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THE INDIRECT DEBATE AND THE COMMUNITY. HOW THE PERIPHERY AND THE CORE RELATE IN THE FREE/OPEN SOURCE SOFTWARE COMMUNITY

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The present paper analyzes the relationship between the core and the periphery in the Free/Open Source innovation model. Considering the core as the sparring partner of the periphery, and not vice versa, the present discussion tries to apply a view opposite to the most diffused one. The first passages of the paper are meant to characterize the periphery, its functions, and the source of the realized division of labor with the core. It is shown that this specific schema is the consequence of the self-organizing nature of the FOSS model, that needs to dissipate resources to assure that the whole dynamics does not cease. However, this peculiar division of labor is possible only if the periphery and the core share the same set of interpretative schemes, norms and vision of the authoritative configuration of the community. To understand how this last passage is possible, I develop a conceptual model based on Wenger's concept of imagination and alignment, usually kept in the background by the literature on FOSS, and on the idea of dissonance (e.g. Kuran, 1998). Eventually, the paper tries discuss the relevant properties of the periphery (invisibility, atomization and instability) emerging from the analysis of the possible flaws of the process.

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June 8th, 2008

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Key Words: *free/libre/open source software, periphery, practice, imagination, alignment, dissonance*

Introduction

The main aim of the present paper is to develop a conceptual model able to account for one of the less studied collective actors of the Free/Libre/Open Source Software (FLOSS): the periphery of the community. Peripheral members, those who orbit around FOSS projects and contribute only sporadically with bug reports, suggestions, comments or extemporaneous solutions, are the key for FOSS success (e.g. Raymond, 1998a). However, the literature has looked at their roles mainly from the core's point of view, without trying to unfold their characteristics as a whole. The periphery has been treated mostly as the "*sparring partner*" of the core. The contribution of the present paper is that it tries to change perspective and assign the role of protagonist to the periphery, analyzing its properties, its functions, its "physiological" relationship with the core (i.e. a relationship that fosters productivity) and the possible negative dynamics realized when such positive relationship is endangered.

The first passages of the paper are meant to characterize the periphery and its functions. It is found that in the division of labor between the two "areas" of the organization of the FOSS community, the periphery implements those functions that hinges upon its very characteristics of favoring quantity (the number of mobilized individuals) at the expenses of quality (of the performed tasks). Bug reporting, monitoring members' rule compliance, providing extemporaneous solutions to technical problems, signaling rule infringement, and providing the pool of individuals that can engage in a legitimate peripheral participation process (Lave and Wenger, 1991) that can fuel the core with new resources, are all capabilities that rest on the large number of peripheral participants, rather than on the quality (in terms of effort and time) of their contributions. The necessity for this specific schema of division of labor is the consequence of the self-organizing nature of the FOSS model, that needs to *dissipate* resources to assure that the whole dynamics does not cease (David and Rullani, *forthcoming*).

However, this peculiar division of labor is possible only if the periphery and the core share the same *structures*, i.e. the same interpretative schemes, the same norms and the same vision of the authoritative configuration of the community (Crowston *et al.*, 2005).

A conceptual model based on Wenger's idea of community of practice (1998a, 1998b) is then derived in order to explain how this commonality is achieved. Being the study focused on peripheral members, not engaged in the core practices, the role of the latter is kept in the background and other modes of belonging part of Wenger's theoretical system are moved to the foreground: imagination and alignment.

Imagination is used to explain how identities can be affected by what I define *indirect* debate. With this term I identify the debate to which individuals are exposed "passively". This is a wide spread situation in communities like the FOSS, where individuals interact through Computer Mediated Communication (CMC, e.g. Kock, 2004), a-synchronically and publicly. The exposition to the community indirect debate and, through that, to the discourse embodying the community identity, individuals are pushed to form opinions on the topics felt as crucial by the community. Taking a position, peripheral members internalize a specific set of structures, which is then embodied in their system of meanings.

Alignment (Wenger, 1998a) and another concept, *dissonance* (Kuran, 1998) are the categories here used to explain this last part of the process. Alignment pushes individuals to integrate in their sets of values and believes the structures conveyed by the opinions in indirect debate they adhere to. In other words, the necessity to integrate the new structures in their identity is not only a process relative to their own representation of their self of the world (as for imagination) but also to their system of values, rules and procedures, of their behaviors both in potential and in act.

Dissonance helps in defining more in depth this mechanism. When individuals adhere to an opinions they are exposed to in the indirect debate, they acquire also the structures of the

community it embodies. If those structures, or part of them, are not consistent with their established sets of believes and rules, this creates incoherence in the internal components of their identities (Kuran, 1998). As a result, they can trigger a process of internalization, i.e. of reconstruction of internal believe and rules around the new principles. Through this the mechanism, the core's structures are spread to the periphery.

Eventually, the paper tries to discuss 'what can go wrong'.

As first, it is argued that the described process is not realized at the same degree for each and every individual. The community is instead a *dissipative* object, in the need of "mobilizing" a lot of peripheral individuals to make the most "reactive" ones internalize its structures.

Moreover, individuals at the periphery are *invisible*, as they manifest their presence only when undertaking some action. The core has thus the problem to infer from the few manifestation of the periphery its general status.

The signals the periphery sends to the core are not only few, but also *atomized*. There is no overarching organization of the peripheral members, and each one has her own idiosyncratic answer to the core's structures and discussions. This transforms many signals into "noise".

These two properties identify the role of the periphery as a source of *instability* at the aggregate level. If the core is unable to capture the blurred and weak signals coming from the periphery on time, it could be difficult to reconcile the periphery and the core structures, and the productive of the whole system can be seriously damaged. Possible situations in which this can happen are analyzed at the end of the paper.

In terms of its structure, the paper develops as follows. In the following subsections I will discuss the specific characteristics of the periphery and what functions it accomplishes in FOSS context. I will then introduce the concepts of imagination and alignment and explain why they are crucial in spreading to the periphery the rules and procedures developed by the core. In the next section I will develop the model used to interpret the relationship between the core and the periphery. I will first recall the concept of reflexivity (Giddens, 1991) as a background, and then introduce the theory of community of practices (Wenger, 1998a). Imagination and alignment, part of this theory but less explored in the context of FOSS, will be related to the specific mode of interaction typical of a virtual community. In section 3 I will focus on the limits of this process, namely dissipation, atomization, invisibility and instability. Section 4 concludes.

1 A look at the Periphery

1.1 The setting: Free Open Source Software

The present paper focuses on Free Open Source Software (FOSS)[1] innovation model. This model of innovation is based on a community composed by software developers who collectively and in a self-organized manner produce software, from operative systems to applications, applying to it a peculiar kind of licenses. Proprietary software is usually sold in its binary version and the further distribution of its copies is prevented by law unless authorized by the copyright holder. This binary version can be read by a machine, but not by humans. This way, vendors are sure that nobody can read the structure or act on the program they have created. Open source licenses, instead, are based on different principles. The software licensed under their terms circulates in the form of source code, i.e. written in a language, as C++ for example, understandable by humans, and can be modified, copied and redistributed by anyone. The most diffused license of this kind, the General Public License (GPL), contains also a clause forcing the recipient of the code to redistribute it under

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[1] For the scope of the paper, Free/Libre Open Source (FLOSS) and Free/Open Source (FOSS) will be all considered as synonyms.

the same terms. If a program is diffused under the GPL, there will be no possibility to release further modifications of the program as proprietary code, and the cooperative regime described above will be the basic organizational structure of the project producing it (Gambardella and Hall, 2006).

The intrinsic openness of the software translated in a cooperative and "open" social structure. The number of developers participating in FOSS projects increased over the years, especially after the spreading of the internet. The community of individuals gathering around the production of FOSS grew exponentially. Nowadays Apache HTTP server, an OSS web server, serves around half of the websites worldwide, corresponding roughly to 33 millions active websites[2]. This success has raised several questions in terms of a wide range of topics, from the FOSS organization to the limits and the real strength of this form of cooperation.

One of the characteristic of the model is that production is organized around a core group of few developers surrounded by a large periphery of individuals who individually produce few contributions –maybe none- most of the time of marginal value. In the case of Apache, for example, Mockus et al. (2000) show that the great majority of changes to the code has been done only by few core developers. On the theoretical side, this phenomenon has generated a very interesting stream of literature. However, the attempts to explain what are the mechanisms that tie together the core and the periphery were just a minor part of the research, mainly focused on specific subprocesses part of this relationship (e.g. individuals' progression from the periphery to the core). Understanding what is the roles of each social component of the model and how they relate one another to support the collective effort of producing code, is however a key research issue. Shedding light on how the whole system is determined by the interrelation between these two groups of developers can help in designing institutions able to export the same principles of openness and collective innovation outside the software sector. Creative industries, in particular, are already witnessing experiments similar to FOSS. Wikipedia, for example, an online encyclopedia able to threaten the Encyclopaedia Britannica, has been built on the same principles, *mutatis mutandis*, that enabled the growth of the FOSS community.

1.2   Motivation: why focusing on the periphery and how

The literature on Free and Open Source Software (FOSS) has documented the disproportion in the number of people actually populating the periphery and those belonging of the core (e.g. Kogut and Metiu, 2001; Mockus et al., 2000). From these studies, the literature has moved on analyzing specifically the progression from the periphery to the core (Jensen and Scacchi, 2005; von Krogh et al., 2003; O'Mahony and Ferraro, 2006). The core and/or the process to enter the core have always been at the center of the research. The periphery's specific characteristics and its relationship with the core have been only defined in residual terms or along very specific dimensions, sometimes considering the periphery simply as composed by those developers who were 'less central' or 'less active' than core ones (e.g. Ngamkajornwiwat *et al*., 2008; Crowston *et al*., 2006, Crowston and Howison, 2005; Muller, 2004)[3].

