1 below.

Case n°	***Name***	***Company / Organization***	***References***
1	Manhattan Project / atomic bomb	US Army	(Lenfle 2011; Hewlett and Anderson 1962; Rhodes 1986)
2	Nuclear Submarines	US Navy	(Hewlett and Duncan 1974)
3	Atlas / Titan ICM	US Air Force	(Hughes 1998; Johnson 2002b)
4	Polaris Missile	US Navy	(Sapolsky 1972; Spinardi 1994)
5	SAGE Defense System	US Air Force	(Hughes 1998; Johnson 2002b)
6	Sidewinder	Navy	(Westrum 1999)
7	IBM System 360	IBM	(Baldwin and Clark 2000; Brooks 2010) (Ceruzzi 2003)
8	XP-80 Jet Airplane	USAF / Lockheed	(Miller 1995)
9	F-117 Stealth bomber	USAF / Lockheed	(Miller 1995; Rich and Janos 1994)
10	IBM PC	IBM	(Baldwin 2005; Chposky and

			Leonsis 1988) (Ceruzzi 2003)
11	Automotive Telematic Services	PSA	(Lenfle and Midler 2003, 2009)
12	Electric Lighting	Edison	(Hughes 1983; Israel 1998; Millard 1990)
13	Prius	Toyota	(Itazaki 2008; Magnusson and Berggren 2001; Nonaka and Peltokorpi 2006)
14	Nylon	Du Pont de Nemours	(Hounshell and Smith 1988)
15	iMode	NTT Docomo	(Funk 2001; Gawer and Cusumano 2002)
16	Catia	Dassault	(Daloz et al. 2010)
17	Centrino	Intel	(Burgelman and Meza 2007)
18	Film camera	Kodak	(Jenkins 1983, 1975)
19	Eiffel economic Bridge	Eiffel	(Eiffel 188x; Le Masson and Weil 2010; Lemoine 1989)
20	Raclette anti-odeur	Tefal	(Le Masson et al. 2010; Chapel 1997, 1999)
21	No bag vaccum cleaner	Dyson	(Dyson and Coren 1997)
22	First locomotive family	Baldwin	(Brown 1995)
23	Ductile tungsten	GE	(Reich 1985)
24	Diesel engine	MAN - Krupp	(Bryant 1973, 1976)
25	Microbus	RATP - Gruau	(Elmquist and Le Masson 2009)
26	Athermic windshields and thin coating	Saint-Gobain	(Hatchuel et al. 2010; Le Masson et al. 2010)
27	Apollo	NASA	(Brooks et al. 1979; Johnson 2002a; Murray and Bly Cox 1989)
28	Eiffel tower	Eiffel	(Eiffel 188x; Le Masson and Weil 2010; Lemoine 1989)
29	BMW car windshield	Saint-Gobain	(Hatchuel et al. 2010; Le Masson et al. 2010)
30	New car project (1990s)	Toyota	(Sobek et al. 1999)
31	Twingo	Renault	(Midler 1993)
32	Poseidon	Navy	(Spinardi 1994)
33	Trident	Navy	(Spinardi 1994)
34	ELINAR	Chevenard – Fourchambault Commentry	(Chevenard 1923, 1933)
35	Trucks	Schlumberger	(Bowker 1994; Allaud and Martin 1976)
36	Blue Amberol Phonograph	TAE inc. (Edison)	(Hughes 1983; Israel 1998; Millard 1990)
37	Gyro 3rd generation	Sperry	(Hughes 1971)
38	AC Generator 1886 version	Thomson Houston	(Carlson 1992)
39	Liquid Scintillation Counter with automatic changer, 1958	Packard	(Rheinberger 2001)
40	Locomotive 2-10-0 type “decapod” for Brazil (1885)	Baldwin	(Brown 1995)
41	Line amplifier telephon repeater (1921)	ATT	(Reich 1985)
42	European High-End specialist project type		(Clark and Fujimoto 1991)
43	European volume project type		(Clark and Fujimoto 1991)

44	Japan project type		(Clark and Fujimoto 1991)
45	US project type		(Clark and Fujimoto 1991)
46	Diver Watch	Omega	(Pasquier 2008a, b)

Table 1: list of cases

Project management descriptors

For each case we analyzed project management, according to the main variables identified in the literature. We describe below each of them, grouped into four classical organizational dimensions: managing risks, managing learning, managing team, managing target value. Below we detail these descriptors. In italic we write the assessment to be accepted or rejected by analyzing the case. The descriptors are not mutually exclusive (for instance, in case of learning, some parts of the project can be based on validation whereas some other parts are more exploratory).

