# Living Infrastructure

**Preprint** · December 2017

DOI: 10.13140/RG.2.2.28505.42082



**2 authors:**

Kai Reimers
RWTH Aachen University
**121** PUBLICATIONS **492** CITATIONS
SEE PROFILE

Robert B. Johnston
The University of Sydney
**132** PUBLICATIONS **1,387** CITATIONS
SEE PROFILE

# Living Infrastructure

Kai Reimers[1] and Robert B. Johnston[2]

[1]RTWH Aachen University, Germany
reimers@wi.rwth-aachen.de

[2]University of Sydney and Monash University, Australia
robert.johnston@sydney.edu.au

## 1. Introduction

Infrastructure is widely regarded as a material system that coordinates the activities of diverse practices. On one view, the ideal for infrastructure is to mechanise sanctioned forms of interaction between practices pursuing different and often conflicting goals, such that the resulting whole forms a well-oiled machine operating under a negotiated highest common denominator (Edwards, 2010). On another view, infrastructure should become an un-noticed lowest common denominator, on the basis of which diverse practices draw meaning and support, but get out of each other's way and act as independently as possible (Hanseth and Lyytinen, 2010).

In this essay, we argue against the notion that infrastructure is a material enabler of *either* a tight *or* loose coupling of activities of diverse practices. Instead, we propose that when infrastructure provides a site for an 'opening' in which practices are held *at once* both near and apart - both already familiar and not yet familiar, both same and other, both resisting and accommodating - life under the influence of these practices is lived to the full. We call the resultant whole 'living infrastructure' to denote that it is both infrastructure *for* living and infrastructure *that* 'lives'[1]. We will argue that such infrastructure is an on-going achievement of becoming[2], which requires nurturing to maintain its continued productivity, and vigilance against the three-fold threats of tokenization, colonization and mechanization: otherwise it will cease to 'live'.

First we present the Medieval European City Square as a motivating example of a living infrastructure. We will employ this exemplar to define the conceptual parts which together we take to constitute 'living infrastructure'. Next we introduce a contemporary empirical case from the German healthcare environment. This is the Federal Unified Medication Plan for medication therapy safety. We argue in detail that this is a nascent living infrastructure providing a site where a productive opening 'happens' between multiple practices involved in medication therapy safety. We analyse this 'happening' to further refine the notion of living infrastructure, by establishing how this opening took hold, how it was kept open, and how it was kept productive. We conclude by briefly contrasting living infrastructure with the traditional view.

[1] Hubert Dreyfus (2017) would say, in the same vein, that it 'shines'. See also Heidegger (1950/1971, p180).

[2] In other words, a process in the strong sense (Tsoukas and Chia, 2002; Langley et al, 2013).

## 2. Conceptual Preliminaries

Our aim in this section is to provide an initial conceptual framework for discussing living infrastructure and the terminology we will employ in the remainder of the paper.

### 2.1 The Medieval City Square

The city square arose as an important part of the Medieval European city layout and provided an open area in which city inhabitants could conduct the various aspects of their daily public lives. Frequently, city squares arose around a public water-well that became their centre piece, and on their sides stood various institutional buildings - for instance a church, a market, the town hall, a school - that made available to the inhabitants important influences on the conduct of a rich city life - such as religion, commerce, government and culture.

The city square thus established the presence of different 'regions' of public city life to the inhabitants, but importantly, it also held regions with a natural antipathy (such and the spiritual and the corporal, or the personal and the social) apart. The geography of the square quite literally protects life in the square from domination by any one region of city life, by placing its institutional representatives on different bounding sides of the square.

We suggest that the medieval square provides a conceptual exemplar for living infrastructure – in this case infrastructure for public city life to be lived to the full. The city square arises as an opening in the clutter of the city; it is maintained as an opening in city life because regions of that life are established as both present and distinct by its layout; and it is productive of a good life because it encourages a continual encounter and evaluation of the 'regions' of city life in the course of daily interaction, and thus a continual on-going evaluation of what a good city life *could be*. In the opening of the city square, the contrasting regions of life are established *as* regions, and a good city life lived in the presence of these regions is disclosed to those who dwell there.

### 2.2 The City Square as Living Infrastructure

In what follows we will draw on the city square exemplar to give an account of how infrastructure more generally can 'live' when it provides the site where such a productive opening can take hold. It 'lives' when such an opening 'happens', and this happening[3] is living life to the full. However, first we must take some care to point out in what respects the example instantiates 'a productive opening' as we see it, and what aspects of the example might lead the reader astray.

Firstly, it is not the square as a material entity creating an open physical space in the city, nor the geography of the square mediating the opposition of the institutional buildings, that we wish to identify with such an opening. That is, here we are not interested in the usual conception of infrastructure as a material structure that coordinates diverse activities. Secondly, we are not interested in the square as a politically negotiated creation of the institutions to demarcate their various territories in their subjects' lives. That is, we are not treating infrastructure as an outcome of social negotiation between 'stake holders' in city living.

