Plurimondi IV, 8, 2011, 5-18

Preface

Changes in water technologies are continuous and proceed through a complex interplay of both abrupt changes and slow processes of adjustment and hybridization. While the study of technological change has traditionally focused the attention on technical features, more recently, instead, there has been a focus on the analysis of the relationship between technical changes and deep modifications of the underlying culture and knowledge which has started together with the analysis of social and institutional practices. This comes from a refined understanding of technologies being conceived as socio-technical systems whose changes are deeply related to the generative interplay between people and technologies (Bijker, 1997; Trist, Murray, 1993).

The transformation pattern of water technologies is particularly complex in developing or emerging countries since in these countries indigenous and Western cultures have melt throughout the history and, later, have produced complex dynamics of socio-technical change and multifaceted processes of domination and resistance. While the interplay of indigenous and Western culture have often led to the collapse of traditional systems, sometimes indigenous technologies have resisted to external dominations and evolved through interesting innovation and hybridization patterns. When this happened, key research questions focused on the modalities through which hybrids of knowledge and technologies have been co-constructed from indigenous and external inputs and on the ways through which old concepts and routines have mixed with new ones (Lanzara, 1993). By doing this, generative enactment process leading to change (Weick, 1995) had been activated while focusing on the analysis of key features of traditions and their generative and innovative force (Barbanente *et al.*, 2010; Brunsson, Olsen, 1998; Weick, 1995).

Technological memory

Starting from evidences introduced by some case studies on water technology in places where tradition and memory still resist innovation and standardization, it has been possible to put forward the concept of 'technological memory' (Borri *et al.*, 2010). The case of the *jagüeyes'* technology in Mexico – small artificial basins used by villagers in the pre-Hispanic Mexico enabling the satisfaction of the population basic water needs – is meaningful as they are persisting today where *Conquistadores* have never arrived and, in other cases, are neglected where their arrival implied relevant water technological changes.

Since ancestral periods, water technology in arid climate countries has presented extraordinary examples of specific organizations devoted to designing, constructing and managing complex and ambitious works. The wide and frequent dimensions of these works as well as the evidence about the impressive collective organization of the needed human labour force should not obscure individual contributions. Gradual minor adjustments of original shapes being brought forward by continuous works and by long term repetitions in different places and times suggest that social forms of cognitions and actions have interacted with individual contributions while granting a blend of mutual learning as well as memory and creativity's transfer.

Due to diverse and multiple reasons connected to a gradual disappearance of productive and market organizations on which certain techniques had been based upon, technological memories have suffered from transformations until they became unusable.

An interesting example of the disappearance of a given technological memory, due to the destruction of social and political organizations the technique was based on along with used materials, markets and professional abilities, is presented by the construction of large roofings. Covering large spaces without intermediate supports (see the solution used in Rome during the Empire Age for the building of the Pantheon's dome: a semi-sphere of more than 40 metres of diameter, built in a very sophisticated way with extremely light prefabricated clay pieces settled in concentric circles and linked to a light and tenacious mortar) had been impossible for 1.500 years until the invention of a different building solution (strongly less sophisticated: heavy masonry, made of bricks reinforced by big ribs) used for the construction of the Gothic dome, designed by Filippo Brunelleschi for the cathedral of Saint Mary in Florence (Petrignani, 1978). In this case, the disappearance of the Roman political and productive organization have operatively annihilated the technological memory: building history and techniques, in exceptionally wide perspectives, was presumably perfectly known to Filippo Brunelleschi in Florence or to Andrea Palladio in Venice, the two giants of Italy's Architecture who shared sector technological memory which was needed for emulating the Roman technique of covering large spaces. Nevertheless, they did not have the ability of making it as operational any longer.

Based on the Newell's and Simon's memory model (assuming that human abilities gradually form a series of condition-action rules) or to the Anderson's model (conceiving that abilities are based on the integration of factual memory and procedural memory), it has been possible to assume that a technological memory is indexed and stored by three essential attributes: facts, procedures, and judgments about the two previous ones. In this way, parts of a technological memory, learnt through direct (tradition) or indirect (description) experience, can be gradually put in disuse and finally be deleted, or more probably hibernated, by attaching attributes of obsolescence and impracticability over those.

Technological memories are constituted in agents through direct or indirect experience – the latter as they can spread outside from local origins – and might: (i) be limited to simple passive cognition of facts and procedures ("I know that a certain technique exists" or "I saw that technical device while functioning", or "Somebody described me that technical device but I never had the chance to use it ") or; (ii) become part of an active inclination of the agent as a direction given by him/her to other agents (political agents can impose to other agents – should these already know it or ignore it so that they have to learn it immediately – to adopt that technique), or further; (iii) be integrated in an existing life that is more able to use that technique ("I am a user of that technical device, should it have functionality problems maybe I would be able to repair it" or "I saw that technical device while functioning, while giving me water availability for long time", or, ultimately; (iv) become an active ability ("I know very well that technical device as I had the chance of creating it" or "I was present when this technical device was created and started its functioning", or "I know how to create this type of technical device here", or "I am a user of this technical device", or "I am not a user of this technical device but I could be a user in the future").