1- Process organization for managing risk:

1. *Organize a planned process that is robust to external events (technological and market uncertainties): in case of surprise, it can react and still meet the target.* This is the classical project robustness criteria. For instance in the case of the F117-stealth at Lockheed skunkworks, the authors writes: “evidence of good contingency planning […] included actions taken to recover from […]”. (p. 162) (Rich and Janos 1994)
2. *The project organizes to identify unforeseeable uncertainties (unk unk) or/and the project organizes to increase the variance in the options.*
   The first part of the proposal refers to criteria introduced by Loch et al. (2001; 2006) It takes the form of sophisticated sequential and parallel testing of different solutions. The Manhattan project exhibit clearly this feature (Lenfle and Loch 2010).
   The second part of the sentence refers to the fact that, in a logic of real option pricing, innovative projects value increased with the variety of technological and market scenarios they could address so that risk management consisted in exploring the largest technological and market span (and not only the most “feasible” and “marketable” alternatives) (O'Connor 2008; Adner and Levinthal 2004; Fredberg 2007; Lenfle and Loch 2010). Manhattan project also exhibits this feature since in the project several explorations didn't aim at validating a technological path but did aim at exploring the technological potential opened by the path (Lenfle and Loch 2010).

The first type of risk management is actually based on the fact that the rule used to lead the project are robust to external conditions whereas the second type of risk management consists in identifying external risk that would then require the creation of new rules.

2- Managing project costs and resources associated to learning:

1. *Project learning costs are related to tests and validation: alternatives are tested and evaluated and the relevant (or the best) one is kept.* This approach is at the root of project planning and project as problem solving (Imai et al. 1985; Clark and Fujimoto 1991; Wheelwright and Clark 1992). Edison Electric Lighting or Polaris missile comprised lots of such technological validations. Such a validation logic is possible when technologies evaluation criteria are well-identified in advanced (i.e. one can identify such a list of technologies and validation criteria at the beginning of the project)

2. *Project learning (a) uses deviant explorations to be surprised by the results of such explorations and/or (b) project learning uses systematic, comprehensive investigations and/or (c) project learning uses a fuzzy front end, creative phase.*

   a- The first part of the sentence refers to a "reflexive" learning. This is more than serendipity in the sense that it is a *provoked* surprise (Schön 1990; Le Masson et al. 2011a; Sutton and Hargadon 1996; McGrath 2001). The polymer synthesis in Du Pont corporate research lab initially followed such a logic since it only intended at creating new fibers, never seen before, without any warranty of success.

   b- The second part of the sentence appears when there is an organized design of experiments, close to a traditional "experimental research" logic (Tidd et al. 1997; Verganti 2008). Edison research of a "good" filament for incandescent lamps followed this logic by systematically trying almost all existing fibers.

   c- The third part refers to a preliminary phase that helps to identify multiple pathes, including "moon landing" or crazy one (Koen et al. 2001; Reid and De Brentani 2004). Polaris missile exhibits such a phase that further led to clearly distinguish between two types of tasks: the one where a validation logic was enough and the one where a more exploratory logic was required.

The first type of learning consists in validating existing routines against existing performance criteria whereas the second learning management consists in creating new routines and/or new performance criteria.

3- <u>Coordination means to manage project team and project environment:</u>

1. *Project team is integrated, stable and exhibits clear work division. The relationship with the external environment is well codified.* (Myers and Marquis 1969; Cooper and Kleinschmidt 1987, 1993; Zirger and Maidique 1990). Edison team at Menlo Park is a clear example of such a project team.
2. *Project team (a) is able to commit new (initially external) actors to its network and/or (b) project team is able to change its own ecosystem by motivating external actors to create knowledge and competences to contribute to the future lineage.*

   (a) The first part of the sentence refers to criteria of innovation team that was introduced by Actor Network Theory (ANT) works (Akrich et al. 2002), insisting on the need to mobilize external resources (suppliers, research labs,…) and to "translate" the project to adapt to the need of multiple stakeholders, beyond the project customer. Edison lighting case is precisely mentioned as a case of successful involvement of new actors in the innovator network (Akrich et al. 2002) (the authors use (Hughes 1983)).