Rather, we view the city square as making possible particular lived interactions of the city dwellers that *already* happen under the aegis of these institutions. Thus, the square as a built place is merely

[3] We use 'happening' in line with Heidegger's notion of Ereignis (Polt, 2005) – a productive, dialectical, gathering event (in the extended sense of event).

the ‘site’ where certain oppositions – of nearness and farness – among the ‘regions’ of the overall concern of the square (that is, a good city life) already lived there, are made possible. By connecting and opposing the institutions that embody these regions of life in the built place, the opening that the square grounds establishes them *as* distinct regions of the life lived there. What is productive about the city square is not its spatial or institutional geography but the distinction-making function of its openness. It is the openness of the square - not the square as such - that we view as the ‘opening’. The common concern enacted in the square, the regions of life founded by the square, the openness of the square, the square as the site of this opening, and the happening of this openness, are what together constitute living infrastructure (see Table 1).

Thus, facilitating a good city life is not simply a matter of building a square that coordinates or controls access to the separate, opposing institutions of life. Nor is it a matter of regulating the real estate of the square to prevent institutional encroachment on the political balance of city life. Rather, it is a matter of creating the conditions under which a square as a region-defining opening can arise, be kept open, and can continue to be productive. Only then can the square become infrastructure that ‘lives’. The nature of an opening that makes this happen is the issue that we take up in the remainder of the paper.

We have not created these ideas *ex nihilo*: our conception of the city square as a productive opening has been inspired by our reading of various works from the later philosophical period of Martin Heidegger, in particular the essays “Building, Dwelling, Thinking”, “The Thing” and “The Origin of the Work of Art” (Heidegger, 1971).

Table 1. Conceptual parts that constitute living infrastructure

| **Concept** | **Definition** | **Example (City Square)** |
|---|---|---|
| Concern | A concern defines that aspect of human existence with which the infrastructure deals | The concern is living a good life in a city |
| Region | Regions are distinct aspects of the concern – they are distinct ‘locations on a map’ of the concern. | The regions are the institutions of town life – religion, state, commerce, and education/culture |
| Opening | An opening is the establishment of productive distinctions between the regions of the concern | The establishment of distinctions between spiritual, corporal, individual and social aspects of a good city life |
| Site of an opening | Where a productive opening takes hold | The lived-in city square that provides the conditions of an opening between church, town hall, market and school to happen |
| The happening of an opening | How an opening takes hold, is kept open, and continues to be productive | For any particular city square this could only be uncovered by detailed historical scholarship |

## 3. Case Background

Thanks to advances in general living conditions as well as the medical sciences, people now live much longer but also tend to live with chronic and multiple diseases when they are old, a condition known as multi-morbidity. This condition, in turn, is associated with the continuous use of a cocktail of drugs, so-called poly-pharmacy. Healthcare systems in most developed countries, however, have been erected on the assumption that people fall ill only occasionally and then, for a limited time, use a drug targeted specifically at that illness. Healthcare systems are generally not equipped to cope with monitoring and continuously adapting medication regimes of multiple drugs taken over long periods. This often results in combinations of drugs which are ineffective, due to cancellation of their effects, or risky, if effects of drugs amplify one another in unanticipated ways.

In Germany, the term 'medication therapy safety' was coined for this issue as part of a national action plan published by the Ministry of Health in 2007. This 'National Action Plan for the Improvement of Medication Therapy Safety' has since been updated three more times with the current action plan covering the period 2016-2019. These plans are supported by a 'Coordination Group on Implementing and Updating the Action Plan for Improving Medication Therapy Safety', in the following just 'Coordination Group'. This group has met regularly about three times per year since the publication of the first action plan. The group comprises representatives of various national-level professional associations, the Ministry of Health, and patient groups. Initially, it was mostly physicians, as well as community and hospital pharmacists, who participated in the meetings as professional specialists. Later, members of a national nursing association, the national hospital association, and the federal association of panel doctors – concerned with administering the reimbursement of doctors – officially joined the group.

The structure of the various action plans has remained relatively stable over the years. Sections outline establishing awareness of the problem of medication therapy safety both among medical professionals and patients, creating a 'safety culture', and various more specific measures such as encouraging physicians to report side effects to a national registry, with each attracting funds from the Ministry of Health by competitive tendering. The implementation of some of these measures is the responsibility of the Coordination Group itself, including a project to design and distribute an information flyer for patients to increase awareness for the problem and to establish a safety culture. One idea was to include the template for a 'medication plan' in this flyer so that patients could create their own medication plans.

However, over time this idea took on larger proportions; the group began to discuss what is now called the 'Federal Unified Medication Plan' ('Medication Plan' in the following) as an information and communication tool for all those involved in the medication process. Eventually, the Medication Plan became part of a new law, the so-called e-health law, published in December 2015, obliging physicians from October 2016 to create and print out a medication plan for patients who regularly take three or more drugs. From April 2017, such medication plans must comply with a detailed specification of the Medication Plan. This includes a 2D barcode so that a patient's medication plan can be machine-read and updated. How this Medication Plan came to productively structure interactions among the practices of the Coordination Group is the focus of our case.

## 4. Case Materials

We draw on two kinds of empirical material. Our main source for reconstructing and interpreting the story of the Medication Plan is the published meeting minutes of the Coordination Group. Since the publication of the first action plan in 2007, the group has met 30 times. All 29 publically available meeting minutes were first read from last to first by one of the authors and then, in the reverse order, excerpted and summarized into four categories: (1) composition of the group; (2) discussions concerning the definition of medication therapy safety; (3) discussions concerning the medication plan; (4) other relevant aspects of the discussion.