Of course, I am not claiming here that a discussion of the periphery is novel in the literature on the FOSS phenomenon. Almost every article recognizes that in the FOSS model the key is the openness of its inner processes, and thus the possibility for many more individuals than those actually developing the software to just use the software, spot the bugs, and report ideas and extemporaneous suggestions. My argument here would be that, besides this recognition, few studies have focused on the many individuals in the background of the picture and even fewer have tried to provide an analysis of their relationship with the community. Most of the articles on the matter have

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[2] Data relative to April 2008 retrieved from "April 2008 Web Server Survey", Netcraft, at
http://news.netcraft.com/archives/2008/04/14/april_2008_web_server_survey.html
[3] In this context is interesting to recall also the study of non-users, users and developers of FOSS undertaken by Dahlander and Mckelvey (2005).

approach the periphery considering it just the residual or the starting point of more interesting activities. The features of this undeniably blurred and fuzzy agglomeration of people orbiting around FOSS-related projects, initiatives and discussions are instead very interesting, at least as much as those of the core. This because the periphery is the necessary counterpart of the core: the latter will not be able to function without the former.

Such duality is due to the conditions that make the FOSS enterprise possible: The features of the core need to be completed by the functions performed by the periphery. At the center of the community the *quality overcomes the quantity* in terms of participation: the few core developers are very committed to the FOSS project they work to and perform the greater part of the connected activities. The productive capability of the core resides in this disproportion between the number of the developers and their actual work. On the contrary, the periphery is where the *low quality* of the participation, in terms both on the typology of the performed tasks and of the participants' time and energy spent on them, *is counterbalanced by the quantity*. Around a core of few developers a periphery composed by an enormous plethora of differentiated individuals can prosper. When evaluating the FOSS model of innovation, then, it becomes crucial to evaluate the role of the periphery from the point of view of its functions and characteristics.

The contribution of this article is that it tries to develop a model to describe what is the role of the periphery in the division of labor with the core, how the individuals populating the periphery interact with the core, and what are the mechanisms driving the (positive and negative) relationship between the two. More specifically, I will try to describe how lurkers' (i.e. observers) identity relates to the discussion developed in the community, to explain why that fosters the previously mentioned division of labor and to discuss when that division of labor becomes impossible. I will discuss what processes this mechanism triggers both at the individual and at the aggregate level, and eventually describe the properties of this mechanism.

1.3   The role of the periphery

The periphery of the FOSS community can be thought of as the set of actors marginally involved in the discussions, projects and actions relative to community itself, but who are nevertheless interested in those activities, search for related information and use the software produced by the community. They are more than simple users, as they browse the community archives and observe its activities, contribute by signaling bugs, sporadically by solving them and sending patches, sometimes by participating marginally in the discussions of the community, but they are not involved in the community in any more active manner. In a word, they can be considered "lurkers", i.e. observers, that exhibit only a limited level of activity. Using Wenger's (1998a) conceptualization, we can say that this "cloud" of individuals *orbits* around developers, opinion leaders and all the other people who are instead deeply engaged in the community activity, and compose the core of the community.

A first idea of the functions of the periphery can be given referring directly to the peculiar features of the FOSS production model. The first striking property of this model is that it is not based on the efficient employment of the resources (i.e. individuals' energies, effort and time). Actually, it does not allocates most of the available resources, and most of the times it wastes what has been mobilized. David and Rullani (*forthcoming*) show that a huge mass of developers has to be reached by the FOSS production model (at least to the level of registering to a development platform as SourceForge.net) in order for very few of them to actually become project members or to launch new FOSS projects. A move upward in these steps of activity implies the shrinking by an order of magnitude of the number of mobilized individuals. Moreover, most of the projects launched in the early months of an individual participation in these virtual environments end up to be the only effort undertaken in this direction by the individual. In other words, most resources are simply dissipated. But few of them are actually used, and transformed into the engine of the community. These fewer

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individuals composing the core of the community are the drivers of the overall activity, creating new projects, joining existing ones and carry on most of the actions needed to give life and productive capabilities to the community. Notice that in a process where individuals self-select into tasks (Langlois and Garzarelli, 2008) and where there is no overall direction able to guarantee the match between what is needed and what individuals pursue, this is an expected outcome.

Moreover, the internal order of a self-organizing system (and thus its capability to produce) is not kept simply imposing a hierarchical structure. In the FOSS model authority and leadership certainly exist (Muller, 2004), but it has to be continually renewed and legitimized through specific social processes that not only "cost" developers' energies, time and attention, but that are also not always effective, and can result in further dispersion of resources through conflicts, defections, and so on. Notice that, even if technological, legal and social structures can be ameliorated, the unfavorable rate between productive and available resources is again unavoidable, as it springs from the very characteristics of openness and self-organization of the FOSS itself. The FOSS model of innovation is inherently *dissipative* (David and Rullani, *forthcoming*)[4].

As a first conclusion, it is possible to state that in the FOSS production process case, for the system to survive, it is needed that the set of available resources is much larger than the limits of the effective resources' usage. More specifically, a wide periphery enables the core of the community to draw enough resources to keep its production and social processes alive. The huge number of individuals *orbiting* (Wenger, 1998a) around the core is the initial condition essential to guarantee that at least few will engage into the 'legitimate peripheral participation' process (Lave and Wenger, 1991) that will lead them to the core.

Going further with the analysis it is possible to see that this disproportion in the number of individuals composing the two groups is compensated by the level of engagement they have in the community. The core is composed by far less individuals than the periphery, but those individuals represent the engine of all the community activities. In the periphery the relationship between quality and quantity is the opposite: there a huge number of individuals are undertaking activities much less engaging, and -taken each one by itself- also less relevant. This difference is again given by the nature of the periphery described above: it is a huge pool of heterogeneous resources that, to be mobilized, need to find their own idiosyncratic way into the system in a self-organizing manner. Thus, the activities peripheral individuals can perform *as periphery* inevitable belong to the set of low-profile, low-cost and extemporaneous activities. In the FOSS, however, these activities turn out to be crucial. The openness of the code, i.e. its modularity and its easily accessible structure, allows for a precise division of labor between the core and the periphery that increases the value of the contributions coming from the external regions of the community. Individuals at the periphery, even if minimally active, can engage in many micro-tasks at very low cost. Finding the bugs into the code is a very good example of this kind of tasks (Kogut and Metiu, 2001). The large number of people assures that the overall level of activity is high even if each individual performs just very simple and low-intensity tasks. Additionally, the higher heterogeneity of the individuals populating the periphery (Demazière *et al*., 2007) also assures that the scope of their needs and of their actions will be broad enough to guarantee the coverage of many features of the software (Raymond, 1998a). This process, has been exemplified by the famous Linus' Law reported by Raymond (1998a): "Given enough eyeballs, all bugs are shallow". The resources not mobilized into the process that directs them towards the core are nevertheless helpful as such, i.e. as peripheral resources, precisely because they can perform better than the core the tasks suitable for their peculiarities.

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[4] The discussion on the features (as well as the fallacies) of the this analogy with dissipative systems or structures (Prigogine and Stengers, 1984) is much wider than the scope of the paper. In this case the term dissipation is meant to indicate only the necessity for the process to "waste" a certain amount of the mobilized resources to fuel the dynamics that keeps it alive and productive. As David and Rullani (*forthcoming*) also state, the reader can refer to MacIntosh and MacLean (1999) for further discussion of the analogy in the organization studies.

This process is however more complex and subtle than what the previous simple formulation suggests. Lakhani and von Hippel (2008) have shown that the development of PostgreSQL is not performed by the core in a "pneumatic vacuum". On the contrary, the continual "interference" of more peripheral members is crucial to stimulate the process and provide solutions. In other words, the periphery can provide the core not only with a large workforce able to perform activities such as bug reports, patches production or useful feature identification, it is also the place where extemporaneous –but crucial- solutions are created in a distributed manner.

Besides providing the pool of future resources, the mass of beta-testers and debuggers and the extemporaneous solutions, the periphery has also another role: it assures the functioning of the social practices of the community. The periphery participates not only in the technical processes of production, but also in the construction, replication and preservation of the community believes and ideas. This fundamental role can be better understood referring to the mechanisms at work to assure the enforcement of the rules of the community, both formal (e.g., legal as the OSS licenses) and informal (i.e. the informal but recognized by the community 'ownership' the leader of a project has on its development, Raymond, 1998b). The GPL, for example, is a legal rule that erases the possibility of appropriating the code of the community, and coordinate developers' behaviors around cooperative strategies (Gambardella, Hall, 2006). However, the mere existence of the rules is not enough to assure individuals will comply with them. A mechanism enforcing them is necessary to make agents internalize in their strategies the likelihood of being caught infringing a rule and the punishment for their behavior. Again referring to the GPL, the possibility to enforce it –and thus the possibility for the GPL to have a function at all- is related to the public debate where developers can point out fraudulent behaviors.