   (b) The second part refers to criteria that is actually strongly different from the previous one, where the initial project team is "enlarged" to new stakeholders. In this latter case, the project team only stimulates knowledge creation in the ecosystem that is likely to support the development of the new business (Le Masson et al. 2011b; Le Masson et al. 2009). For instance Toyota Prius pushes several actors of the ecosystem to launch themselves multiple explorations to become competent in power-electronics and energy storage.

The first type of team management often requires stables rules to be able to define ex ante the skills to be involved and the task to be assigned to each team member. By contrast, the second type of team management insists on the capacity to adapt the

configuration of the team (and the related network and ecosystem) to the discovery of new issues.

4- Managing target value:

1. *The project target value is given by a clear list of requirements and well-defined specifications.* This helps to organize value division inside the project and project suppliers. The existence of this list of specification is usually quite easy to assess. One good example is given by F-117-Stealth: "the project was tailored to the specific needs of the program objectives" (p. 162) (Miller 1995)
2. *Project target value (a) requires sense-making during the project and/or (b) project target value is created during the project*.
   (a) The first part of the sentence means that the value is not given at the beginning but results from the progressive aggregation of initially scattered interests (Thiry 2001). In the end, the value is unified. One example is made by Edison Lighting project, in which the value of light, compared to gas lighting, was only progressively identified. In Manhattan the true value of the multiple technological alternatives were identified only late in the process when the multiple technological alternatives began to be combined.
   (b) Contrary to the first part of the sentence, where the value was present but is identified and aggregated during the process, the second part considers that some value is designed during the process, with the logical consequence that there are often multiple, contrasted and even contradictory values that are created and only one part of them is embodied in the final project. (Hatchuel et al. 2005; Gillier and Hooge 2012; Elmquist and Le Masson 2009; Loch et al. 2006; Van de Ven et al. 1999). For instance Toyota Prius project revealed that hybrid engines could be related to a new kind of "fun driving" instead of fuel consumption reduction. This further led to develop hybrid for 4-driving wheel cars, with quite high average fuel consumption.

The first type of value management is based on target value fixed exogenously and stable during the project. The project is not in charge to explore the value itself. The second type of value management is based on the exploration of new values during the project.

In the independent variables, that describe managerial actions to manage a project, one can distinguish variables that are all based on exogenously fixed rules (1.1, 2.1, 3.1, 4.1) (realize an existing list of specifications, while being robust to well-identified risks, learn through on empirical tests and organize an integrated, stable project team with clear work division), whereas another set of variables is "rule-renew-oriented" (the other descriptors).

For each case we check the success of new business development with the two indicators below:

A- Lineages: *There a family of products/services that is new and associated to the first project.* We provide some additional indications to answer the above assessment:
   a. Criteria for newness: see criteria of O'Connor et al. for major innovation (O'Connor 2008); other indicators can be added such as: new product name (eg Hybrid Synergy drive in the case of Toyota Prius).

b. Criteria for family: several derivatives with several generations (eg. Prius models 1 to 4 and derivatives like Lexus Hybrid cars) and regular improvement and changes, in a logic of dominant design (Abernathy and Utterback 1978)
c. Criteria of association: the first product is used as a reference or the competences created at the occasion of the first product are widely reused for the following ones (eg. the competences acquired during the Manhattan project are reused and improved on other nuclear weapons) (Maidique and Zirger 1985).

B- New organizations supporting the new family of products. *There is a new organization that contributes to the new business development.* We provide some additional indications to answer the above assessment:
   a. Criteria for new organizations: new business unit, new function (invention of corporate Research labs, of skunk works,…) .
   b. Criteria for existence of the organization: contribute significantly to the lineage of products over time, with a relative stability.
   c. Criteria for newness: the organization was not here at the beginning of the project (we follow here the "misalignment" criteria of Leifer et al. (Leifer et al. 2000))

We also add control variable, that are often mentioned for new business development:

a- *Is there an established dominant design at the beginning of the project, on the project field?* This parameter controls for the fact that the existence of a dominant design would impede the development of new business development (lock in effect).

b- *What is the relative size of the project organization compared to the whole organization?* This parameter controls for the fact that a project that is relatively small compared to the rest of the organization could be less likely to provoke the emergence of a new business in the organization.

