



Standardization in Action: Achieving Local Universality through Medical Protocols

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Source: *Social Studies of Science*, Vol. 27, No. 2 (Apr., 1997), pp. 273-305

Published by: Sage Publications, Ltd.

Stable URL: <http://www.jstor.org/stable/285471>

Accessed: 26/01/2010 08:18

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• **ABSTRACT**

In this paper, we argue that universality is always 'local universality'. The achievement of local universality depends on how standards manage the tension involved in transforming work practices, while simultaneously being grounded in those practices. We investigate how this is done in two case studies — an oncology protocol and the Cardio Pulmonary Resuscitation (CPR) protocol. These protocols are viewed as technoscientific scripts which crystallize multiple trajectories. In the process of obtaining local universality, we illustrate how protocols feed off previous standards and practices. We then indicate how the protocols function through the distributed work of a multitude of heterogeneous actors. Finally, we argue that, in this process, the protocols themselves are necessarily changed and partially reappropriated.

Standardization in Action: Achieving Local Universality through Medical Protocols

Stefan Timmermans and Marc Berg

Universality through standardization is at the heart of medical and scientific practice.¹ In his obligatory book of passage, *Science in Action*, Bruno Latour made it the sixth principle of technoscience: 'The history of technoscience is in a large part the history of the resources scattered along networks to accelerate the mobility, faithfulness, combination, and cohesion of traces that make action at a distance possible'.² Standards aim at making actions comparable over time and space; they are mobile and stable, and can be combined with other resources. According to Latour, our task as social scientists is to follow the transformation, from weak and short to strong and long, of the networks which provide the conditions and links for the achievement of universality. In his case study of Louis Pasteur's work on the anthrax vaccine, Latour discusses how the vaccine would only work universally if the farmers respected some crucial laboratory standards such as 'disinfection, cleanliness, conservation, inoculation gesture, timing, and recording'.³ Latour

offers a detailed analysis of how Pasteur managed to change the work practices of farmers to adhere to those laboratory standards. In this process, the extension and strengthening of networks is the trick that allows universality to take place: 'Scientific facts are like trains, they do not work off their rails. You can extend the rails and connect them but you cannot drive a locomotive through a field'.⁴

We agree with this focus on the importance of establishing networks to allow universality. However, we would like to highlight two interrelated aspects of this process which tend to be under-represented in many actor-network studies. First, Latour emphasizes the process of creating associations and enrolments *de novo*. But Pasteur did not raise the world just with the anthrax vaccine: the world was already raised in many different ways. The terrible anthrax disease was fought with isolation techniques, immunology, herbal wisdom, and other forms of emerging medicine. An anthrax vaccine was one more element that was inserted into a set of already existing interests, associations, and practices. The anthrax vaccine was able to change the world through an extension — and importantly, a transformation — of networks already firmly in place.⁵ One of the central tensions in creating and achieving universalizations is the relationship with past infrastructures, procedures, and practices. Standards will attempt to change and replace those practices but, we will argue, the same standards need, to a certain degree, to incorporate and extend those routines. To understand the 'universalization' of standards, it is crucial to look at these processes of incorporation and transformation.

Second, although an actor-network analysis can in principle be written from the viewpoint of every actor in the network,⁶ in most case studies the perspective of scientists or engineers is chosen. For example, in Michel Callon's scallops study, the three scientists remain 'the primum movens'.⁷ Latour repeatedly emphasizes how Pasteur is the actor handling the lever to change the world: 'this interest of outsiders for lab experiments is not a given: it is the result of Pasteur's work in enrolling and enlisting them'.⁸ In those case studies, the result is that the prime movers become the spokespersons talking in unison for the entities which are brought together — and these entities become docile 'points' in the network. But feminist scholars have shown that the perspective of an actor-network analysis radically changes if one takes the viewpoint of those who have to be enrolled, or those who are excluded from the proposed translation.⁹ Here we argue that 'universality' does not

necessarily imply the presence of centralized (scientific) control. First of all, we will demonstrate that standardization efforts do not require a central actor — in fact, they often do without it. Achieving universality should be seen as a *distributed* activity.¹⁰ In addition, non-docile actants may well be a *sine qua non* for universality in practice. Rather than being antagonistic to it, a certain looseness in the network may be the preferred (or only possible) way to achieve standardization.