> *"In the eyes of both legal scholars and informants, the GPL's strength stems not necessarily from its legality, but from the public collective opinion of community members. Informants also stressed that the primary vehicle by which they could enforce their license terms was by identifying and critiquing violations on on-line mailing lists and bulletin boards"* (O'Mahony, 2003: 1189)

Even if the explanation behind this mechanism can have various natures, as O'Mahony discusses in the rest of her text, the *public collective opinion* conveyed by *on-line mailing lists and bulletin boards* plays a crucial role in the process. The opinions on misuse or infringement of the GPL are discussed publicly, and stored into the messages sent on the internet. Another quote from O'Mahony (2003) shows how the periphery can have a crucial role in this:

> *"Reports of source code violations often come from customers of [copyright infringing] vendors who post to a community list or report the infraction to the copyright holder. 'We had three people writing to us saying, "My company bought this product from them, because we need this […] tool for the work we were doing, and we discovered that it looks like it is based on [your software], and darn it they didn't give us the source code (Informant, Non-Profit Foundation)'"* (O'Mahony, 2003: p. 1187).

Monitoring and spreading information on copyright infringement –as well as any other behavior not respecting the rules of the community- it is an activity that the periphery is in the position of doing effectively. The large number of heterogeneous individuals composing the periphery and the modular, easy and low-cost task of monitoring the others' behaviors and post a message when an infringement is found are properties that map those of bug identification and reporting. Fallacies in others' code or behavior can be easily spot by a community of observers by one or even more orders of magnitude larger than that of the few protagonists of the development process.

Moreover, as it is the case for technical solutions, also in this case extemporaneous stimuli relative

to the social environment and culture of the community can once again come from the periphery. Elliott and Scacchi (2003) report a case in which a discussion on the basic values the FOSS community (namely, the lack of freedom attached to the use of non-FOSS code) is triggered precisely by an outsider. I will report this case more precisely later in the text, but by now the message I would like to emphasize is that the periphery is crucial for social control, rules compliance and construction of the ethos at the foundation of the work of the community.

Summarizing, the periphery has a crucial role in the FOSS model of innovation because:

A. it constitutes the pool from which the core draws the resources it needs to function. The progression from the periphery to the core of some developers is what assures the continual provision of new skills, energies and ideas to the core.

B. it undertakes a series of technical tasks (bugs reports and extemporaneous solutions) that can help the core to improve and develop the code, enhancing its productivity.

C. it constitutes the main devices through which social control (in form of monitoring or questioning members' rule compliance) is undertaken.

These functions are specific to the periphery as they derive directly from the properties described above, and in particular from the unbalanced ratio between the quantity and the quality of peripheral members' participation. The periphery itself constitutes a fundamental –and peculiar- part of the FOSS model, and its role should be assessed more in dept.

1.4   The importance of a shared vision between the core and the periphery: From practices to imagination and alignment

The relationship between the core and the periphery in the FOSS world needs to be described by a conceptual model that accounts for the functions described above. In the following I will try to perform such an exercise using as a starting point the concept of Community of Practice (Wenger, 1998a, 1998b). This framework will be expanded in certain directions (e.g. using the concepts of imagination and alignment) and just sketched in other directions (e.g. the centripetal process described as "legitimate peripheral participation", Lave and Wenger, 1991). This because I will try to focus on those processes that I believe are less explored and nevertheless crucial to our understanding of the FOSS model of innovation[5].

In Wenger (1998a, 1998b) idea of *Community of Practices* the nexus of ties that constitutes a community is a twofold space. On the one hand the common space is populated by the everyday life of the community, where artifacts are produced, tasks are performed and interaction among members takes place. On the other hand in the same space -and together with the first activities- individuals construct their 'representations of the world'. This last term reflects the semantics, the system of meanings, through which reality is organized and filtered to be intelligible. The community carries on a continuous collective *negotiation of meanings*, in which each member of a community relates to the others in order to define, make sense of and evaluate (i.e. give a meaning to) the system of facts they share.

Wenger (1998a) notices that this process takes place in three basic dimensions, each one interrelated to the others. The first dimension, the one that is most developed in the literature and especially in the FOSS-related studies, refers to *practices*. Practices are the "flesh and bones" of a community as they develop along the many channels of the community members' interaction. Performing a common task together or simply interacting to solve a problem are all examples of practices. The negotiation of meanings that this interaction induces *per se* is the center of the process through which communities of practices evolve.

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[5]. To see how the literature on FOSS has analyzed the community using the concept of community of practice or of epistemic community I redirect the reader to Lin (2003a, 2003b, 2004a, 2004), Edwards (2001) and Cohendet et al. (2001).

However this experience of the world realized through practices, and that Wenger calls *engagement*, is not the only process that shapes individuals' identities. When individuals relate to a discourse defining the broader context of their actions and of their identity, for example with respect to religion, law or science, this also results in a negotiation of meaning. A discourse places the individual in a specific social and productive context and re-transmits her a specific vision of herself and of the meaning of the actions she is undertaking. The individual identity is then the result of the continuous re-negotiation of the meanings defining the individual's experience in that context through a process similar to that described above for the practices. Wenger calls this process *imagination*.

The third dimension he introduces, *alignment*, deals with a negotiation taking place at the level of the individual's compliance with rules. Both practices, imagination and alignment are channels through which individuals negotiate the meanings of their experience of the reality, but alignment describes specifically a situation in which the individual's identity is affected by the "power structure" of the context she is placed in. Feeling the need to comply with a rule, or to apply a specific procedure, or to think about a problem in a certain manner, are all behaviors that act on her vision of the world, and ultimately on the meanings she gives to those experiences and actions. Political participation is the perfect example of this process.

The last two processes, as said, have not been analyzed in the literature as much as practices. However, my claim is that when dealing with the FOSS model of innovation, and especially when focusing on its peripheral participants, they deserve more attention.

In the FOSS world communication is almost always mediated by computers, a-synchronous and often stored into publicly accessible virtual spaces. This means that everybody else, also those peripheral members who do not participate in the debate, has a wide and easy access to all the details of the discussions taking place in the community. Stories, representation of the developed products and experiences can spread in the community very quickly. Debate, confrontation, negotiation of meanings do not happen only through direct engagement, through direct dialog. Instead, the *indirect debate* constituted by all members' discussions, stored and publicly accessible through the internet, becomes crucial to create the peripheral individual's vision of the community and of the software produced by the collective. The representation the individual has of the productive context she is part of, of the discourse she is immersed in, changes in response to what she can read through this indirect debate. The individual's experience of the discourse stored in electronic communications triggers an individual reflective movement (Hemetsberger and Reinhardt, 2006) that acts on the subject's perception of the community, of the software and of the self. This movement has the same nature of the negotiation of meanings at work at the level of practices. The different is simply the context: the discourse conveyed by the indirect debate in the former case, the direct interaction in the latter.

While imagination allows us to account for the indirect debate, a crucial feature of the FOSS world, alignment opens the possibility to discuss more in dept the mechanisms through which the FOSS community enlarges and transmits to the periphery the set of rules, procedures and visions elaborated in these discussions by the core. Alignment takes place when the peripheral individuals' exposition to the social values, the production procedures and informal and formal rules conveyed by the indirect debate act on their identities not only changing their vision of the self and of world, but also changing the meaning of their actions, the relative importance of each specific rules or procedure, and eventually their behavior.

The last passage is crucial, as it embodies one crucial condition for the community to be productive. As Crowston et al. (2005) show, the core produces, maintains and continually redefines a certain number of structures, i.e. "the rules and resources that influence, guide or justify individual action", p. 10. In other words, the core continually develops a set of social rules as well as technical procedures aimed at guiding the social and technical processes constituting the activity of the

community. If the core fails to propagate to the periphery these structures, none of the functions seen above can develop as much as we observe today. For example without a spread understating of the community social rules, i.e. of the 'structures of legitimation', there will be no detection of infringements simply because the rules to be enforced will not be felt as fundamental by the periphery. The technical contributions of the periphery will be reduced to the simple bug-spotting mechanism, which can still be effective as it relies on the very structure of the periphery, but that will capture only a smaller part of the potential this region of the community can express. Without a spread vision of the product and of the production procedures (i.e. 'structures of signification'[6]) extemporaneous solutions and micro-distributed processes of innovation (Lakhani and von Hippel, 2008) will be far less likely and difficult to combine into a coherent productive effort. Along the same line, without a spread understanding of the formal and especially informal organization of the community, its roles and the distribution of the control on different resource (i.e. 'structures of domination'), 'legitimate peripheral participation' (Lave and Wenger, 1991) attracting peripheral individuals into the core will become a long apprenticeship process, where barriers to entry are higher and the likelihood of dropouts increases. In other words, both socially as well as technically, there will be no way to contain decisions, contributions and behaviors pointing towards different directions simply because the periphery will not see any main direction to follow.

2   A conceptual model of the relationship between the core and the periphery

2.1   The background: Reflexive Identity

In order to see how the process described in the previous section works, a step back is needed. The center of Wenger's idea of community is the concept of identity. In sociology, this concept has received a lot of attention. Individual identity is nowadays conceived of as a dynamic object, constantly revised by the subjects to cope with the emerging contradictions and novelties induced by her interaction with the environment. In this vision the interaction between the social context and the subject is "stored" in individual biographies which provide the material the subject reorganizes and re-structures in order to shape her continually changing identity (Giddens, 1991). Also economists assigned an increasing attention to this category. As Akerlof and Cranton (2001), for example, state: "[…] a source of motivation is missing from current economic models of organizations. [We] characterize this missing source as identity. By identity we mean a person's self image — as an individual and as part of a group. The rituals […] and other organizational features can change the way people see themselves; they become part of the organization and internalize its rules. In […] organizations, such identification - or lack of it - plays a critical role in determination of work effort, incentive schemes, and organizational design", Akerlof and Kranton (2005), p. 1.