Analysis

We intended to lead a SEM (structural equation modeling) analysis, with a confirmatory factorial analysis for the measurement model on the project management features. Still the size of the sample is too small for the moment.

For this paper we had to rely on a less robust, more exploratory method: we first test the factors (latent variables: "rule-reuse" vs "rule-renew" factors) through a confirmatory factor analysis. We use Stata 11 with confa package (developed by S. Kolenikov et al. (Kolenikov 2009)). To test H1 and H2 we conduct a logistic regression using two categories based on the latent variables ("rule-reuse_high" vs "rule-reuse_low", to test H1; and "rule-renew_high" vs "rule-renew_low" to test H2). We took into account the control variables. The statistic method used in the method will be improved in next versions, including a complete SEM.

We conducted complementary empirical analysis on the cases that exhibit both good exploratory levels and good "rule-reuse" levels. For the cases in the configurations we first confirm again the values assigned to the descriptors and we analyze the strategies elaborated to combine good rule-renew and good rule-reuse in a project.

MAIN RESULTS

Example of a project analysis

We first give below one example of the way we analyze the Manhattan project:
Formally launched by the US Government in the summer of 1942, the Manhattan project leads to the design, development and use of the first atomic bombs against Japan in august 1945. In record time the engineers and scientist moved from the most meager laboratory data to working devices that constitutes historical breakthrough in the history of technology and open the atomic age. What is interesting for our study is that the Manhattan case has long been wrongly presented as the origins of modern project management (Lenfle & Loch, 2010). However, a close look at the management of the project reveals that most of the best practices of modern project management (PMI, 2008) are broken. As explained by the project director, L. Groves [1962, p. 19], "*the whole endeavour was founded on possibilities rather than probabilities. Of theory there was a great deal, of proven knowledge, not much*". Therefore they "*decided almost at the very beginning* (…) *to abandon completely all normal orderly procedures in the development of the production plants.* » (ibid, p. 72). Thus one cannot find in the Manhattan project the basics of project management: costs were unknown, planning impossible as well as risk management, and so on. Moreover the project strategy proved very original compared to what contemporary textbooks are teaching. Indeed, in order to manage unforeseeable uncertainties, the project managers decided to adopt a parallel approach i.e. to explore and implement simultaneously the different technical solutions. This finally allows the project to succeed in record time (see Hewlett & Anderson, 1962 or Rhodes, 1986 for a complete history of the case and Lenfle, 2011 for an analysis of the project strategy). What is interesting for our analysis is threefold :

1. Instead of, as assumed by the PMI model, defining at the beginning the requirements of the weapons which, given the scientific uncertainties, was impossible, the project steering committee explicitly decided to explore multiple scenarios. The goal was twofold: adapt to the unknown and reduce time to delivery ;
2. The entire project was fundamentally an experimental learning process (Loch & al, 2006). Each time they face a new problem (and there were a lot of them!) they experiment, add new solutions (e.g. thermal diffusion to enrich uranium), explore simultaneously different approaches, try seemingly crazy ideas (e.g. implosion weapons)… and adapt project strategy accordingly;
3. They cannot rely on existing competences since there were none. So they had to build almost from scratch an entire industry. To do this the army set up a dedicated organization with three pillars : the army corps of engineers, scientists and private firms like Du Pont, Union Carbide or Westinghouse (to name a few). In this sense Manhattan gives the fundamental impetus to the militaro-industrial complex.

One interesting feature of the project is its final success despite its violation of project management best practices. But there is more. Indeed reducing Manhattan results to the bombing of Hiroshima and Nagasaki and the ensuing surrender of Japan is profoundly misleading (Lenfle, 2012). What is striking is that Manhattan gives birth to lineages of new products that improve the initial design (ibid). Moreover the project generated an extremely rich knowledge base in various fields (nuclear science and engineering, computing, science of explosives, etc), which would later expand

and can be considered the cradle of the nuclear industry (military at first, but also probably civilian). And, last but not least, it also leaves behind him organizations (mainly plants and laboratories) that will survive in the postwar years through the Atomic Energy Commission created august 1, 1946 (see Lenfle, 2012).