These points taken together add up to an ambiguous and precarious status of ‘universality’. We introduce the term *local universality* to address these ambiguities. Local universality emphasizes that universality always rests on real-time work, and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations. ‘Universality’, here, has become a non-transcendental term — no longer implying a rupture with the ‘local’, but transforming and emerging in and through it. To capture the way in which standardization achieves a universal character while feeding off already existing networks, to grasp the emergent and distributed qualities of universality, and to explore the consequences of local universality, we focus on the construction and use of some specific means of standardization: medical standards or protocols. In our conceptualization, *a medical standard is viewed as a technoscientific script which crystallizes multiple trajectories*.

Three elements are important in our conceptualization. First, we analyze protocols as embedding *technoscientific scripts*, a point of view which originated in Madeleine Akrich’s fieldwork.¹¹ The ‘script’ of a technological artefact refers to the hypotheses, embedded in the artefact, about the entities which make up the world in which the artefact will be inserted. A technoscientific script specifies actions, settings, and actors who are defined with specific tastes, motives, aspirations, political prejudices, and a value system. For example, the French electrical car was designed for ‘post-industrial consumers who were grappling with new social movements’.¹² The designers of the car envisaged consumers who would see cars not as status symbols but as simple, useful objects, and who would rely on public transportation and their own means of transportation. These elements — consumers wary of pollution, a post-industrial society, and public transportation — are inscribed in the script by designers and de-scribed by users.¹³ As Akrich shows, designers and users negotiate about the script to follow: still, ‘it is only when the script

set out by the designer is acted out — whether in conformity with the intentions of the designer or not — that an integrated network of technical objects and actors is stabilized'.¹⁴

The second element in our conceptualization concerns the temporal location of the different actors brought together in the protocol. Following the conceptual work of Anselm Strauss,¹⁵ each actor follows a *trajectory* which refers to a past, a present, and a possible future. For the patient, a medical event such as a cardiac arrest could be an outcome of a medical history with high cholesterol levels, high blood pressure, numerous diets, and forgotten New Year's resolutions. The doctor who orders the protocol, while, for example, following a research trajectory, sees the patient as one case in a project. The trajectory of the nurse who administers the protocol might be characterized by the tasks of her shift. Everett Hughes has hinted at the intertwining of different trajectories in the same situation when he stated that one person's emergency is another's routine.¹⁶ For the patient a coronary bypass is a life-changing event; for the surgeon, one of several done in a week.¹⁷

Not only people but things, such as measurement instruments and medications, follow trajectories as well. A particular anaesthetic drug has a research history of instances in which its use is warranted, and led to its certification by organizations such as the Federal Drug Administration; it has a lifespan of about 15 minutes when injected in a certain dose; and is expected to be absorbed by the body after an hour. A machine such as a defibrillator has a history and a life course situated in the electric heart activity it monitors and the electric shocks it administers. Things and humans alike follow trajectories flowing from their pasts towards possible futures. Protocols themselves have trajectories — they are constructed and reconstructed both by their designers and in concrete use.

Third, it is this protocol as a *standard* which intervenes in the different trajectories of patients, instruments, drugs, and staff, re-directing their courses. The protocol functions as a *crystallization* instance: in putting the protocol to work, the different trajectories are temporarily brought together and, as we will show, transformed. Crystallization refers to the fact that the protocol makes the implicit trajectories explicit in specific ways. It makes the roles and requirements of the involved actors visible: it puts forward that the goal of the doctor is to save a life or limb, and that the purpose of drug Y is to counteract hypoxic acidosis. At the same time, crystallization

emphasizes the contingent and temporary character of articulating these multiple trajectories. The roles and requirements could have been specified differently; and other scripts can and will articulate them in different ways. During the crystallization process the prescriptions of the protocol might be 'betrayed',¹⁸ or altered beyond recognition, by the actors using the protocol. Also, the trajectories of the actors might diverge for many reasons, instead of being brought together by the protocol.