As this brief description of the approached to the concept makes clear, identity can be thought of as the result of two main "reflexive moments". On the one hand, each subject is recognized as part of a social context which in turn is shaped by and shapes her identity. The term 'reflexive' here represents the cyclical dynamics typical of complex processes where single units determine the emergent properties of the whole system and in turn are shaped by these properties. On the other hand, reflexivity refers also to the psychological process undertaken by the subjects when they search -both consciously and unconsciously- their new identity. Individuals construct their new self-identities by means of their active reflection on their biographies.

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[6] The mechanism described by Cowston et al. (2005) is based on the idea that individuals' mental models have to be shared in order for them to agree on the interpretation of their activity and of their cooperation. This idea is close to the concept of *cognitive distance* reported by Muller (2004). When cognitive distance is low, i.e. cognitive models of agents are close one another, knowledge transfer became easier as well as sharing of common interests and incentives. The effects are consistent with those reported here.

The first idea of reflexivity, the study of the co-evolution between the individual and the social dimensions, has been central to many studies in the literature. Bowles (1998) shows that different allocation rules (being them "capitalistic", "communist" "patriarchal" or "corporatist") "[Affect] who meets whom, on what terms, to perform which tasks, and with what expectation of rewards […]. These allocation rules therefore influence the process of human development, affecting personality, habits, tastes, identities", (Bowles, 1998: 76). A sharp empirical evidence of this is offered by Henrich *et al.* (2001), who performed a set of experiments, as the Ultimatum Game and the Public Goods Game, among individuals of 15 small-scale societies in Asia, Africa and South America. In the regressions aimed at explaining the observed agents' behavior, individual variables (such as sex, wealth, ...) have been found to have a marginal role, while a great forecasting capability has been found in the social variables (features of the social structure of each ethnic group and/or village the individuals came from). A further ethnographic analysis of these communities enabled the authors to explain this outcome. Institutions shaping the interaction of individuals in their everyday life were mapped into the experiments, determining subjects' behaviors much more than what their individual characteristics could do. This means that the institutions shaping agents' interaction in each group are fundamental in determining the behavior of their members. As a last step, since the creation of institutions and norms is an emerging property of the interaction among agents, the "reflexivity circle" can be closed around the co-evolution of collective institutions and individual behavior (Coriat, Dosi, 1998).

On the side of the individual's reflection on their biographies, Lindgren and Wåhlin (2001) develop the concept of *reflexive identity* construction. "The word 'reflexive' is linked to our capacity to reflect and think about ourselves in relation to otherness in a particular context. […] Men and women are not just mirrors of environmental conditions but also possess their own opinions that in some sense are distinctive. […] The phrase 'identity construction' can be said to draw attention to the self-preservation instincts of the particular individual concerned." (Wåhlin, 2003: 12)[7]. Individuals, and especially those who move across the boundaries of different social and organizational contexts, feel continually the necessity to cope with the contradictions novel situations open in their current identity. In their empirical analysis, the authors show that individuals reflect upon the "breaks" in their biographies in search for the answers to questions like "Who am I?" and "Where am I going?", so that "Reflexivity is used by individuals in the process of getting to know themselves better." (Lindgren and Wåhlin, 2001: 362). The authors notice that "In these situations people tend to turn inward in search of deeper values and/or theoretical grounds for their pathfinding. [...Moreover...] In our empirical study we observed that our respondents gave voice to something beyond self-fulfillment and instrumentalism. [...] Elements of this more profound identity, beyond institutionalised identities, are constructed in a reflexive manner." (Lindgren and Wåhlin, 2001: 370). Thus, reflection affects not only the superficial layer of the identity, but acts also at a deeper level. In other words, reflexive identity construction shows that reflexivity is a "powerful" tool to redefine individuals' identity: it can reach and act upon the regions of the subject's identity where the drivers of individual behaviors are rooted, where her system of values and aims belongs.

In the present paper, the second approach is developed into a mechanism aimed at explaining how and when peripheral members of the FOSS community absorb the *structures* (Crowston et al., 2005) adopted by the community core. The process relates also the first conception of reflexivity inasmuch as it tries to move to the aggregate level the previous individual perspective. The

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[7] In an older work, Wåhlin and Lindgren state: "By using the word 'reflexive' we draw attention to the fact that people reflect upon life in different critical situations, and also that their reflexivity is revealed when they articulate their narratives in interaction with others (for example, ourselves as researchers). This reflexive identity can also be described as a bridge between the theoretical concept of 'self-identity' and the concept of 'social identity' which again emphasises the continual re-definitions associated with identity construction." (Lindgren and Wåhlin, 2001; p. 361).

consequences of peripheral members' reflexive movements on the overall relationship between the core and the periphery of the FOSS community will be discussed and the possible different outcomes analyzed.

2.2   A wider conceptualization of "negotiation of meanings"

Moving from this background, the first step towards a definition of the process described in the previous section works needs to be taken with respect to Wenger's (1998a, b) conceptualization of communities. In the author's opinion, social structures are based on the continuous co-evolution of the individuals' identities and of the context the individuals themselves are immersed in. This process is at work at several levels. If the interaction between members of a group is considered the reference context, for example, this process can be described as the continuous co-evolution of the group members' visions of the world and of their common enterprise. The group members' idiosyncratic experiences of the common enterprise will be based on a negotiate of meanings mediating the other members' practices and representation of the world. The meaning each individual will finally give to her experience is interwoven with others' experiences and representations, and actually it is created in through the shared enterprise and the social interaction themselves. This process then acts on all the individuals taking part in the negotiation, on their representations of the world and ultimately on their identities in a reflective manner (Lindgren and Wåhlin, 2001). The whole process can then be conceived of as a link connecting the individual and the social levels through a precise mechanism: the *negotiation of meanings*.

Several authors from a wide range of different disciplines have described the interlink between collective-level structure and the individual vision of the self and of the world in a similar fashion. For example, Golden-Biddle and Rao (1997: 594), for example, describe this coevolving dynamics in the field of nonprofit organizations: "Organizational identity -the shared beliefs of members about the central, enduring and distinctive characteristics of the organization- constitutes part of the shared meanings held by members. In a social construction perspective, identity becomes an important collectively-held frame invoked to make sense of their world […]. Identity influences not only how members define themselves, but also their interpretation of issues and roles, responses to problems, and feelings about outcomes". Consistently, Tuomi (2001) states the fundamental role of communities in determining individuals' identities: "[A] community […] does not emerge from putting together a sufficient number of individuals. On the contrary, individuals became persons with individual identities through their membership in the various communities they are members of. Identity […] is grounded on communities, with their specific systems of activity and collective meaning processing." Similarly, Lin (2003b) describes the dynamic negotiation of meanings and its effects on identities in the specific FOSS environment as follows: "Social worlds and identity are interactively constructed, and perspectives and aspirations emerge dynamically from this interaction. Since meanings are both culturally created and mediated, all interpretations or perspectives are based in communities or social worlds"[8].

The mechanism of negotiation of meanings has been described above in precise setting: *engagement*. Consider how Shah (2006) describes the evolution in developers' motivations: "[...] a need for software-related improvements drives initial participation. The majority of participants leave the community once their needs are met, however, a small subset remains involved. For this set of developers, motives evolve over time and participation becomes a hobby." (p. 1000). Among possible explanations for this process, the author identifies also the hypothesis that the "interaction with the community leads to a shift in the individual's identity and self-perception." (p. 1011). This is the perspective taken by Bagozzi and Dholakia (2006), who write: "Initial participation by novice users is driven by specific task-oriented goals [...]. But over time, as the user comes to form deeper relationships with other [community of FOSS users] members, the community metamorphosizes

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[8] To further investigate how this process could work in practice in a virtual environment see Rheingold (2000), Levy (1984) and Preece (2000).

into a friendship group and a social entity with which one identifies." (p. 1111). What is at the basis of negotiation of meanings is the close interaction between the individuals who engage in a common experience.

However the process of negotiation of meanings as described above is much wider than that. As Wenger states (1998a: p. 173) "I talked about identity in terms of belonging to communities of practice. But to make sense of the formation of identity in a context such as the institutional non-participation […] it is necessary to consider modes of belonging other than engagement." This means that other modes of belonging should be considered when dealing with "sparse" social contexts, where "institutional non-participation" can be the most important modality of participation. Thus, when dealing with FOSS, an excessive focus on practices risks to overlook the crucial role of other forms of belonging and the *negotiation of meanings* at work also a those levels (Wenger, 1998a)

In the context of FOSS, Muller (2004) is one of the very few authors accounting not only for *engagement* but also for the other modes of belonging described by Wenger (1998a), *imagination* and *alignment*. However, he develops these constructs on a more general level, as the conceptual model he derives can be easily applied to communities as such (Muller 2003). The specificities of the FOSS world, where the periphery has the different functions and the peculiar characteristics described above, and CMC is the main media of exchanges between developers, do not receive much attention. However, CMC becomes crucial when focusing on the periphery. This because, as said, when dealing with FOSS, the discussion stored in mailing lists, forums and even in between the lines of the distributed code, and publicly accessible to all the members of the community, represent the whole discourse an individual orbiting around the FOSS world faces. It is true, as Kloos (2006) shows with respect to blogs, wikis and social bookmarking, that CMC of this kind can sustain the micro processes behind *each one* of the modes of belonging. His empirical description of the "nuts and bolts" of engagement, imagination and alignment in a virtual environment shows that virtual spaces and social software are in fact able to reproduce all those typologies of social constructs. However when dealing with peripheral members and trying to single out the drivers of their actions, it becomes necessary to recognize that the meanings they are able to give to their experiences related to FOSS are based mainly on the indirect discourse described above, and are built drawing "material" from it. Thus, as far as peripheral individuals are concerned, the modes of belonging that should be given the highest importance are those taking into account precisely this "distance" between the actor and the discourse, and at the same time the incredibly detailed representation of the discourse itself offered by the repositories mentioned above.