The second empirical source is the experiences of one of the authors as a founder of the 'Aachen Learning Community on Innovative Use of IT in Drug Distribution' (Claßen et al., 2015), a group of healthcare practitioners that has met about twice per year since February 2012 and which mirrors the composition and concerns of the Coordination Group, albeit at the local level. Recently, this group has started a project to document and reflect on experiences of physicians, pharmacists, and patients with the Medication Plan through an ongoing series of reflective video conversations. Apart from using domain specific knowledge from one of the author's active participation in the discussions and

activities of the Aachen Learning Community, we will also draw on findings from the first series of reflective video conversations.

## 5. Case Findings

In this section, we describe and interpret the story of the Medication Plan. The development of this case narrative has also contributed to developing the notion of living infrastructure as the happening of an opening and therefore serves to illuminate rather than just illustrate our basic concepts. The story of the Medication Plan thus serves a similar function to our city square example, namely, as an archetype of a general principle. While the city square metaphor was useful for deriving the basic concepts as defined in Table 1, the concrete contours of the happening of an opening could only be fleshed out through detailed historical analysis of a particular case. This led us to distinguish three issues that together reveal the happening of an opening:

1. How the opening took hold,
2. How the opening was kept open,
3. How the opening was kept productive.

While it would be tempting to associate these issues with distinct phases in a linear development process, we will argue later that they are better understood as constitutive parts of the happening of an opening. Thus, in each sub-section below, we present an episode particularly appropriate to each issue and do not intend these to be read as chronological.

### 5.1 How the Opening Took Hold

In this section, we will document how the various practices making up the Coordination Group came to encounter each other in a way that opened up the possibility of talking about and probing into new ways, not entirely managed and controlled by physicians, for determining and adjusting the medication therapy of patients. Out of this re-orienting of the dialogue between practices arose the Medication Plan which, in turn, became a site for re-orienting the relationships between the practices, initially those of physicians and pharmacists, but later also of regulators and patients.

Traditionally, the relationship between physician and pharmacist is perceived to be asymmetrical, although that was not always the case (Schmitz, 1998). Accordingly, the pharmacist is supposed to merely follow the prescription written by the physician, dispensing the specific drug intended by the physician to the patient. Only in cases when a certain drug may threaten the life of a patient is the pharmacist expected and obliged to intervene in the physician's medication decision by refusing to dispense that drug. In addition, the pharmacist is supposed to look out for possible prescribing errors, for example where the names of two drugs are very similar. As these are exceptional situations, it is not customary for the pharmacist to seek to communicate with the prescribing physician and physicians tend to evade direct conversation with pharmacists about the medication of a particular patient.

This separation between the two practices is reflected in the institutional structure of the German healthcare system which has very few platforms where physicians and pharmacists are able to interact as professionals. To the extent that such institutionalized forums for the interaction exist, these are typically concerned with allocating resources and workloads but not with medication. The constitution of the Coordination Group was therefore an unlikely gathering because the participating practices, especially those of physicians and pharmacists, could come together under the aegis of a shared professional concern, namely medication therapy safety.

The idea of the Medication Plan evolved from an addendum to an information flyer for patients, into an information and communication tool for all actors involved in medication. As such, the Medication Plan announces the possibility of more intense and frequent communication and cooperation between the various practices, in contrast to the then current one-directional information flow from physicians to patients, pharmacists, and nurses and relatives. However, the potential shift in how these various practices might be re-oriented through the Medication Plan was not explicitly discussed by the Coordination Group. Rather, discussions were about whether the information flyer should include a 'unified' medication plan as a template for patients or not. Physicians were initially opposed to that idea, arguing that *patients* should design a medication plan according to their needs.

The possibility that the medication plan might become a new information tool for *all those* involved in medication decisions marked a significant broadening of its purpose, here signified by our capitalization of the medication plan as 'Medication Plan'. Such a possibility was explicitly announced in the second ministerial action plan, published immediately after the group's eighth meeting. The second action plan also specified a measure to hold a workshop with software providers to 'implement' the Medication Plan in software systems for general physicians, community pharmacists, and hospitals. Thus, there was a clear intention to broaden the reach of the medication plan from an information tool for patients to these other practices, which would allow them to become involved in novel ways in medication processes. The action plan justified this new position by referring to the discussions in the Coordination Group; however, prior to the publication of the second action plan these discussions only referred to the medication plan as an addendum to the information flyer.

Even though there are no indications in the meeting minutes that the Coordination Group explicitly discussed using the Medication Plan for re-orienting the various practices, there must have been an openness for this possibility. Otherwise, the action plan could not have referred to these discussions to justify the idea that the medication plan was to become a new information tool for all practices involved in medication processes, since that implies a significant shift from current practice using the prescription as a one-directional information tool. It appears that another discussion, which occurred concurrently with the discussions of the Medication Plan, greatly contributed to creating this openness, namely, a discussion concerning the definition of key terms related to medication therapy safety. One important aspect of that discussion was a proposal to distinguish between 'undesired drug effects' and 'undesired drug events'. While undesired biochemical drug effects cannot be avoided, some undesired drug events can be avoided, for example, by changing the way or the time that a certain drug is taken. Making this distinction turned out to be important. For example, in one session the group had queried the federal association of physicians about whether the current education of physicians sufficiently addressed medication therapy safety. The association had replied in the affirmative, arguing that the topic of pharmacovigilance is firmly established in medical curricula. Pharmacovigilance, however, only addresses undesired drug *effects* but not undesired drug *events*, such as interactions between various drugs. The group therefore decided that there was a need to educate physicians about the difference between pharmacovigilance and medication therapy safety.