Here, we follow standardization in action in the analysis of two case studies of medical protocols. Our goal is to assess how the universal character of medical protocols depends on previously established networks, how universality is contingently and collectively produced, and how localization and universality are inevitably intertwined. This analysis is based on research by the two authors. Stefan Timmermans observed 112 resuscitative efforts over a period of 14 months in the emergency departments of two US hospitals, and he complemented this empirical material by interviewing 57 emergency department personnel about their involvement with resuscitative efforts in three American and one Belgian hospital. Marc Berg studied the development of several research protocols through interviews and participatory observation, and spent two months studying the usage of research protocols in everyday medical work in a Dutch hospital.

The Protocols

Cardio Pulmonary Resuscitation (CPR) and Advanced Cardiac Life Support (ACLS) are international protocols,¹⁹ aimed at saving the lives of patients experiencing cardiac arrest or apparent sudden death resulting from electric shock, drowning, respiratory arrest, or other causes.²⁰ The three major components of CPR are securing an open airway, artificial ventilation, and closed-chest cardiac massage.²¹ As can be seen from Figure 1, the protocol details what needs to be done when, by whom, and in what order. The script of the protocol defines a rescuer, a victim, an emergency medical system, and a narrative. It assumes that the victim is kept in a supine position, and that the emergency medical system needs to be alerted before the resuscitative effort starts. The rescuer bends over the victim and is able to feel for a carotid pulse and listen for breathing; knows how to locate the xiphoid complex, and then is able to

FIGURE 1
The CPR Protocol



CPR and ECC Performance Sheet

Adult One-Rescuer CPR Name _____

Date _____

Step	Objective	Critical Performance	S	U
1. AIRWAY	Assessment: Determine unresponsiveness.	Tap or gently shake shoulder.		
	Call for help.	Shout 'Are you OK?'		
	Position the victim.	Call out 'Help!'		
	Open the airway	Turn on back as unit, if necessary, supporting head and neck (4–10 sec.)		
		Use head-tilt/chin-lift maneuver.		
2. BREATHING	Assessment: Determine breathlessness.	Maintain open airway.		
		Ear over mouth, observe chest: look, listen, feel for breathing (3–5 sec.)		
	Ventilate twice.	Maintain open airway.		
		Seal mouth and nose properly.		
		Ventilate 2 times at 1–1.5 sec/ inspiration.		
		Observe chest rise (adequate ventilation volume).		
3. CIRCULATION	Assessment: Determine pulselessness.	Allow deflation between breaths.		
		Feel for carotid pulse on near side of victim (5–10 sec)		
	Activate EMS system.			
		Maintain head-tilt with other hand.		
		If someone responded to call for help, send him/her to activate EMS system.		
		Total time, Step 1—Activate EMS system: 15–35 sec.		
	Begin chest compressions.	Rescuer kneels by victim's shoulders.		
		Landmark check prior to hand placement.		
		Proper hand position throughout.		
		Rescuer's shoulders over victim's sternum.		
		Equal compression-relaxation.		
		Compress 1½ to 2 inches.		
		Keep hands on sternum during upstroke.		
		Complete chest relaxation on upstroke.		
		Say any helpful mnemonic.		
		Compression rate: 80–100/min (15 per 9–11 sec).		
4. Compression/Ventilation Cycles	Do 4 cycles of 15 compressions and 2 ventilations.	Proper compression/ventilation ratio 15 compressions to 2 ventilations per cycle.		
		Observe chest rise: 1–5 sec/inspiration; 4 cycles/52–73 sec.		
5. Reassessment*	Determine pulselessness	Feel for carotid pulse (5 sec).† If there is no pulse, go to Step 6.		
6. Continue CPR	Ventilate twice.	Ventilate 2 times.		
	Resume compression/ventilation cycles.	Observe chest rise: 1–1.5 sec/inspiration.		
		Feel for carotid pulse every few minutes.		