Result 1: measurement model

The measurement model is represented in figure 1 below.

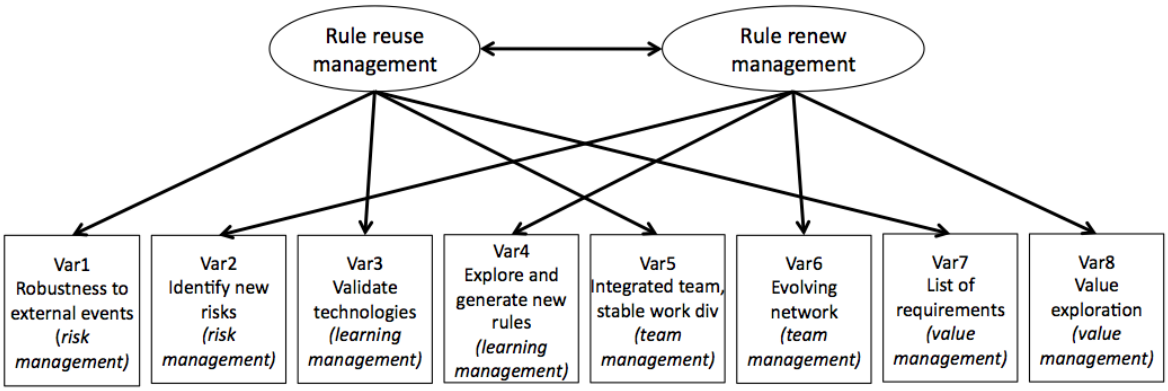

Figure 1: measurement model

We conduct a confirmatory factor analysis (see results in table 2 below). Note that the case-control study can cause violation of normality in situation of strong correlation between factors and cases. Hence we rely on an alternative method to the classical (quasi-) MLEs estimation (or estimation by the variance-covariance matrix). We chose the so-called Satorra-Bentler "robust" errors estimate, after (Satorra and Bentler 1994).

The reported estimates are as follows: the estimated means of the data; loadings grouped by the latent variables; factor covariances and variances of the error term. All parameters are freely estimated except for loadings used for identification which have a coefficient estimate of 1 and are missing standard error.

The final set of the displayed statistics is likelihood ratios and two specific tests. The second test is against an independence model. The first line is for a test against saturated model (fit to the model). Note that in the case of Satorra-Bentler estimation, the test of the goodness of fit with a likelihood-ratio is no more valid. Santorra and Bentler proposed Satterthwaite-type correction Tsc, and Tadj, the first one corrects the scale and the second the scale and the degrees of freedom. With this new estimation, the fit is good. These two tests are given in the two last lines.

The second test shows that the current model is a big improvement when compared with the null model, in which variables are assumed to be independent. This confirms the *multidimensionality* of rule-reuse and rule-renew factors.

The Tsc and Tadj tests show that the model is fitting well. In particular one can notice that the paths from the item to the factors are significant to the 5% level providing support for the *convergent validity* of the model.

This result confirms the measurement model of project management that we built from the literature review: a model based on two main factors: rule-reuse management and rule-renew management. The last factor can even be assimilated to a "rule-renewal management".

log likelihood = -541.18523 Number of obs = 46

	Satorra-Bentler Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Means						
var1	3.391304	.2205817	15.37	0.000	2.958972	3.823637
var3	3.326087	.2322212	14.32	0.000	2.870942	3.781232
var5	3.76087	.1744145	21.56	0.000	3.419023	4.102716
var7	3.73913	.2026172	18.45	0.000	3.342008	4.136253
var2	3.26087	.2543291	12.82	0.000	2.762394	3.759345
var4	3.630435	.2348607	15.46	0.000	3.170116	4.090753
var6	3.347826	.2305116	14.52	0.000	2.896032	3.79962
var8	3.173913	.250339	12.68	0.000	2.683258	3.664568
Loadings						
R						
var1	1	.	.	.	.	.
var3	.9432382	.1818156	5.19	0.000	.5868862	1.29959
var5	.5303342	.1358387	3.90	0.000	.2640953	.796573
var7	.823764	.1502184	5.48	0.000	.5293414	1.118187
E						
var2	1	.	.	.	.	.
var4	.9261635	.06009	15.41	0.000	.8083893	1.043938
var6	.7341926	.0938248	7.83	0.000	.5502993	.9180859
var8	.8769581	.0728601	12.04	0.000	.7341549	1.019761
Factor cov.						
R-R	1.721485	.4021316	4.28	0.000	.9333219	2.509649
E-E	2.671646	.2918144	9.16	0.000	2.0997	3.243591
R-E	-1.460869	.2975537	-4.91	0.000	-2.044064	-.8776745
Var[error]						
var1	.5167035	.2092214	2.47	0.014	.106637	.92677
var3	.9490239	.3648372	2.60	0.009	.2339562	1.664092
var5	.9151643	.1711965	5.35	0.000	.5796253	1.250703
var7	.7202941	.2231312	3.23	0.001	.2829649	1.157623
var2	.303785	.104609	2.90	0.004	.098755	.5088149
var4	.2456576	.0847136	2.90	0.004	.0796219	.4116932
var6	1.004116	.1499147	6.70	0.000	.7102891	1.297944
var8	.8281578	.1896101	4.37	0.000	.4565289	1.199787