2.3   Peripheral individuals' opinions and the role of the indirect debate: imagination

When dealing with imagination the construction of the new meanings and of the new identity follows a peculiar route. In particular, as said, the vision I will employ here tries to adapt Wenger's conceptualization of imagination to the specific context of the FOSS community adopting the view point of the periphery. In this case, in fact, the discourses relative to the FOSS are conveyed through the *indirect debate* peripheral members are exposed to. By and large, every individual belonging to the community can always access the very core of a conversation that some time ago other individuals had about a specific topic. Public conversations are written and stored, and very often further discussion refers to previous posts. Hemetsberger and Reinhardt (2006) give a vivid description of the lively debate FOSS developers and participants are able to produce:

> *"Through speech acts such as explaining, evaluating, rejecting, correcting, insisting on an opinion or defending it, programmers engage in processes of collective reflection that potentially result in new knowledge-building. When the community engages in a process of conceptualization, first ideas and future goals are presented and comments are requested. After such initial*

messages, lively interactive conversation occurs, with comments supporting and further elaborating on the idea. Community members also present different perspectives towards the problem, or point out flaws or even errors in the presentation. These feedbacks and comments are again commented on, and initiate collective reflection processes. Thus the conversation revolves around the construction of the problem itself" (p. 203)

In searching information on a particular topic related to the FOSS world it is common to enter directly these conversations going through the threads of messages archived in forums or mailing lists. The following quote again from the study by Hemetsberger and Reinhardt (2006) makes this process clear:

"Our findings show that newcomers engage in exploring those archives in search of answers to their technical problems. They find the discussions in chronological order, which helps them to re-experience the lines of thoughts of the discussants. Quite often it is not the content of the discourse but the lines of arguments that provide the most valuable insights for learners." (p. 208)

The fact that "stored conversation" are the basic material upon which the discourse on FOSS is realized gives the chance to put forward a more precise definition of the process that related this discourse to peripheral individuals' identities, i.e. of imagination. In debates and conversations, the participates' system of meanings and values "emerge to the surface" when community members are pushed to express an opinion on the discussed topic. In the FOSS case, an example of this "emersion" process is given by the case analyzed by Elliott and Scacchi (2003). The authors report a debate between conflicting views on the use of tools that are not Free Software. Two quotes from that debate can give the reader a clearer idea of the capability of the online conversation to capture the emotional level of the discussion and the difference in the systems of values of the discussants:

<CyrilB> neilt: you are compromising our freedom by using non-free software: we can't modify and/or redistribute the source vector file.

[…]

<neilt> otoh i see no reason to avoid non-free software either if this is really a freedom thing then we should be free to use whatever we want in which every participant tries expresses her or his opinions and elaborates on them to convince the other to act in a certain way.". (p. 26)

Exposed to such a conversation, observers can feel the challenge to form their own idea on the basis of their own preferences and on the other "material" conveyed to them by the indirect debate.

Consider again the case described in the previous quotes from Shah (2006) and Bagozzi and Dholakia (2006) of the FOSS user who initially orbits around the community just to fulfill a specific need of hers. Facing the community environment in order to find out the code, the information and the solutions she needs, forces the user to observe how other members interact. Cruising the community environment, she is exposed to the indirect debated surrounding her, i.e. to a set of visions of the world or of the product, opinions and arguments. In other words, to the *structures* (Crowston et al., 2005) of the community. Some of these structures will be close to her current visions and ideas, but some others will not. Being a peripheral member, she will probably face with higher likelihood than other members debated on topics she did not consider before, she was not aware or had just an abstract idea of. Being exposed to such debates, she will suddenly find herself in the need of answering questions and acquiring positions about topics she never thought of. In other words, the structures behind the positions conveyed by the indirect debate start to interact with her systems of meanings and principles. At this stage, the observer can experience a contradiction between these two sets of rules and visions. The meanings she attaches to this

contradictory experience can thus trigger a change in her identity and in the representation the individual made of the reality. In other words, it can trigger a *negotiation of meaning*.

The discussion Linus Torvalds and Andy Tanenbaum had on the embryo of Linux, one of the fundamental parts of the GNU/Linux operating system that has become the most diffused FOSS operating system for desktop, can be a good example of such indirect debate[9]. That discussion took place publicly and was participated by different people. But its importance went well beyond the circle of interacting developers. Today it is has become a fundamental piece of the FOSS history. That debate *indirectly* affected the vision of FOSS and of the community of thousands individuals precisely through *imagination*, through their indirect experience of the FOSS discourse.

Another example can be retrieved from Kloos' (2006) empirical work on weblogs, wikis and social bookmarking. The author has interviewed students using a weblog to make sense of the main contents of a course they were following. Kloos uses quotes such as:

*"Yes, I have been able to form a clearer picture of the course. The blog has helped me in creating this picture." (*Kloos, 2006, *p. 97)*

to argue that online communication has the capability to sustain imagination in the Wengerian sense as it contributes to the formation of an image of the social subject the individual is facing. Another quote from the same source can make clear that this picture can be challenged precisely through the discovery of unexpected opinions, as described above:

*"There were many posts that were not directly related to the course. A form of mind expanding, yes. New things that were posted on the blog could shed new light on subjects, introducing connections you might not have been aware of before." (*Kloos, 2006, *p. 103)*

Notice that, as I will discuss in a further section, the urge to take a position under the stimulus of the indirect debate is not a general processes valid for all possible circumstances. The connection between exposure to the indirect debate, negotiation of meanings through imagination and acquisition of a specific position is realized only under certain conditions, that I shall specify later (section 3). In what follows I will try to keep the focus on the red thread that moves from imagination and arrives to alignment in the assumption that imagination is actually effective in triggering a negotiation of meanings between the structures of the community and the peripheral individuals' established set of meanings.

2.4   Dissonance and the rules internalization: alignment

To understand how the process described above develops and to what conclusion it leads to it is useful to recall the concept of *dissonance*. Dissonance can take different forms, as -for example- 'moral' or 'expressive' dissonance (Kuran, 1998). In general, it represents the mismatching between the individual's identity components, being they behaviors, preferences, moral values, opinions or traits. As Kirman and Teschl (2006) argue building on a series of different theories (e.g. Akerlof and Kranton, 2000; Higgins, 1987; Livet, 2004, 2006) dissonance results in a "psychological wellbeing loss". In other words, it can be defined as the *cost of incoherence*. To place this in the context of FOSS it is useful to briefly describe the case of Spip, an OSS project oriented to the production of internet publishing software (Demazière *et al.*, 2007). The project's core members have a strong political vision that is well expressed by the following quote from the project's charter:

"*[…T]he participation to the Spip-zone must take place within the framework of the goals and values promoted by the initial Minirézo project, and notably to promote and defend freedom of speech for all on the Internet, to remain defiant towards financial interests, and to respect the identity of each and everyone. […] This site is not a development platform for military or business-*

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[9] See http://www.oreilly.com/catalog/opensources/book/appa.html.

oriented versions of Spip, which would change its nature. It is neither designed to be used as a communication or advertising media for consultants" (Demazière *et al*., 2007, p. 14).

This view, however, is in contrast with the fact that individuals related to Spip on the basis of their profession and business are an important component of the users and peripheral contributors of the project (Demazière *et al*., 2007). This clash of views generates in that typology of peripheral members precisely the dissonance discussed above:

*"I am in love with the Spip community [...b]ut I'm an outsider in the community because I've not yet been able to find the right words to explain that while I'm 100% for the participation in this project, I still need to earn a living" (Armand)." (*Demazière *et al*., 2007, p. 15*)*

As emerges from the previous quote, peripheral members with a background different from that of the community seem to actively search for a way to compose their identity with the basic values expressed by the community core. This because in general individuals experiencing dissonance try to reduce it changing the different elements of their identities to re-establish coherency (Kirman and Teschl, 2006). In a social context, alignment becomes then crucial as new element that enter the stage. After that imagination has triggered a process of negotiation of meanings that makes the peripheral individual acquire a position in the indirect debate she witnesses, alignment forces her to relate this position to the set of procedures and rules she gave for granted. If no dissonance is experience, the individual's set of values and principles was already endowed with the necessary structure to sustain the new position, and the updating of the set happens without frictions. However, in the case of a peripheral member, she is likely to face debates on a topics she is not very informed on. In this cases, it will be also likely that the position she decides to adhere with after having witnessed the discussion is not completely coherent with her established principles. The incoherence between the established behavioral rules and the new ones introduced through imagination will then lead to a certain level of dissonance. Kuran (1998) argues that one way of reducing dissonance is to align private preferences (what the individual *does* believe) to public preferences (what the individual *shows* to believe). In the present context this *internalization* process can be described as a change in one's personal values (and eventually possible actions) to conform to those attached to the position the she has chosen in among those presented in the indirect debate. The result of this move is the experience of rule compliance, even what it is not turned into action (as it is often the case for peripheral members) but remains in the background as a procedure to be applied when needed. Through this experience the peripheral members absorbs into her system of values the structures, i.e. the social rules and the technical procedures, shared by the core of the community.