* If 2nd rescuer arrives to replace 1st rescuer: (a) 2nd rescuer identifies self by saying 'I Know CPR. Can I help?' (b) 2nd rescuer then does pulse check in Step 5 and continues with Step 6. (During practice and testing only one rescuer actually ventilates the manikin. The 2nd rescuer simulates ventilation.) (c) 1st rescuer assesses the adequacy of 2nd rescuer's CPR by observing chest rise during ventilations and by checking the pulse during chest compressions.
 † If pulse is present, open airway and check for spontaneous breathing: (a) if breathing is present, maintain open airway and monitor pulse and breathing. (b) If breathing is absent, perform rescue breathing at 12 times/min and monitor pulse.

Instructor _____ Check: Satisfactory _____ Unsatisfactory _____
 Source: AHA, *Instructor's Manual for Basic Life Support* (Dallas, TX: American Heart Association, 1987, 1990), n.p.
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maintain an airway, ventilate the patient and perform chest compressions. All these different actions — the ABC sequence (or Airway, Breathing, and Circulation)²² — are ordered and coordinated by the protocol. The script of CPR is constructed in such a way that it can function in almost any setting. CPR does not require any props or additional equipment, only a hard surface and enough space to bend over the patient. Finally, the values inscribed in CPR are that lives are worth saving and should be saved fast.²³

FRAM-6 is an oncological research protocol for the treatment of patients with Hodgkin's disease²⁴ who have not reacted adequately to 'ordinary' chemotherapeutic treatment. For patients deemed suitable, the protocol prescribes so-called 'high-dose' chemotherapeutic treatment, followed by bone marrow transplantation. The protocol is an 'international collaborative study', in which nine Dutch and two American centres participate. The 30-page manuscript starts by discussing the background to the study (the reasons for selecting this disease and these drugs), and outlines the study's objective and its design. After summarizing the known information on the drugs used in the protocol, the patients' eligibility criteria are discussed. To name a few:

- patients must have histologically proven Hodgkin's disease at diagnosis.
- patients should have shown resistance to MOPP,²⁵ as shown by either progression while receiving MOPP, or failure to achieve a Complete Remission after six cycles of MOPP, or relapse within a year of completion of MOPP.
- patients must have adequate cardiac (≥ 0.5 ejection fraction) and pulmonary function (vital capacity $\geq 70\%$ of predicted and a diffusion capacity of $\geq 50\%$), and so forth.

The treatment plan requires patients first to receive two courses of cisplatin, cytarabine, and dexamethosone (abbreviated as DHAP), in three-to-four-week cycles. If hematological or renal toxicity should occur, the doses should be reduced, according to included tables (see Table 1). Next, the high-dose chemotherapy regimen is outlined (see Table 2). This table is explained as follows:

- CYCLOPHOSPHAMIDE: 1.5 g/m² will be dissolved in 500 cc of D5/W and given over two hours intravenously daily for 4 days (days -6 through -3).

TABLE 1
Dose Reduction in Case of Renal Toxicity

Serum Creatinine (mg/% μ mol/l)		Creatinine Clearance (cc/min)	Modification Cisplatin
0.6–1.4	or	> 60	None
50–120			
1.5–2.0	or	40–60	25% reduction of CDDP
130–180			
> 2.0	or	< 40	Delete DDP
> 180			

Source: FRAM-6 protocol.

- BCNU:²⁶ 300 mg/m² will be dissolved in 100 cc of D5/W and will be given IV piggyback over 30 minutes on day –6 only.
- ETOPOSIDE: will be started on day –6 and given two times/day for three days, each dose being 125 mg/m². Etoposide is dissolved in D5/W NS at a concentration of 1.0 mg/ml and infused intravenously at the rate of 250 mg/hr. To ensure stability of the drug at this concentration, doses greater than 250 mg will be divided into bags of equal strengths. The pharmacy will mix each bag on call after the completion of the previous dose.

The protocol further specifies that patients will be admitted to the hospital for the duration of the treatment programme:

Patients shall be nursed either in the protective environment or in a private room.
All patients shall receive oral prophylactic antibiotics starting 10 days prior to

TABLE 2
Chemotherapy Regimen

	Day						
	–6	–5	–4	–3	–2	–1	0
BCNU 300 mg/m ²	X						
Cyclophosphamide 1.5 g/m ²	X	X	X	X			
Etoposide 125 mg/m ²	X	X	X				
ABMT							X

Source: FRAM-6 protocol.