R2	
var1	0.7524
var3	0.6040
var5	0.3385
var7	0.6051
var2	0.8784
var4	0.8836
var6	0.5764
var8	0.6972

Goodness of fit test: LR = 42.548 ; Prob[chi2(19) > LR] = 0.0015
Test vs independence: LR = 268.325 ; Prob[chi2(28) > LR] = 0.0000

Satorra-Bentler Tsc = 45.678 ; Prob[chi2(19) > Tsc] = 0.0006
Satorra-Bentler Tadj = 24.207 ; Prob[chi2(10.1) > Tadj] = 0.0073

Table 2: Confirmatory Factor Analysis results

Result 2: hypothesis testing

We test the simple model represented below (figure 2), under two control variables, dominant design and relative size.

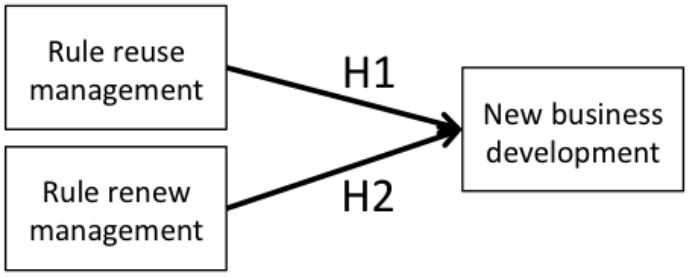

Figure 2: model R factor and E factor vs new business development

Following the CFA we created two variables, R and E, both being an average of the items they significantly load. When R is superior (resp. inf) to the threshold 3.00 we consider that the project was R_high (resp. R_low). The same for E.
The control variables dominant design (DD) and relative size (relSize) are also coded in 0-1 value at the threshold 3.00.
The hypotheses are:
H1: The rule-reuse factor R is independent of new business creation.
H2: the rule-renew factor E is positively related to new business creation.
H1 and H2 remain true with the control factors dominant design and relative size.

The result of the logistic regression are given below. They confirm H1 and H2, with the control factors.

Logistic regression — Number of obs = 46; LR chi2(4) = 34.78; Prob > chi2 = 0.0000; Log likelihood = -14.103078; Pseudo R2 = 0.5522

nBD	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
rulebased	-.9490447	1.500032	-0.63	0.527	-3.889053	1.990964
explo	4.458672	1.377134	3.24	0.001	1.759539	7.157805
DD	1.038004	1.245954	0.83	0.405	-1.404021	3.480029
relSize	.0337635	1.050835	0.03	0.974	-2.025835	2.093362
_cons	-1.475029	1.92862	-0.76	0.444	-5.255056	2.304997