The distinction between undesired drug effects and events opened the possibility for a legitimate and substantial involvement of pharmacists in medication decisions. Pharmacists are recognized to be 'experts in drugs' and could therefore better fine-tune a certain drug regime to make sure that avoidable undesired drug *events* are indeed avoided: as long as only undesired drug *effects* (colloquially known as 'side effects') mattered, it was clear that only physicians should make medication decisions because only they could trade off side effects against intended effects.[4]

[4] It is interesting to note that the group maintained that distinction for a considerable time even after a European directive had re-defined undesired drug effects to include medication errors, a re-definition which effectively

We interpret these events as indicative of an opening taking hold. Initially, only a certain openness to an as-yet unspecified possibility of a new way of orienting the various practices is noticeable. This openness is manifest in both the readiness to see the Medication Plan as something more substantial than was initially envisaged, and in the making of the distinction between undesired drug events and effects. Both these manifestations announce the possibility of a more significant involvement of pharmacists and other practices in medication processes which, however, was not yet specified or even thematised. Yet, following the publication of the second action plan, the Medication Plan would become the main *site* for working out these new roles, which came to concern the relationship between patient and regulatory practices in addition to pharmacists and physicians. Thus, the 'taking hold' of the opening involved the *anticipation* of a possibility that had yet to be worked out and defined.

## 5.2 How the Opening was Kept Open

In this section, we will describe (1) how, in the discussions within the Coordination Group, various efforts to 'appropriate' the Medication Plan by particular practices involved were fended off, and (2) how this keeping at bay contributed to working out the emerging re-orienting of these practices that the opening had already brought forth.

The composition of the Coordination Group had stabilized after the first few meetings to representatives of

- the Ministry of Health, which we here interpret as articulating the *regulatory* practices concerned with allocating costs and benefits within the healthcare system,
- the drug committee of the federal association of *physicians*
- the federal associations of hospital and community *pharmacists*,
- an 'action platform for patient safety' which includes *patient* organizations but is dominated by healthcare professionals,
- and of federal *patient* and *nursing* organizations.

Thus, the group comprised five practices, namely those of regulators, physicians, pharmacists, patients, and nurses.

There were two kinds of moves to claim ownership of the Medication Plan which we characterize as attempts at 'appropriation' in the following, namely, (1) proposals to restrict its purpose, and (2) proposals to limit the leeway users have in filling in medication data.

The first type of appropriation gesture, proposals to restrict the purpose of the Medication Plan, aimed at positioning it primarily as a document for patients to help them comply with the instructions of physicians. Such proposals were successfully countered with the argument that the communication function of the Medication Plan is essential for improving medication therapy safety. The topic of these discussions was whether the Medication Plan should also include a 2D barcode. This barcode would facilitate communication between the various practices. For example, patients may also buy some Over-The-Counter (OTC) drugs when presenting a prescription to a pharmacist. The pharmacist

collapses the distinction between undesired drug effects and undesired drug events and which the group eventually incorporated into its glossary. However, even one year after the need for adapting to the European directive had been first discussed by the group, the group decided that a proposed project would only be funded if the distinction between undesired drug effects and medication errors is accepted and worked into the project proposal. Thus, the group maintained this distinction in the face of considerable external pressure to give it up.

could then read the 2D barcode into her system, add the OTC drugs to the Medication Plan, check for possible undesired drug events, and print out the updated and validated Medication Plan. On his next visit to the physician, the patient would present the updated Medication Plan again so that the data entered by the pharmacist are now available to the physician too. This might include information about why the patient has been dispensed the OTC drugs, thus facilitating a direct professional exchange between pharmacist and physician.

On two occasions, participants expressly opposed this inclusion of the barcode as part of the Medication Plan, arguing that the purpose of the Medication Plan was primarily to instruct patients. Opposition to the 2D barcode was articulated by the representative of the Ministry of Health, who argued that dropping the barcode would avoid the necessity of equipping physician practices with scanners. Also, the representative of the hospital association was against inclusion of the 2D barcode in the Medication Plan, arguing that pursuing purposes other than instructing patients about the right way to take drugs would increase the barriers to its adoption. These two arguments reflect concerns about the 'costs' of implementing the Medication Plan in physician practices and hospitals. However, restricting the purpose of the Medication Plan to ensuring compliance by patients would have also strengthened a traditional understanding of the role of physicians as having complete authority over the medication of a patient.

By fending off this closure gesture, the opening that had emerged in the initial meetings of the Coordination Group, as a potential re-orienting of the practices of pharmacist and physician, was kept open. This 'keeping open' did not just consist of rejecting a narrow understanding of the purpose of the Medication Plan, but also specified a way in which the professions involved in medication decisions might communicate with each other. This is significant since the traditional means of communication between physician and pharmacist, the prescription, does not allow for a 'talking back' of the pharmacist to the physician. Hence, fending off efforts to restrict the Medication Plan to a single purpose also helped to further clarify the relationship between physician and pharmacist and to elaborate the opening that had emerged as a potential re-orienting of these practice.