[high dose treatment] in order to provide selective decontamination of the gastrointestinal tract. This will be done according to local protocols. Patients shall be discharged from the hospital when the absolute granulocyte count is over $500/\text{mm}^3$ for two consecutive days.

The resuscitation and oncology protocols are very different. In most Western countries CPR is a default treatment for sudden death. Although the protocol is tinkered with every couple of years during an international conference, the ABC of resuscitation is taught in a drill-like fashion. In order to be successful it should be used by 'lay' and medical people alike. Literally 'anyone, anywhere' should be resuscitated.²⁷ In contrast, FRAM-6 is primarily aimed at gathering research findings for a new treatment plan. Careful procedures to secure informed consent and elaborate deliberations need to be followed if patients are to be included in the protocol. Linking a particular patient to the protocol is a strictly medical prerogative.

But the important similarity is that both protocols standardize a set of practices, actors, and situations. They intervene in a specified situation and prescribe a set of medical interventions which should be performed in a similar way, to achieve results which are comparable over time and space. According to the protocol designers, it should not matter whether a housewife or a retired golf player resuscitates a person suffering from a cardiac arrest, whether they know the patient or not, whether the patient is transported to a small rural emergency department or to a major teaching hospital. What matters is that the first responders, the paramedics, and the emergency department follow the steps of the protocol. Similarly, once a patient fulfils the FRAM-6 criteria and is included in the study, the protocol designers and people interpreting the results obtained from the study assume that the protocol follows its pre-charted course.

To understand the functioning of protocols, we will analyze them as technoscientific scripts which crystallize multiple trajectories. It is important to point out that a technoscientific script is not simply equal to the prescriptions in the protocol. Some of the roles a script defines might be drawn directly from the text, such as the precise dosage of Cyclophosphamide and the expected toxicity it can bring. Similarly, the script prescribes meticulously who the patient is, what the role of the pharmacist is ('who shall mix the bag of Etoposide on call'), the rescuer, and so forth. However, when the protocol is studied as an artefact immersed in practice, more trajectories appear to be affected, and in more ways than is apparent from a bare reading of its text. The interests at stake, the redistribution of costs,

the research careers involved, the technologies which are skipped, the laboratory tests which are deemed more crucial than others — all these issues often only come into view when the protocol is being implemented and/or used. Only then does it become clear what is *not* explicitly mentioned in the protocol, how the protocol changes pre-existing practices, what stipulations are assumed but are not explicitly written out. The sheer scope and depth of both protocols' impacts on patients lives, histories and futures, for example, go far beyond anything explicated in the protocols — however meticulously the virtual patient is dissected in their pages.

It is, in our view, in this extended layer of reverberations where the significance of the concept of 'script' lies. It is to this deep influencing and reshaping of a broad and heterogeneous array of trajectories that we think attention needs to be drawn. In the next section, we will show how universality is achieved during the creation of the medical protocols.

Historical Trajectories of Local Universality

Research protocols, such as oncology protocols, are the contingent outcome of processes of negotiations between heterogeneous actors, as the following fragment (based on fieldnotes and derived from a discussion of a new research protocol) illustrates:

Together with Pearson, a pulmonologist, oncologist Jeff Bear discusses Peters' last version of his research protocol. Ross Peters is a resident working on his PhD thesis, and Bear is Peters' supervisor. The protocol they are discussing should become a chapter in Peters' thesis — and, if possible, a publication in a renowned oncology journal. Following Bear's suggestion, Peters has written a draft for Peripheral Stem Cell transplant therapy for patients with small-cell carcinoma of the lung.²⁸ This is an aggressive form of lung cancer, which does not react very well to traditional chemotherapy. Drawing from a plethora of studies, Peters comes up with suggestions to add to the list of drugs he uses in the protocol. It is a variation of an existing protocol designed for Hodgkin's Disease. They discuss the steps in the draft. 'Were we going to check contamination of the peripheral blood? [whether cancer cells are present in the blood, which might then be present in the peripheral stem cell transplantation as well]', asks Peters. 'No', Bear says. 'We shouldn't do that. That is too costly and time-consuming, and it is quite hard to achieve good results. So we better skip that.' They discuss radiotherapy, but Bear says that he has not been able to persuade the radiologists to cooperate: they apparently do not believe in local irradiation in such patients. Pearson objects to the BCNU, one of the high-dose drugs: 'I've never seen that