Of course this is just one possible outcome of the process. Dissonance can be reduced entering the debate and questioning the community principles (Kuran, 1998) or simply moving away from the community. The process labeled as "alignment" is realized also through the experiences of rebellion, non-compliance and eventually abandonment, and defines identities also in terms of diversity, distance and ultimately exclusion. As said before for the case of imagination, I am here focusing on a path that can be realized only under certain conditions. I will discuss the action the individuals can take to adapt the social structure to their believes in sections 3. In what follows I will try to describe the consequences of the process described above in more detail.

As said, I assume here that peripheral individuals adhere to opinions and positions held by one side of *querelle* that involves different parties in the indirect debate. Each party carries a specific set of values and ideas. Muller (2004) presents a simulation model in which core members are endowed with different behaviors and different levels of participation. During the interaction they aggregate around different behavioral rules. The final outcome varies from complete convergence to convergence in groups that are not able to reconcile their views.

In the present framework another step is added, as the concept of *structure* (community rules and procedures) is detached form that of *opinion*. In this context, in fact, from the view point of rules

internalization, the specific position in the indirect debate chosen by the peripheral individual is to a certain extent irrelevant. Every side of a possible discussion the individual is facing, in fact, usually embodies a certain trait of the community, and thus a common set of structures. This is the consequence of the simple fact that those groups are subgroups of the larger core of the community. In order for them to recognize each other as a legitimate member of the community, they need to find a common ground they can use to mediate the difference (Muller, 2004). If this is the case, whatever side the individual chooses to join, she will commit to a position embodying not only the idiosyncratic visions and ideas of the chosen subgroup, but also the structures common to both subgroups. This means that the process of structures internalization does not necessary lead to a *common* vision of the world: Individual *a* and *b* can have different opinions and principles before and after the process. What it means is that the very core of the community structures, the common ground on which the subgroups stand, is internalized by the individuals, and so are the rules it entails.

The *querelle* between Free Software advocates (mainly gathered around the Free Software Foundation, FSF) and the Open Source Software proponents (represented by the Open Source Initiative, OSI) can be a good case to describe this process at work. Dahlander (2007) gives a precise description of the debate: "The FSF rests upon an ideology that strongly urges that information should be free […]. FSF and OSI are united that the source code must be available, but disagree about many underlying beliefs. OSI felt that it opened the possibility for firms to commercialize and make money out of FOSS. […] Pragmatic supporters of free software have been more willing to accommodate firms. Pragmatic arguments relate to the benefits of open code compared to closed code […] rather than ideological motives that software ought to be free." (2007, p. 14-15). This debate concerns the very structure of the community, and it is considered fundamental by community members. In the FLOSS-EU survey (Ghosh *et al*., 2002) 48% states "I think of myself as a part of the Free Software community", 32.6% says "I think of myself as a part of the Open Source community" and only 19.4% of the sample do not care. The FLOSS-US survey (David *et al*., 2003) presents similar numbers: "I identify more with the Free Software community" has been marked by 31.4% of the responders, while 31.5% marked "I identify more with the Open Source Software community"[10].

The debate around this topic is then a crucial arena where different visions of the community and of the whole FOSS movement meet, contaminate and confront one another. Yet, it is not likely that members at the periphery have thoroughly thought about this argument. As the analysis of the developers' motivations dynamics has shown (Shah, 2006; Rullani, 2006; Glott, 2004; Glott et al., 2004), most of the peripheral members are basically users of the code, much less sensitive than core members to the ideological features of the FOSS movement. It is then not very likely that the peripheral member is fully aware of such a distinction before facing the indirect debate, where instead she will experience the expositions to messages relative to this unknown topic. She is likely to face conversation of the same "heat" as that one showed above, and thus pushed to form her own opinion. The debate on this issue and the comparison she makes to members' positions, thus, strongly affects the peripheral individual's vision of the problem, to the point that the position she decides to support starts to interact with her established ideas on freedom, software production, and all the other related discourses composing her set of established opinions. If dissonance emerges at this point, in certain conditions -that I will discuss later- she will be pushed to align her established opinions to the idea of freedom conveyed by the position she adheres to. This in turn will connect the feeling of rule compliance (in potentiality –as it is usually the case for peripheral members- as well as in actuality) to the norms she finds "attached" to the position she committed to. Alignment will redefine her identity according to this new "mixture" of rules.

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[10] To further explore the terms of the debate, see Giuri *et al.* (2002), Stallman (1998), Weber (2004) and the web site of the *Open Source Initiative* (www.opensource.org/) and of the *Free Software Foundation* (http://www.fsf.org)

In the example, as both the 'free' and the 'open' field, even if structurally different, share the belief that software has to be produced in a cooperative manner and redistributed following the principles of FOSS licenses (Dahlander, 2007), the community structure the peripheral member internalizes is precisely this common feature. Whatever is the position she decides to adopt, her identity will be reshaped according to the common principle shared by the two positions.

This line of argumentation leads directly to the conclusion that, under certain conditions, when a peripheral individual takes a position, she is pushed to change her identity consistently, redefining her principles around this new ethical structure. This means that periphery absorbs the principles adopted by the core of the community, and thus to its social rules and technical procedures.

3   What can go wrong

As announced before, the terms used in the previous section should have the flavor of the possibility. The reflexive process seen above is not affecting each and every peripheral individual, but as said only a subset of them. The two bifurcations of my argument I left behind in the previous discussion where relative to the possibility that 1) peripheral individuals do not react to the indirect debate and simply not consider it as a social context to engage with 2) even if they do, dissonance can lead to outcomes different form community structures internalization. I shall now discuss the two cases more in dept.

3.1   A first limit: some more dissipation

The possibility that the exposition to the indirect debate will be powerful enough to trigger a negotiation of meaning in a peripheral member's experience of the FOSS community is directly connected to her "sensitivity" both to the topics stored in the online discussions and to the media used for interaction, i.e. computers. If the individual's vision of the world has no connection to the topic discussed in the community or is not open to anything different than, for example, finding a specific information she needs to use the software, it is very unlikely that the dynamics described above can be realized. The role of interest in the common enterprise –at least in potential and in abstract terms- is an essential components of every community of practices (Wenger, 1998a). At the same time, if the individual is interested, the possibility for the negotiation of meanings to happen is positively associated to the degree of "sensitivity" the individual has with respect to CMC. If the individual is not familiar to this typology of communication or if she is not able to project the text on the forums and in the code into a representation of the social environment that produced them, again the process described above is very unlikely to happen.

However, this is does not mean that what has been said until now is the description of a marginal event. The process I described is a 'immanent' process. As the sociological and philosophical literature show, the processes upon which the different form of reflexivity are based are *innate*, and in this sense 'necessary' (Wenger, 1998a; Habermas, 1968, 1981; see also Fougère, 2004; for an account of this with respect to Bakhtin's theory). This means that they are present in every individual, even if their importance can differ across different environments. Reflexivity becomes effective only in those contexts where the exposition to others is actually able to trigger these processes. The FOSS community is just one possible social space, and it could be not so relevant for a certain typology of individuals. For example, the FOSS production is undertaken mostly through the internet. Anthropological studies relative to CMC (e.g. Carbone and Ferri, 1999) have shown that it cannot be considered as something "less" than face-to-face communication. It is a different way of communicating, but still able to convey strong feelings and emotions (Rheingold, 2000). However, each individual reacts differently to CMC. This results in a different perception of the quality and quantity of interaction, i.e. a different perception of the "thickness" of the relationship. If an individual is not reactive to CMC, her participation –and especially her peripheral participation- in the FOSS community is unlikely to be able to trigger reflexivity processes. On the

contrary, more reactive individuals will be involved enough in the social environment of the community to trigger those processes.

In other words, the process described above can be strong enough to affect a substantial number of individuals, but at the same time add another dimension to the dissipative property of FOSS model of innovation: In order for active developers to emerge, the community must have mobilized and "burnt" an even larger amount of resources (i.e. individuals) to be able to activate just a much smaller amount of them (i.e. those "sensitive" to the topics discussed and to CMC).

3.2   A second set of limits: atomization, invisibility and instability

3.2.1   The individual level

Let the individuals experiencing structures internalization (A) be labeled as type-A individuals. Even in the case of an individual "sensitive" to the indirect debate, the possible mismatch between the peripheral member's identity and the discourse can lead to an outcome different form A. If the gap is too wide, in fact, the tension create by dissonance can be ineffective in pushing the homogenization of the core's structures with the peripheral individual's identity. As said, alignment does not affect individuals' identities only making them converge towards the public rule. It can act in terms of differentiation and distance from the public environment.

To understand what can happen in this case, it is useful to recall what is the process at work in the general case, beyond the distinction between periphery and core. Kuran (1998) argues that there two main mechanisms through which expressive dissonance can be reduced: internalization and revolt. The first one has been described in the previous section, while the second can be defined as exposition of "knowledge and feelings that had tended to be concealed" (p. 152). In this latter case, the individual can decrease her dissonance entering the debate and exposing her opinion. In the FLOSS context, a third mechanism for dissonance reduction is also possible. While Kuran analysis is applied to nations and states, whose membership, together with its rights and obligations, is acquired at the moment of one's birth and difficult to cancel, in the present context the focus is on a community whose membership is easily manageable. Thus, a member can decrease her dissonance simply leaving the community[11].