The second appropriating move concerned various proposals to use coding systems for automatically filling in medication data. Instead of entering plaintext into a particular field, users would have to enter a code into software that would retrieve and fill the field contents from an appropriate database. The range of possible entries into a data field would thus be significantly constrained as compared to a plaintext field. Specifically, pharmacists proposed to use codes for, among others, the fields 'active ingredient', 'suggestions for taking a particular drug' (e.g. 'before the meal'), and 'reason for taking a particular drug' (e.g. 'against high blood pressure'). The first field, 'active ingredient', concerns the relationship between pharmacist and physician, the second and third fields the relations between pharmacist, physician, and patient.

The proposal to use codes for the field 'active ingredient' were related to a prominent project located in East Germany. There, a different form of re-orientation between the professions of pharmacists and physicians was proposed and tried out. This project was initiated by the federal association of pharmacists, which is also an institutional member of the Coordination Group, and the federal association of panel physicians, which was often present as a guest in the Coordination Group meetings before becoming a regular member. The most important element of this project was an agreement that physicians only prescribe so-called active ingredients, the chemical substance that causes the intended as well as the unintended effects of a drug in the human body, and pharmacists

then select the appropriate drug.[5] Within the East German project, a complex choreography of interactions between the physician and the pharmacist was designed that would produce a medication plan which reflected their joint decision making, which is then handed over to the patient. The two projects are thus similar but also distinct. The Medication Plan, as envisaged by the Coordination Group, is (also) a communication tool for pharmacist and physician; by contrast, the medication plan as envisioned in the East German project is seen as the *result* of such communication. Moreover, as part of that project the roles of physician and pharmacist are precisely defined and their communication is precisely choreographed. This vision would have transformed the Medication Plan into a mechanistic form of communication – a coordination mechanism. As such this vision would have threatened the Medication Plan as the site of an opening where new forms of orienting the practices involved could continually be discovered and tried out. While the Coordination Group did not thematise advantages and disadvantages of the East German model, it rejected the proposal to use a coding system for filling the data field 'active ingredient' on the grounds that no mature coding systems are available for that purpose, thus fending off the possible 'closure' that would have resulted from bringing the medication plan idea under the influence of the East German project.

Proposals, also by pharmacist members of the Coordination Group, to use codes for the fields 'suggestions for taking a particular drug' and 'reason for taking a particular drug' were also rejected because of concerns about possible misinterpretations of these codes, especially by patients. The requirement that the contents of the medication plan must be intelligible to patients was emphasized several times in the context of discussing the use of codes. The group decided to use plaintext for these two fields in order to prevent any kind of 'wrong interpretation' until sufficient feedback from real-life tests had evaluated whether codes are helpful for users. Through this rejection, the group thus made it clear that patients are to be involved as active users of the medication plan, without specifying what 'active use' really means. By fending off the interests of professionals, pharmacists in this case, the group came to assign a positive role to patients as users of the medication plan.

We interpret these moves and counter-moves as an ongoing, dialectical working out of the opening. Efforts to appropriate the Medication Plan exclusively as an instructional device to ensure compliance by patients and as a tool to enforce a legalistic and technical version of medication management were fended off. These counter-moves, however, also produced a more nuanced picture of how the Medication Plan could function in a new form of interaction between the practices of physicians, pharmacists, and patients, while continuing to resist specifying how this interaction should or must look like on each occasion. Hence, the opening was kept open in these discussions and this also elaborated the re-orienting of the various practices involved.

## 5.3 How the Opening was Kept Productive

In this section, we document how, as the Medication Plan was tested, distinctions characterizing the involved practices came to the fore that had been glossed over in prior discussions. Articulation of these distinctions led to a further elaboration of the re-orienting of practices involved in medication. Moreover, as the Medication Plan was thematised in practice, the concern out of which it emerged was also elaborated.

Projects to test the Medication Plan were announced along with the publication of the concept itself after the eighth meeting; however, the first test results were thematised only about five years later. As of October 2016, general practitioners are legally obliged to prepare and print a medication plan

[5] Drugs whose patent protection has expired are normally offered by several manufacturers. These drugs differ in price but also in composition concerning additives and other substances, and probably in quality as well.

for patients who regularly take three or more prescription drugs, and as of April 2017 such medication plans have to be compliant with the specification of the Medication Plan published by the group, including the specifications for the 2D barcode.

A continuing theme throughout the discussions of the group relating to these tests and initial experiences with the Medication Plan concerned problems with the various coding systems for automatic data filling. While the group rejected proposals to use such coding systems for several fields, as described above, four fields can be filled automatically by drawing on a code system for drug names known as the 'PZN' which emerged in the 1970s and is maintained jointly by trade associations of pharmaceutical manufacturers, wholesalers, and community pharmacies (Wagner, 2005). The PZN code acts as a data key for retrieving further drug-related information from commercially operated databases, including the trade name of the drug as registered with the authorities, the name of the active ingredient, the pharmaceutical form (e.g. tablet or a liquid), and the quantity of the active ingredient in one unit. A further field concerns the medication schedule, when to take each unit of the medicine.