work.' Peters counters that he has some articles claiming some effect, but Bear sides with Pearson and says that we can do without that. Peters is silent: he realizes that Bear is eager to keep Pearson interested; all the patients, after all, have to be entered by the pulmonologists, who 'have' the lung-cancer patients. 'Now we have room for something else', Bear says. 'What about Carbo?' Pearson asks. 'Well, that would be excellent', Bear says, 'but then we'd have to get into a fight with our dispensary again. It's a terribly expensive drug, and it'd have to be paid for by his budget. You'd have to count on \$4000 per patient in these amounts. And I could try to use some other funding, but that would take so much time and trouble to arrange'.

The protocol designers, funding agencies, the different groups of involved physicians, patients' hopes and desires, organizational facilities, laboratory capabilities, drug companies, the patients' organs' own resilience, and so forth, all come into play in the negotiation processes leading up to the 'final' protocol.²⁹ What kind of drugs are used, how they are to be dosed, who should receive them: all these 'decisions' are not so much a product of consciously developed plans as a result of these continuous, dispersed and often contingent interactions. The actual shape of the tool, in other words, resembles no one 'blueprint' but is accomplished 'in-course'.³⁰

In addition, the widespread usage of research protocols in the field of oncology can only be understood by the dispersed force of many previous network-building activities.³¹ Oncology practices, partially through their historical ties with research protocols, are already heavily pre-structured in ways congenial to new protocols. Through time, the settings in which they function have become configured in such a way as to ensure a relatively smooth fit between tool and practice. Medical personnel are used to these intervening instruments, the ward's infrastructure is already pre-structured to provide the complex chemotherapeutic treatments on the required strictly regulated basis, and data items or criteria are often taken over from earlier protocols. Moreover, research protocols thrive on the existence of institutions that aid in the proper execution of protocols, financially reward compliance, distribute centralized equipment, and so on. Similarly, practices have become more amenable for research protocols through such developments as the expansion of administrative bureaucracy, standardization efforts, the increasing usage of uniformly 'packaged' technologies, increasing computerization of laboratories, and so forth.³²

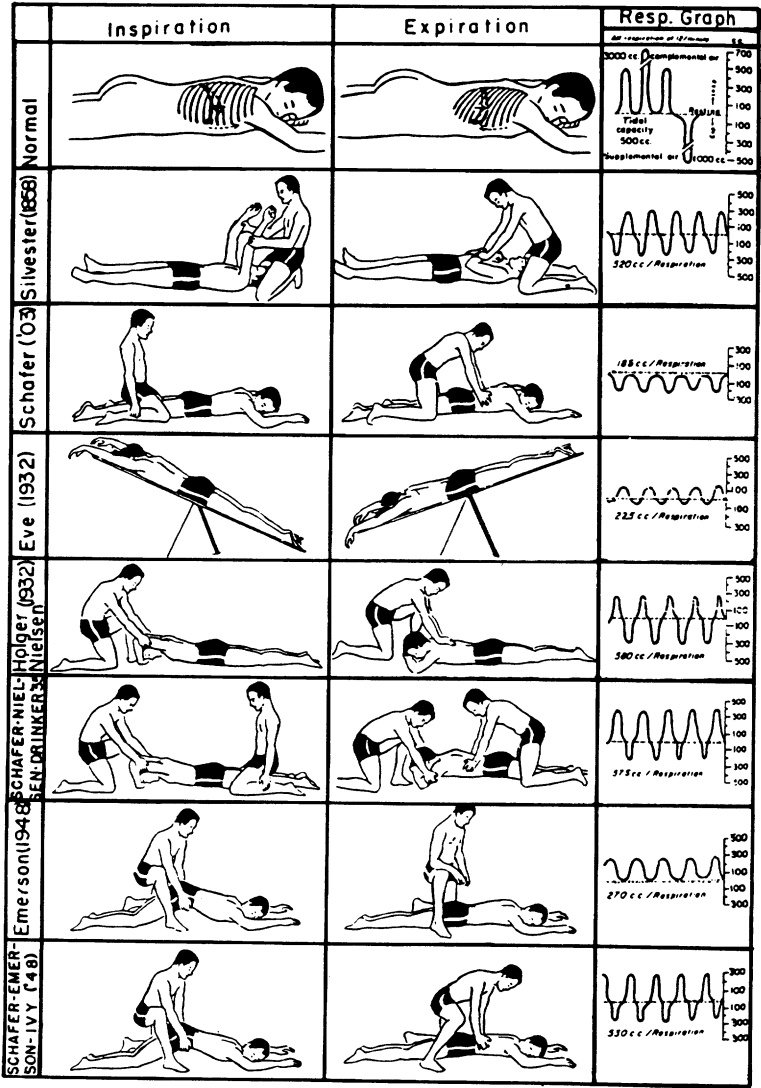
This same process of grafting on to a strongly pre-configured world can be seen in the case of resuscitation protocols. At this moment, CPR and its more advanced twin protocol, ACLS, are the