Concluding, when peripheral members experience a high level of dissonance, the probability that they move along an outward trajectory (Wenger, 1998a) and exit from the community increases. Let us label this event as C_{out}. The other outcome that acquires higher probability is the individual entering an inward trajectory (Wenger, 1998a), triggering or accelerating possible legitimate peripheral participation processes she could be involved in (Lave and Wenger, 1991). In this case, labeled as C_{in}, those who experience dissonance through the *indirect* debate engage in the *direct* debate questioning the established discourse, which now becomes the center of a new, deeper, debate. Elliott and Scacchi's (2003) example represents precisely one of these cases.

The set of possible behaviors is however not limited to dissonance reduction mechanisms such as internalization, revolt and leaving. Another case, called B, is possible. The level of dissonance may be high enough to prevent structures internalization, but not high enough to result in active reactions such as A or C. In this case, Kuran's (1989, 1995) conceptualization can help in understanding what could be the outcome of such process. In his framework, the situation depicted above brings about an unsolved mismatch between the individual's private and public preferences, and this generates the accumulation of the resulting dissonance. The mismatch between her identity

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[11] Notice that the three outcomes recall the framework adopted by Muller (2004), i.e. Hirschman's concepts of loyalty, voice and exit. In Mueller's study a developer's disagreement with the cognitive model adopted by the other community members results either in her exiting the community, voicing her complaint, or changing her behavior on the push of loyalty towards the community. The same reasoning can be move from the level of cognitive models to that of dissonance, and from developers to peripheral members.

components is simply left aside and not expressed in her behavior (that conform to the publicly expressed preferences, both in potential and in act), but the cost of incoherence is not diminished. This means that, in our case, the peripheral individual does not significantly change her behavior, but accumulate dissonance probably following an orbiting trajectory around the community (Wenger, 1998a).

As is it is easy to imagine, this situation cannot last for long. Other episodes will make the accumulated dissonance emerge again. Some other may even increase it, expanding the discrepancy between the individual's established values and the structures the debate conveys. As Kuran (1989) argues, above a certain threshold a relatively insignificant event can make individuals move to a type-*C* behavior. The peculiarity of the trigger event is that is can be of relatively minimal entity and still be effective, as its power comes from the individuals' *accumulated* dissonance. As the author further explains, an example of this event is the exposition of the pervasiveness of the accumulated dissonance. In this case, few individuals questioning the apparent agreement pervading the public opinion can show to "inactive" individuals experiencing accumulated dissonance that disagreement is more widespread than expected. This can push an individual with a very high level of accumulated dissonance to manifest her disagreement or to leave the community. In other words, it can lead a type-*B* individual to become type-*C*.

3.2.2   *The aggregate level and some general properties*

As a last step along the path of understanding how the periphery works and how it relates to the core, an analysis of the possible aggregate properties of these two collectives is presented. On the basis of these properties, the relationship between them is retrieved and its dynamics made explicit.

Atomization: the periphery cannot be considered an organized group of individuals. Most of the times they will take their decisions on an individual basis, relating to what they observe in the core. In other words, every individual in the periphery will have an idiosyncratic answer to the indirect debate she is exposed to. Some of them will leave, some of them will enter the community following a normal 'legitimate peripheral participation' process (Lave and Wenger, 1991) or a much more radical process questioning the community rules, some of them will remain in the orbit around the core absorbing its structures. In some situations, when the core takes actions that limit the access to the project or harm the possibilities peripheral members have to act in the project arena, they may organize into a group and contrast these decisions. But most of the times, they will be individuals relating just to the core, and not one another.

This lack of group dynamics makes the collective outcome a fragmented object, difficult to predict. It is difficult to have a vision of what the periphery is and what processes are moving it when signals do not conform to recognizable patterns and do not mirror aggregate properties of the collective. Signals are mixed and turn into "noise". This perspective can be better defined using a theater as an example. The core, composed by the actors on stage, can be considered a group working together. On the contrary the public is mostly composed by stand-alone individuals or small cliques who observe the play and decide to whistle, applaud or leave on the basis of their individual experience.

However, it is possible to draw some general scenarios. To do that, the first step is to consider first what possible groups the peripheral individuals can form. A certain share *a* of peripheral individuals internalize the community structures (type-*A* individuals) orbiting around the community or moving along an inward trajectory following the 'legitimate peripheral participation' scheme. Another share *b* instead accumulates dissonance (type-*B* individuals). In that case their behaviors are similar to those of share *a*, but only up to a certain moment (different from one another), when a trigger event will move them closer to the last group of individuals, those labeled as type-*C* individuals. Individuals belonging to this last group of share *c* move along outward trajectories and leave the community (type-*C$_{out}$*) or to adopt more "radical" inward trajectories and "erupt" into the debate

(type-C_{in}). I will call the share of individuals adopting behavior C_{out} as c_{out}, and that of those applying C_{in} as c_{in}

As a second step, I will define the particular "physiological" situation described in the previous section as the benchmark for the analysis. In this situation a is much higher than b and c, and the core and the periphery interact in the optimal conditions to foster the community's productivity. Set this situation as a benchmark, the following discussion will try to describe the potential outcomes of different situations in terms of the changes in the shares a, b and c.

In the 'physiological' case, the debate within the core is such that many peripheral members simply absorb the basic rules and procedures adopted by the core, and the system can proceed on the path of a physiological development. When this is not the case (e.g. because the core is too closed), and a fracture between many peripheral members and the core increases the overall level of dissonance, and c and b increase while a decreases. The dynamics of the relationship in this phase, depicted also in Figure 2, opens the possibility to state another property of the periphery: invisibility.

Figure 2. Dissonance dynamics and its possible outcomes at the aggregate level.
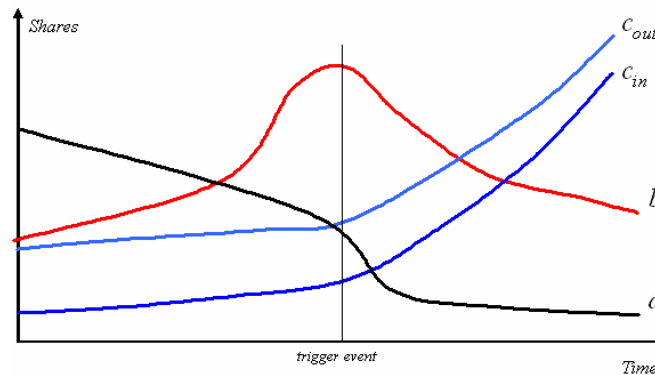
Invisibility: besides the atomization property seen above, another property of the periphery makes the core unaware of what kind of the periphery it is facing. The FOSS community is in fact a virtual community. Contrary to the physical space, where the mere presence is already a means of interaction, in the virtual space the act of observing others' behavior is usually not detected. Members of a virtual space become visible only if they *act* in that virtual space. But peripheral members are only by definition only minimally active, i.e. minimally visible. Their invisibility can be can be exemplified recalling the previous metaphor of the theater. Being the protagonist on stage, the core does not see the periphery in the stalls. On the contrary, the periphery beholds the core and decides to applaud, to whistle or to leave to a certain extent independently of the core's intentions.

In terms of the dynamics described above, this means that in the short run the only signal the core would be able to capture would be that coming from c_{in}, i.e. in the share of developers entering the debate and questioning the basic believes of the core. The increase in c_{out} will instead be very difficult to notice in the short run, as it consists of the disappearance of already invisible individuals. Also the decrease in a will be difficult to detect, as fluctuations at the level of the participation of peripheral members are the norm. Eventually, the change in b will be also invisible, as dissonance accumulation is based on the idea of preserving the internal mismatch in the identity components without expressing disagreement openly. This amounts to say that the core will be likely not to perceive the real size of the process at work, and will probably see no reason to change the direction of its relationship with the periphery.

A third property can be derived directly from the previous statement: instability.

Instability: the discussion above shows how the periphery's aggregate behavior can be difficult to

predict and to detect. This leads to instability, as the fractures between the core and its periphery will usually be invisible and unpredictable in the short term. But the described dynamics is not the only source of instability. If the time window is enlarged other processes increasing the instability can be triggered.

1) To see how the first of this process could work it is useful to recall Kuran's studies of dissonance and revolution. As Kuran (1989, 1995) shows, dissonance can be preserved as latent in many individuals. In this case a relatively insignificant trigger event, such as a small number of individuals questioning the status quo and showing that disagreement is more widespread than expected, can result in what he calls a *revolution* (Kuran, 1989; 1995; 1998). The same process can be reframed in this context. For example, the increase in c_{in} can be seen as a trigger event followed by Kuran's mechanism. When a certain number of peripheral members enter the debate and question the decisions of the core, this shows other peripheral members belonging to group $\boldsymbol{B}$ that the disagreement is not confined to their own individual opinion. This can act as a trigger event, and other peripheral members belonging to $\boldsymbol{B}$ will then follow and enter the debate as well. A new debate is now in place, this time questioning the structures of the community[12]. This process is represented in Figure 2 as a decrease in the share b and an increase of c_{in}.

2) Of course this is only true for part of the type-$\boldsymbol{B}$ individuals. For some other peripheral members the high level of dissonance will simply result in a diminished interest in a community, and the new discussion triggered by the initial increase in c_{in} will simply push them to leave the community, increasing c_{out} at the expenses of b. A further increase in c_{out} is also to be expected, this time at the expenses of a. As the debate moves from the physiological phase to the phase where basic principles are discussed, many more individuals will leave the community, as its activity is now obscured by the discussion. Thus, even if the previous process is finally redirected to a physiological situation, the revolution absorbed or a new equilibrium found, the periphery will be now much less populated then before. Being the quantity of individuals involved rather than their qualities the crucial factor driving the productivity of the periphery, this will in turn deprive the community of an effective periphery. Figure 2 tries to depict also this effect in a further decrease in a and b, and in an increase in c_{out}.