When creating a Medication Plan, a physician or a pharmacist could use their computer system to retrieve drug-related data from the databases of several data providers using the PZN as a key.[6] However, field tests consistently showed that there are differences between data providers in how such data are maintained, especially the 'active ingredient' and 'pharmaceutical form' but also the 'trade name' fields. As a result of these inconsistency, the contents of the Medication Plan may change when it is scanned compared to when it is printed out again, even though the medication itself did not change.

While in their discussions of these problems the members of the Coordination Group were mostly concerned with the costs of making the various data sources consistent, the discovery of these inconsistencies was also productive. For example, the group decided to design their own classification system for pharmaceutical forms. This move was heavily criticized by the three main database providers who feared damage to their businesses. They meanwhile cooperated to make their own classification systems for the pharmaceutical form of drugs consistent. However, the Coordination Group decided that it would continue to maintain and make available its own classification system, arguing that contents used in the Medication Plan should be in the public domain. More importantly, the group also argued that all contents of the Medication Plan must be intelligible to patients, an argument that had been made in other contexts as well, as reported above. Thus, the discovery of these data inconsistencies also contributed to a further elaboration of the re-orienting of the practices involved in medication processes by reasserting the active role of patients in its use.

While most tests of the Medication Plan involving patients concerned questions of usability and legibility, a project of the Aachen Learning Community, in which one of the authors is actively involved, studied how the Medication Plan changes the relations of the various practices by conducting reflective video conversations with patients, pharmacists, and physicians. One finding from these conversations is noteworthy. It became clear that the Medication Plan can become an occasion to bring into view the medication of a patient *as a whole*. This was most clearly articulated by a diabetes patient, but also by the physician member of the Learning Community. The patient reported how the Medication Plan had enabled thematising her medication holistically in both her interactions with her

[6] While the 'e-health law' later specified that only physicians are obliged to create and print out a Medication Plan, earlier discussions in the group show that the group also envisaged that pharmacists can create and print a Medication Plan for patients. Presently, the role of pharmacists in creating and updating the Medication Plan has not yet become clear.

physicians and her pharmacist. The most striking incidence of this concerned her interaction with a neurologist. He had refused to create a Medication Plan for her on the grounds that he was not her family doctor. However, talking about the Medication Plan led him to review her medication, subsequently finding a medication error. Thus, the talk about the Medication Plan seems to have changed the way that he views or comports to the medication, namely now in a more holistic manner. A Medication Plan was eventually created and printed by her endocrinologist. This also included the medication prescribed by the other physicians (about 6) she regularly sees as well as OTC drugs. Her pharmacist then spent about half an hour going through the Medication Plan again. Both, her family doctor and her pharmacist had initially responded rather negatively to her request to prepare and check her medication plan but then became rather enthusiastic about this. Overall, she feels that her medication has acquired a new quality – that of being reviewed and approved holistically – even in cases where the medication was not changed. Moreover, her family doctor began to be concerned with the way she takes certain drugs and has asked her to visit more often to follow up on her medication-taking practice. The patient described this as 'reining in' her drug taking practice, something that was not entirely unwelcome to her.

The physician member of the Aachen Learning Community confirmed these observations that the Medication Plan provides an occasion to concern oneself more intensively and holistically with the medication of a patient. In particular, he noted (our translation):

> My experience is that the correct filling-in of the Medication Plan requires a lot of work, a lot of thinking through; it also occasionally forces the physician to check whether everything written down there [on the Medication Plan] is still up-to-date, is it still necessary? On the other hand, it is an instrument which calls for a lot of dynamic, because the Medication Plan is normally valid only for a few weeks or months and is then changed and modified again, and this, on each occasion, requires a new thinking through of the plan and the medication. Of course, not everything will be changed, but everything must be critically evaluated, and this is an important process.

He also believes that the Medication Plan is important for both physician and patient. In addition, he sees a need to comply with regulatory intentions.

We interpret these experiences as showing that the Medication Plan is 'generative' in the sense that, in practical use and testing, it continues to generate discussions and discoveries, resulting in further re-orienting of the practices involved in medication as the opening is further elaborated. This elaboration results from an ongoing practical interpretation of the Medication Plan such that, as its possible uses and purposes come to be better understood, each participant also comes to understand their own practice better and in a more nuanced way.

## 6. Discussion

In this section, we will interpret the happening of an opening, revealed by the Medication Plan case above, as a dialectic process of opposing proximity and distance between the practices as regions of a concern. This overarching dialectic of *nearness* and *farness* can be analysed into three constituent dialectics, namely, between the *already familiar* and the *not yet familiar*, between the *self* and the *other*, and between *resistance* and *accommodation*. Each dialectic powers an aspect of the overall happening of an opening and we will describe these sub-processes in the following sub-sections. To bring out how and why these dialectical processes can be productive, we will also describe how the delicate balance of nearness and farness in each is in constant danger of being closed down.

## 6.1 Recursive Processes in an Opening

The dialectic of the *already familiar* and the *not yet familiar* is the most fragile and hidden of the three dialectics. It involves a *recursive* process because it is powered by the anticipation of a possibility which has *not yet* become manifest, but which must still be assumed to be sufficiently solid to become the *basis* for concrete action and to manifest itself as something familiar. For example, for the Medication Plan to be able to become a site of an opening, the members of the Coordination Group had to allow a possible reality for the Medication Plan to structure their discussions and thus, in a sense, to create the foundations for its own coming into existence. Consequently, there was a high risk that such intuitive action would not live-up to the expectations of participants or that it was ill-founded. As well as being productive this process creates a particular vulnerability and fragility of the opening as well.