In a process of technical imitation, consisting of introducing an exogenous technique into a place, the whole set of cognitions and resources on which manual based techniques are still used at present, result into a technical change or in an ecological variant of the manual based technique (no matter how much relevant) whose inspiring principle (the ontology) remains substantially the same to the extent that either the imitator had conceptualized that technique or that the technique was represented to the imitator (the latter describing a technique to this by a protagonist, primarily, or informed, secondarily, by the agent). Therefore, in technological transfer and in the use of a technological memory it is important to distinguish general principles from local applications (Borri *et al.*, 2010).

Influential theories about the architecture of cognition consider memory as an organization of atomic condition-action rules' set (Newell, Simon, 1972) or, alternatively, as frames (Schank, Colby, 1973), while, more recently, the two alternative forms of memory organization have been seen as complementary (Johnson-Laird, 1988): in a contingent action model, for instance, the use of a causal frame, that is immediate and not as a sequential representation of the reality, would be selected at first instead of a sequence of atomic rules.

It is arguable that a technological memory cannot be effectively constituted when the principle of its component's functioning and applicability is not clear in detail: in this case a technique would not be memorized or, would only be destined to passive cognition. Commonsense warns people against technique's possible superficiality and its merely normative orientation (i.e. "Use that technique, it has a lot of positive credentials!") as a source of potential disasters.

It could also e assumed that an operational technological memory – leading to actions – is constituted by facts and explanations about these as it is not a mere if-then shaped recording of events and phenomena where causal relations are relaxed. Nevertheless, such an assumption includes the case of a technological memory which works without incorporating explanation, in a form of a black box: it is possible to see a machinery while working without understanding the inner reasons and its causes. The last assertion, in sum, drives people to wonder whether differences between two kind of memories exist, that is between those technological memories which are to orient implementation and which are not necessarily located at the top of the hierarchy of agents' intelligence in his/her relation with the world, and other memories that can relate to and deal with events and natural phenomena whose reason is impossible to understand. An interesting hypothesis to cultivate is that a difference exists, coming from the intuitive perception that, against unclear natural phenomena, all human agents would share the same knowledge condition while facing unclear human phenomena (see the use of an unfamiliar technique) asymmetries amongst human agents would occur, depending on their familiarity or not with that technique. From this perspective, it would be a nonsense, apart from possible intentional learning aimed at entering a circle of technical scholars, to cultivate technological memories which reveal to be impracticable for the following reason: we face impracticable techniques which avoid us to use them or delegate their usage to specialists (see the Nozick's hypothesis about the emergence of a technical rationality which is becoming inaccessible to non-specialists) (Nozick, 1993).

According to the aforementioned assumptions, the selective constitution of a technological memory, is respectively with large or narrow stitches when human agents intuitively perceive that they need a large filter's technique, enable to increase their survival abilities in future solitary confrontations or when they can delegate a technical problem solving to others (Borri *et al.*, 2010).

In this reasoning the following question is nested: in a water technology like the one of the *jagüeyes* which shows a problem of technological memory drama occurring in a village community under the influence of exogenous innovations, is the *jagüeyes* technological memory spread across the whole village community or is it owned by experts only? Our case studies report a technological memory which is diffused across the whole set of community agents because of its simplicity which makes it easily to memorise and be reproduced by all while preventing it from turning into agents' exclusive patrimony. The society as a whole, which is made of single individuals, had to contribute to maintain the *jagüeyes* working so that they became active players of such a technique as well as the main agents of the relative technological memory.

Ultimately, the previous water technology case study allow experts to argue in favour of the existence of a technological memory. The latter is featured by that selective nature that is enriched of causal relations, characterised by variable distributions occurring within the whole set of agents who are to practise a given technique according to a proper technological memory; that is affected by changes deriving from ecology-based utility functions as well as strong linkages with resource and organizational systems and weak linkages with individuals (this happens because techniques, differently from what happens for if-then rules involved in the manipulation and recognition of biotic or a-biotic entities, are part of complex social chains and can hardly be implemented in isolation).

Therefore, technological memories have a high social connotation, meaning that they are not as basic (since they do not pertain to fundamental facts and processes) but as it happens in other social domains, they accept the division of work ("You have that memory which differs from mine …").

In practice, by virtue of the principle of sociality, technological memories essentially work in interactive ways and cannot be understood, constituted and experienced in isolation. Because of their lack of basic contents they can be cleaned or, at least, confined into sleeping memories to be retrieved and turned to be active only in particular conditions of need or intention.

It has also been possible to find out that communities affected by organizational breakings in water technologies suffer from a destruction of their own technological memories. In fact, they are forced to start from scratch until the adoption of new techniques which are often exogenous and worse than traditional ones.