Table 3: Logistic regression for H1 and H2

Actually only 4 projects are below the threshold 3.0: XP-80 Jet Airplane of the Lockheed Skunk Works, Polaris missile, IBM 360 and IBM PC. In these cases the projects are related to new business development but they don't exhibit a high value on rule-renew factor. Going back to the detailed case studies, we found in all four cases an interesting pattern: the rule-renew often preceded the project. In the case of Polaris (first US submarine missile), there were already many building blocks to realize a missile and even if there were many challenges for building a submarine missile, even if the new submarine missile appeared as a "new business" in itself, the rule-renew could be limited to the design of a new, very compact missile warhead and solid propellant. The case of IBM PC is even more interesting: the rule-renew was actually made by other companies and research labs and IBM project actually consisted in using the rule-renew made by others, hence a strategy of open architecture using external components (intel CPU, Microsoft OS, etc.). Thus it is true that the project was not a place for rule-renew but still, there was a (hidden) rule-renew to get the new business development.
These results confirm 1) the idea that new business development requires that the management is "rule-renew oriented". 2) It also confirms a less self-evident hypothesis: new product development can emerge equally in cases where there is a management that is strongly based on existing rule or cases where management is not strongly based on existing rules. The exceptions to H2 of course pinpoint the fact that exploration is not only limited to project, and there are cases where new business

development is based on rule-renew activities that are independent of the firm project or even independent of the firm itself. These cases are beyond the scope of this paper, since we selected a sample where there was a project and new business development.

Result 3: qualitative analysis

Result 1 confirms our measurement model for two latent variables, rule-reuse managerial principles on the one hand and exploratory managerial principles on the other hand. One could even say rule creation or rule renewal managerial principle for this latter factor.

Result 2 confirms that rule-reuse managerial principle and new business development are independent whereas exploratory managerial principles are positively related to new business development.

These results lead us to identify several categories of projects (see data points below):

1- We find a lot of projects (11) that are R_low and E_high. Project management was more oriented towards rule renewal that rule reusing and this might explain that they finally led to new business development. The most extreme project is Manhattan, which exhibits the lowest score in rule_based and the highest in rule-renew.

2- We find in the upper right corner projects that are both R_high and E_high. These situations are more counterintuitive since they suppose to be good at reusing rule and renewing rules. How could these projects combine the opposite? We find threee projects here: Edison Lighting System, Toyota Prius and Saint-Gobain Windshields with thin coating. When rereading cases in details we find interesting patterns that could explain the positive relation between rule-reuse management and rule-renew oriented management: in all three cases, we find actually series of projects or a portfolio of interdependent projects. Each single project is well-driven with clearcut objective (resources, spec, delay,…) but the objective itself can be exploratory. For instance one of the first Prius action was a concept car for the Tokyo Motor Show and the concept car intended to explore some customer values and technological alternatives. One of the sub-projects of Edison Lighting consisted in the development of demonstrators for Christmas Mall Lighting. Hence the logic of efficient reuse is put to the service of exploration, it supports efficient, well-oriented exploration.

3- In the middle we find projects where there seems to be a trade-off between rule-reuse management and rule-renew management. We find here multiple patterns.

   a. Low scores in rule-renew can be explained by front-end exploration, just like in IBM360. For instance F117-Stealth and the Stealth family, actually results also from exploration run by university mathematicians (for wavelength reflections), by suppliers (surface structure to reflect radar wavelength), by the company and all its competitors (since the end of WW2, every military aircraft designer is working on low radar reflection) and by the “customer” himself (US army) who had the opportunity to learn by trying the multiple proposals.

   b. We find also a logic of decoupling: the project is actually subdivided into several building blocks, some of them being rule-reuse and the other being more exploratory. This is clearly the case of Polaris, where the vast majority of the tasks were rule based, except the warhead (which precisely was not integrated into a the PERT). One finds similar patterns for Eiffel, Baldwin and Kodak. Eiffel low cost, transportable bridges combine pattern a) and b): multiple preliminary explorations help to design well-delimited exploration

areas inside the project, where exploratory could be launched with limited risks (try steel instead of iron, try new ways to throw the bridges…);

c. Still the logic of rule-reuse and the logic of rule-renew can also lead to some limitations in the rule-renew or limited success in rule-reuse management. The domination of rule-reuse can lead to avoid some technological rule-renews and conversely the unavoidable technological challenges will cause dramatic delay in the project (see IBM 360).