The danger which constantly threatens to break the productive tension inherent in this recursive process is not that people refuse to allow a possible reality into their discourse – this may be the case, but would simply signify a lack of imagination – but rather, that the possible reality that announces itself in such discourse is seen merely as a 'token' for some intentions that cannot or should not in fact be expected to become actual. In other words, a rift is created between present reality and a purely symbolic world that cannot be bridged. In our example, that danger could have manifested in a discourse about the Medication Plan characterized by an expectation that the Medication Plan will never acquire any real meaning, even if used in practice. This would amount to the discussion acquiring such a token character. This danger of *tokenization* was ever present, not only in the initial discussions, but also throughout the testing of the Medication Plan and in its everyday use. Conversely, the opening for which the Medication Plan has become a site continues to be productive only if, throughout its conception and everyday use an as yet unknown and unfamiliar reality is allowed to structure the conversations about the Medication Plan and inform ways of using it. Since this recursive process accounts for the 'taking hold' of an opening, it follows that the taking hold is not a singular event after which an opening 'exists', but part of the *ongoing* becoming of the opening, and that there is an ever present danger that relations between practices may become unproductive and the opening disappears.

## 6.2 Assertive Processes in an Opening

An opening is also at risk from efforts to take over control over it – to appropriate it. For example, pharmacist members in the Coordination Group have repeatedly attempted to transform the character of the Medication Plan into a primarily pharmaceutical document through proposals to add various fields that are especially important from a pharmaceutical perspective. Likewise, members of the pharmacist and the regulatory practices have attempted to transform the Medication Plan into a coordination mechanism by proposing a detailed choreography of interactions between pharmacist and physician which would impose a narrow technical understanding of medication processes on physicians. Such efforts, however, were opposed by other members and eventually fended off.

The interplay between appropriation moves and assertive countermoves are the manifestation of another kind of process at work in the happening of an opening. Again there is a dialectic at work here because, while counter-actions mainly served to keep practices from dominating or 'colonizing' the Medication Plan as the site of the opening, they also contributed to the further working out of the relationships between the various practices. Such assertive processes are thus powered by a productive opposition between 'oneself' and 'the other'. They are productive to the extent that engagement with the other not only contributes to a better understanding of the other but also to a better understanding of one's own role and possibilities. The danger is that the opening becomes 'colonized' by one practice that imposes its way of understanding and acting on the other practices to such an extent that there is no openness to alternate perspectives.

## 6.3 Performative Processes in an Opening

There is a third process in the happening of an opening which is highly significant for its productivity. It is powered by a dialectical encounter between the materiality of the site of the opening and the human agency of the practitioners. For example, in field tests it was discovered that certain medication schedules could not be captured by the Medication Plan. Such discoveries, however, were not interpreted as uncovering deficiencies in the 'design' of the Medication Plan that should and could be eliminated by re-designing the Medication Plan as an artefact. Rather, they were *performed* in subsequent actions as disclosing further meaningful distinctions that needed somehow to be addressed. Tellingly, the Coordination Group appreciated the existence of more complex medication regimes while also resisting calls for re-designing the Medication Plan to capture such medication regimes more mechanically. Other examples concern the practical interactions of physicians and pharmacists with the Medication Plan, which led them to change their comportment toward it and to understand the medication of their patients in a more holistic manner.

We interpret such discoveries as resulting from a *performative* dialectic of resistance and accommodation in interactions between human agency and a certain 'material agency' of the site of the opening, as described by Pickering's mangle of practice concept (1995). For instance, when interacting with the Medication Plan, one does not just encounter a certain material artefact, but all the other practices involved in medication processes in a performative manner. Such encounters with the resistance offered by the site of the opening may thus be experienced as a form of 'practice resistance' (Johnston, Reimers and Klein, 2016) that calls into question or renders problematic certain aspects of one's own interpretations and understandings. By accommodating to such resistance by adjusting one's understanding and way of acting, the relationships between the various practices are further refined and elaborated. This dialectic is, therefore, also productive. The danger consists in reconciling such discrepancies in a mechanical manner, for example, by re-designing the Medication Plan to accommodate every variation that occurs in practice. Another form of 'mechanizing' the Medication Plan would be to prescribe ways of interacting through it so tightly that human agency is entirely deleted, as envisioned by the East German project. In both kinds of mechanization, a seemingly straightforward mechanical 'solution' to an existing 'problem' would be 'implemented': the result would be to close down an 'opportunity' to disclose new meaningful distinctions that support more nuanced productive relations between the practices.

In sum, the nature of an opening consists in a certain way of re-orienting the various practices to one another which is productive. Three dialectics are at work in this re-orienting: a recursive dialectic that allows an opening to take hold, an assertive dialectic that keeps multiple perspectives in play, and a performative dialectic the keeps the opening productive. Each dialectic process is powered by a distinct opposition at work among practices, namely, between the already familiar and the not yet familiar, between self and other, and between resistance and accommodation. As such, they are each aspects of a more general dialectic of nearness and farness. Together these dialectics hold the practices apart as distinct and autonomous regions of a concern, and *at the same time*, provide a site where creative tensions and new meaningful distinctions are kept in play through close productive interaction.