3) Another source of instability is also possible, led by a condition of instability inside the core. This is when, irrespectively of the actions of the peripheral members, the core members' different opinions do *not* embody the same structures. If this is the case, in most circumstances peripheral individuals' reactions will increase instability. Even in the most physiological case, in fact, when their levels of dissonance are low, their experience of the indirect debate will make them absorb the structures conveyed only by one of the different sides, and discard the rules of the other sides of the *querelle*. This means that, even if the core can find a possible equilibrium and absorb the contrast, it will be surrounded by a fractioned periphery, that still needs to be recomposed around the new structures.

The *querelle* analyzed above opposing 'free' and 'open' software advocates can illustrate once again this point. By now, the two positions confront one another but share the same principle relative to source code openness and FOSS way of working. However, the increased importance of economic actors in the FOSS arena can trigger serious changes in the community structure. Firms' interaction with the community could in fact evolve towards a point where firm-based projects become a significant part of FOSS production. The bifurcation at this point can be expressed by a question: "Will firms be able to preserve the features of the production process *Free Software advocates* believe are essential?". A positive answer to this question keeps the debate on the track

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[12] Notice that this accelerates again the increase in c_{in}, establishing a positive feedback that reinforces the frictions in the debate (this effect is also captured by the shape of the curves in Figure 2). This is perfectly in line with Kuran's (1989) description of the revolutionary process. The resulting difficulty in predicting the revolutions is also consistent with what presented here.

of a physiological evolution of the community. A negative answer, instead, means that Free Software advocates' disagreement will move the debate to a point where the distance between the two positions is too wide to be closed. Principles which do not have a common root shared by all the community members will acquire more importance and will become the center of the debate. The discussion will be witnessed by the developers engaged in the debate as well as by those following it from the "periphery", for experienced developers as well as for newcomers who try to make sense of the discourse they begin to face reading others' opinions.

Even if the disagreement is reabsorbed, many peripheral members have reduced their dissonance internalizing the structures that typical only of one of the two sides. Being the debate about the very meaning of FOSS, freedom and collective production, some of the peripheral members have chosen to adhere to one side and part to the other side, and to harmonize their sets of believes only to one of the structures. When a new agreement in the core is find and values such as freedom or openness redefined, the periphery is likely to show a certain level of inertia. It will difficult for all the peripheral members adopt the new structure quickly and smoothly, as the recent harmonization between their system of values and procedures and that adopted in the debate is still ongoing. A certain level of dissonance will be probably remain latent, increasing b and thus the instability of the whole system.

3.2.3 Two examples

It is possible to recognize some of the passages discussed above in the case of Netscape's first attempt to release its browser as open source. As Bonaccorsi and Rossi (2005) state:

"*When, in 1998, the code of the Mozilla Web browser was released to the Open Source community under a non copyleft license, the Netscape Public License (NPL), it was able to attract very few contributions*" (Bonaccorsi and Rossi, 2005; p. 23)

De Laat (2005) explains the reaction of the open source community –constituting the pool of resources Netscape's project was planning to draw from- very vividly:

"*This [NPL] license proposal was 'beta-tested' in public, via a special web-site. Many hackers were enraged, especially by the special rights Netscape reserved for themselves*" (De Laat, 2005, p. 1527).

In other words, there was a mismatching between the structures of cooperation the core of the project (i.e. the company) had, and that of the periphery (i.e. open source community) it was supposed to attract resources from[13]. Many of the peripheral members (i.e. developers possibly interested in the project) simply left. Others expressed their anger during the 'beta-testing' phase and in other forums and mailing lists, giving the community a clear signal about what was going wrong. As a consequence, the company changed its license scheme.

However, that was not the only problem Netscape had to face. As Augustin (1999) argues, Netscape's idea of open source development's procedures also mismatched the expectations of the open source community. The author states:

"*Even though Mozilla code was constantly open and available, there was never a release. In one year, the code was never stamped with a number, called "alpha", and never widely announced as a release. You can't go that long without calling something a release. People lose interest. Mindshare wanes. Developers begin to lose hope*" (Augustin, 1999).

In *nuce*, the structures of legitimation as well as domination and signification the Netscape core developers were broadcasting into their periphery were in contrast with the peripheral members'

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[13] Consider how Augustin (1999) describes the situation at that time "Mozilla never achieved the success of the Open Source projects that inspired it. The contributor base has remained largely Netscape employees. The "Open Source Community" never really embraced Mozilla and the project has stalled."

view. The dissonance reached a point that many individuals did not participate in the process and some of them voiced their complaints. The company was however able to capture the signal coming from the periphery and changed its strategy accordingly, regaining momentum.

Another interesting case is offered by Alan Cox's discussion of Linux 8086 project. Cox says:

"*The problem that started to arise was the arrival of a lot of (mostly well meaning) and dangerously half clued people with opinions - not code, opinions. […]*".

The instability of the situation was rooted in the disproportion between the peripheral participation and the core capability to manage the interest of the peripheral members. With the project's growth, the number of peripheral members increased beyond the core's capabilities to transfer its structures to the periphery, so that it became impossible to discriminate the noise form the productive comments.

"*The real developers have many of the other list members in their kill files[14] so they can communicate via the list. It ceased to be a bazaar model and turns into a core team. […]*"

Cox argues that this strategy weakened the project, as:

"*Given a better ratio of active programmers to potentially useful wannabe programmers would have rapidly turned some of the noise into productivity*" (Cox, 1998).

A possible solution could have been adopting Linus Torvarlds' strategy, common also to other projects (e.g. Freenet: von Krogh et al., 2003): code is the most important contribution. Peripheral members could have been exposed to this rule through the indirect debate they were witnessing and many of them would have absorbed it. Thus, the share of contributions related to the code would have increased and the "noise" reduced. Cox recalls this argument when bringing the example of the Linux Kernel:

"*In the Linux case […] as the project grew people who would have turned into "The committee for the administration of the structural planning of the Linux kernel" instead got dropped in an environment where they were expected to deliver and where failure wasn't seen as a problem. To quote Linus [Torvalds, Linux's founder] "show me the source"*

However, this is a process that works only for that particular part of the periphery that is able and willing to provide code to the project. As Cox puts forward:

"*Don't forget non programmers, […] forgotten people who maintain web sites, change logs, mailing lists and documentation […]. Linus says "Show me the code". That is a narrow view of a real project. When you hear "I'd love to help but I can't program", you hear a documenter. When they say "But English is not my first language" you have a documenter and translator for another language.*"

This last passage is crucial. In the literature it is often the case that what is labeled as "periphery" is the group of less active developers. When the periphery is recognized as an much broader area, it is brought on stage just because it is the starting point of a legitimate peripheral participation process. The last quoted sentence helps in clarifying the contribution of the present paper as a study of the periphery as such, in all its components and singling out its very properties. Core developers and project managers should consider also this when creating strategies to improve the relationship with the periphery.

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[14] This techniques allows the developer to not receive any email from specific addresses (those indicated in the "kill file").

4   Conclusions

The paper presented an analysis of the relationship between the core and the periphery in the FOSS innovation model. With respect to the existing literature, the novelty is that it tried to apply an opposite view, considering the core as the "*sparring partner*" of the periphery.

The paper defined at first the properties of the periphery in the specific context of the FOSS (e.g. *dissipation*, David and Rullani, *forthcoming*), and then to tried to uncover the different functions the periphery can perform thank to those properties. Structuration theory -as reframed by Crowston et al. (2005) in the context of FOSS- has been then used to argue that those functions can be productive only when the same *structures* (i.e. procedures and values) applied in the core are also shared by the peripheral members of the community. From this, I derived the need for a better understanding of the processes determining peripheral members' identity (and the structures they accept and apply).

To answer to this need, I elaborated a conceptual model based on Wenger's (1998a) idea of community of practice. In doing that, however, I have not focused on the *practices*, as engagement in a "thick" interaction is very far from the modality of participation typical of peripheral members. I instead focused on other two constructs, *imagination* and *alignment*, often overlooked by the literature on FOSS. These constructs also allowed me to account for the specific modality of interaction typical of virtual communities such as FOSS, i.e. Computer Mediated Communication.

To be able to go more in depth in the definition of the process leading to peripheral members' structures internalization, I integrated this theoretical background with the concept of *dissonance* (e.g. Kuran, 1998).

I then used the same set of theories (especially Kuran, 1989, 1995 and 1998) to analyze what can happen when such internalization is not possible. As a result, other three properties of the periphery have been revealed: *atomization, invisibility* and *instability*.

A better understanding of the processes connecting the periphery and the core allows for a series of speculations connected to the strategies the core of a project should apply to foster a positive relationship with its periphery. For example, when projects grow, new strategies accounting for a more complex organization are necessary. My claim here would be that in that case the core has also to create procedures and channels through which the peripheral signals can be processed and "ordered". The cost of not being able to process these manifestations is a higher degree of instability of the whole OSS project[15].

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[15] Suggesting what those strategies could be is out of the scope of the paper. However, the reader can refer to Kuran (1995) for a discussion on what policies could be used to improve detection and prediction of the revolutionary phases, and thus to diminish the risk associated to high levels of accumulated dissonance.

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