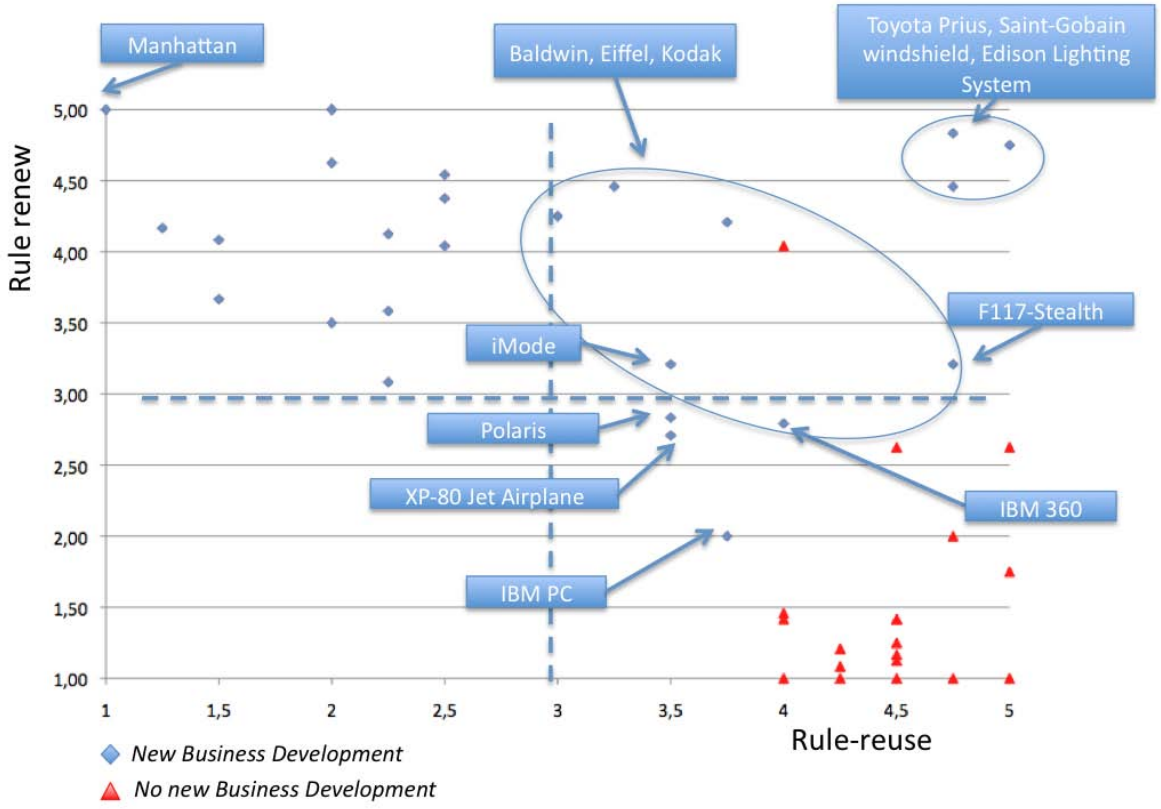

Figure 3: E and R factors for projects leading to new business development

DISCUSSION AND MANAGERIAL IMPLICATIONS

This paper adds to the literature on new business development and project management. It is based on a sample of 26 projects leading to new business development, and 20 control cases not leading to new business development, each case being an in-depth, controllable, contextualized, long term case study. 1) It shows that the distinction between rule-reuse management and rule-renew (or rule renewal) management is meaningful to characterize project management in new business development situation. 2) It shows that successful new business development doesn't require rule-reuse management but coincides with rule-renewal management; 3) it shows different forms of interactions between rule-reuse and rule-renewal management. 4) it clarifies the management principles of exploratory projects by integrating the literature in a single framework. The historical analysis demonstrates their relevance.

Managerial implications.

These results have strong managerial implications:

1- project management can be a good way to organize for new business development, to the condition that it is clearly oriented toward rule-renewal and, therefore, rely on specific management principles. Project management can be also be oriented to rule-reuse but it is not necessary and it will require to manage the combination between rule-reuse and rule renew.
2- The projects that don't follow rule-reuse principles are not necessarily bad! Project evaluation has to adopt a dual perspective. For instance strongly rule-reuse projects should justify that they don't need to renew rules and conversely strongly rule-renew projects should justify that they are really unable to reuse any rule of the organization.
3- This adds a new dimension to project management: the strategic capacity to combine rule reuse and rule renew. Some of our cases echo already known strategy: sequences of rule-reuse heading to rule-renew; decoupling rule reuse and rule-renew in different projects tasks or module, parallel rule-reuse projects providing pieces for rule-renew,… These strategies might pave the way to new forms of project portfolio management or the management of platforms of projects.

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