Dilemmas on water technology

The following issues – technological change, in general, and technological memory, in particular – have been central in the research developed within the EU-FP6 funded project ANTINOMOS "A knowledge network for solving real life water problems in developing countries: bridging contrasts". The project started from the assumption that it is necessary to embark on a deep investigation of traditional as well as modern technologies' acceptance and performances in developing or emerging countries in order to pursue a more holistic understanding of water issues and, at the same time, to increase the link of knowledge to action in real life contexts. In particular, the project has attempted to overcome the persistent conflict between modern approaches and indigenous solutions to water problems by trying to unveil the knowledge embedded together with their transformation patterns. The conflict between them is, in fact, part of a larger opposition amongst knowledge systems in which those technologies are embedded.

While mainstream international interventions are still mainly devoted to transfer modern Western technologies to developing countries, local contexts are mainly seen as limiting factors for an easy transfer of external solution instead than a source of useful knowledge for water problems. By this perspective, traditional technologies and practices are still often perceived in the mainstream as being based on irrational beliefs and myths, thus being subjective, context-specific, and lacking a sound cause-effect basis (Millar, Curtis, 1999). They are considered to be the product of a non-scientific system of thought which should be "modernized" through the transfer of other thought's systems. (Kloppenburg, 1991). In the attempt to challenge this simplistic view, the ANTINOMOS project has developed the analysis of several modern and indigenous technologies in India, Mexico, and South Africa.

The papers collected in this volume are the results of a research which is directly or indirectly related to the ANTINOMOS project itself. Papers were discussed during the last project conference held in Bari, in November 2010.

Three papers amongst those contained in this volume have project partners among the authors (Atif Kubursi et al., Subodh Bishnoi et al., Darja Kragić Kok et al.) while seven papers were written by researchers interested in contributing to the ANTINOMOS debate through the account of their own research experience (Luis Santos Pereira, Lorenzo Caponetti et al., Antonio Leone et al., Francesca De Serio et al., Elda Perlino et al., Marwan Haddad et al., Clara Copeta et al.).

The two papers contained in the first section called "Intersections" aim at exploring multi and trans-disciplinary issues on human settlements which reflect multiple and hybrid cultures.

The paper by Atif Kubursi, Dino Borri and Laura Grassini suggests a model that would be able to link the innovation possibility curve of a water technology to factor endowments of a single country and its costs. Based on a critique of the Rostovian conception of linear progress from tradition to modernity, authors have argued about the need to root innovation on traditional knowledge and technologies.

The paper by Luis Santos Pereira discusses key challenges of natural and made-man water technologies to cope with water scarcity. Moreover, there is a focus on aspects which are connected to current difficulties in the adoption of innovative water technologies as well as the importance of water management issues when the implementation of water technologies is considered.

The section called "Practices" aims at including alternative, self-sustaining, innovative and democratizing practices while transforming natural and life spaces of local communities. It is composed of five papers.

The paper by Lorenzo Caponetti and Maria Nicolina Ripa focuses on both archaeological as well as functional aspects of a traditional technology from Tuscany, the so called cuniculi. In this paper there is an attempt to demonstrate how this system can represent a valuable tool for a sustainable water management and to what

extent principles upon which they are inspired could be a valid option when planning and building 21st century water systems.

The paper by Subodh Bishnoi, Gautam Prateek, Nirmal Sahay and Anil K. Gupta analyses several traditional and traditional-modified technologies for rainwater harvesting and sanitation in Gujarat and discusses how they blend traditional wisdom while devising modern solutions to contemporary problems.

The paper by Antonio Leone, Nicola Lopez and Flavia Milone, instead, suggests a method to assess suitable areas for the development of an inlet wetland in arid creeks of the Apulian region through the analysis of landscape functionality such as water self-sanitation capacity.

In their paper, Francesca De Serio and Michele Mossa discuss a wide range of empirical data related to the monitoring of coastal waters neighbouring a sea outfall in order to evaluate the reciprocal influence between a wastewater outfall and its neighbouring circulation: this to validate predictive hydrodynamic models.

The paper by Darja Kragić Kok, Henri Spanjers and Markus Starkl makes a review of global knowledge based technologies and practices for water supply and sanitation, with a focus on technologies to be used for the rural and peri-urban areas in developing countries. It also proceeds with the classification of (waste) water treatment systems in matrices using complexity and treated water/effluent quality as the main criteria.

The section called "Vision" aims at encouraging discussion about possible futures, virtual worlds, dream pieces and the anticipation of experiments. It is composed by three papers.

After reviewing a series of studies on the impact of individual pollutants of drinking water on human health as well as on cancer risk, in particular, the paper by Elda Perlino and Elvira Tarsitano suggests that the old logic of giving priority to pathogenetic and etiological aspects of urban hygiene rather than general ones must be replaced and that urban sanitation must be considered as a whole to make human health safe.

The paper by Marwan Haddad critically discusses the political and technical requirements for the use of non-conventional water resources to solve water problems in the Middle East. In doing so, it analyzes the cumulative influence of non conventional water resources and opportunities to reduce water use, to enhance water conservation and to preserve the environment in Palestine.

The paper by Clara Copeta tells about stories of two water-diviners from Apulia region and the way they entered in contact with water, in the sense that they were able to detect its presence even from long distances, as they were gifted by a sort of special sensitiveness.

Dino Borri, Laura Grassini

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