## 7 Conclusion

We set out to elaborate the notion of 'living infrastructure'. We drew on the example of the Medieval European City Square to suggest what a living infrastructure might consist of, and what might justify the adjective 'living' to distinguish it from traditional conceptions of infrastructure. The key idea is the notion that a living infrastructure becomes the *site* where an *opening* between certain *regions* of life, that share some *concern, happens*. This happening of the opening is an on-going process of nurturing and safeguarding certain productive oppositions between the regions of living that are at once recursive, assertive and performative in the sense developed in the previous section.

We then presented an empirical case of the Federal Unified Medication Plan for medication therapy safety in the German healthcare environment. By a careful interpretation of the case materials we sharpened our conceptual tools and showed that this Medication Plan provides a site where a productive opening happens between multiple practices involved in medication processes in pursuit of a common concern for medication therapy safety. Thus, like the City Square, the Medication Plan exemplifies our notion of living infrastructure, as displayed in Table 2.

Finally, we should briefly return to our comments at the beginning of the paper about the traditional conception of infrastructure as a material coordination system and relate them to the notion of living infrastructure. We will simply note, as discussed in the previous section, that when an infrastructure becomes tokenized, colonized or mechanized the productive tension between the regions of life lived there closes down. The infrastructure is no longer a site that holds open practices as distinctive and productive regions of life lived to the full: at most, only a mere material coordination mechanism for coordinating the transactional elements of existence remains.

Table 2. Our conceptual framework, the City Square and the Medication Plan compared

| **Concept** | **Definition** | **Examples** | |
|---|---|---|---|
| | | **The City Square** | **The Medication Plan** |
| Concern | A concern defines that aspect of human existence with which the infrastructure deals | The concern is living a good life in a city | The concern is medication therapy safety |
| Region | Regions are distinct aspects of the concern – they are distinct 'locations on a map' of the concern. | The regions are the institutions of town life – religion, state, commerce, and education/culture | The practices involved with medication – medical, pharmaceutical, patienthood, regulatory |
| Opening | An opening is the establishment of productive distinctions between the regions of the concern | The establishment of distinctions between spiritual, corporal, individual and social aspects of a good city life | The establishment of productive relations between distinct practices involved in medication processes |
| Site of an opening | Where an instance of an opening takes hold | The lived-in city square that provides the conditions of an opening between church, town hall, market and school to happen | An actual in-use Medication Plan sustains a productive opening between physician, pharmacist, patient, and regulator/insurer |
| The happening of opening | How an opening arises, is kept open, and continues to be productive | The city square as an opening happens through various on-going dialectical processes, which could be documented for any particular city square | The Medication Plan as an opening happens by: taking hold through a dialectic of the already familiar and the not yet familiar; being held open through a dialectic of self and other; and remaining productive through a dialectic of resistance and accommodation |

## References


Claßen, A., Eisert, A., Everding, W., Grebe, I., Härter, S., Hildmann, R. et al. (2015). *Arzneimitteltherapiesicherheit im Spannungsfeld von vollständiger Medikationsübersicht, mündigem Patienten und individualisierter Medikation*. Göttingen: Cuvillier Verlag.

Dreyfus, H. L. (2017). Heidegger's Ontology of Art. In *Background Practices: Essays on the Understanding of Being*, edited by M.A. Wrathall, Oxford, UK: Oxford University Press.

Edwards, P. N. (2010). *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge, MA: MIT Press.

Hanseth, O. and Lyytinen, K. (2010). Design Theory for Dynamic Complexity in Information Infrastructures: The Case of Building the Internet. In *Journal of Information Technology*, 25(1), pp. 9–19.

Heidegger, M. (1950/1971). The Thing. In *Poetry, Language, Thought,* translated by A. Hofstadter, New York: Harper & Row.

Heidegger, M. (1971). *Poetry, Language, Thought*. Translated by A. Hofstadter, New York: Harper & Row.

Johnston R. B., Reimers K. and Klein S. (2016). Performing Research Validity: A "Mangle of Practice" Approach. In *Beyond Interpretivism? New Encounters with Technology and Organization*, edited by L. Introna, D. Kavanagh, S. Kelly, W. Orlikowski and S. Scott, Cham, Switzerland: Springer, pp. 201-14.

Langley, A., Smallman, C., Tsoukas, H. and Van de Ven, A.H. (2013). Process Studies of Change in Organization and Management: Unveiling Temporality, Activity, and Flow. *Academy of Management Journal*, 38(1), 1–13.

Polt, R. (2005). Ereignis. In A *Companion to Heidegger*, edited by H.L. Dreyfus and M.A. Wrathall, Malden, MA: Blackwell.

Schmitz, R. (1998). *Geschichte der Pharmazie: Von den Anfängen bis zum Ausgang des Mittelalters*, Bd. 1: Eschborn: Govi-Verlag.

Tsoukas, H. and Chia, R. (2002). On Organizational Becoming: Rethinking Organizational Change. *Organization Science*, 13, 567–582.

Wagner, T. (2005). Interorganisationale Informationssysteme in der Distribution pharmazeutischer Produkte in Deutschland. In *Fallstudien interorganisationaler Informationssysteme -- Ergebnisse aus vier Branchen und vier Ländern*, edited by K. Reimers, T. Wagner and A. Zenke, Göttingen: Cuvillier Verlag, pp. 43–78.