only ways in Western medicine to save patients who suffer from a cardiac arrest.³³ However, these are fairly recent developments. From the turn of the century up until World War II, the Schafer or prone pressure technique was considered the best technique to restore life.³⁴ After 1944, this method was discredited, and was replaced by an array of manual ventilation techniques, aimed at restoring inspiration and expiration by alternately pushing and pulling diverse body parts (see Figure 2).³⁵ This menu of manual resuscitation techniques was in turn replaced by mouth-to-mouth ventilation. Before 1960, resuscitation was thus a matter of artificially restoring the ventilation. CPR was formulated for the first time in 1960 when closed-chest cardiac massage was discovered, and combined with mouth-to-mouth ventilation.³⁶

At every transition point, the previous technique was disqualified after extensive medical testing, and the next technique was hailed as being more effective, and having the potential to save more lives.³⁷ In each situation, medical researchers presented their findings as definitive, solid, simple, and fool-proof. The national conferences at which they presented their findings concluded with the recommendation that the research phase was over and that all efforts should be put into educating and training the public. But every time the researchers were proved wrong when new developments showed that the current techniques were unsatisfactory (manual and only mouth-to-mouth techniques),³⁸ or plainly ineffective (in the case of the Schafer technique).³⁹ Even now, part of the technique and protocols are altered every eight years at national conferences, and research is geared at finding ways to resuscitate not only lungs and heart but also the brain.⁴⁰

In 1960, mouth-to-mouth ventilation, one of CPR's two core components, was already taught to the general public while surgeons practised open-chest cardiac massage.⁴¹ The technique and protocols clearly benefited from an infrastructure which was in place. In the US, the American Red Cross, diverse electric utility organizations, the Armed Forces, and Scouting groups had been teaching the succession of resuscitation techniques. Before CPR was even developed, it was already decided that a resuscitation script needed to be applicable in every setting, be simple enough to be learned by adults and children alike, and should not require any props. Also, along with the development of the resuscitation protocols, an entire emergency medical system consisting of ambulances with paramedics, centralized rescue phones, and emergency medical

FIGURE 2
Inspiratory and Expiratory Phases of Normal Respiration



Source: Archer S. Gordon, David S. Fainer and A. C. Ivy, 'Artificial Respiration: A New Method and a Comparative Study of Different Methods in Adults', *JAMA*, Vol. 144, No. 17 (23 December 1950), 1455-64, at 1456.

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departments in hospitals was developed.⁴² The resuscitation protocols tapped into these resources and flourished along with this infrastructure: their emergence and current shape can only be understood if their origin is seen as highly dispersed and pre-structured.

There was also not just one mastermind (or even one organization) that centralized the discovery-dissemination-usage of resuscitative efforts. When Kouwenhoven and his collaborators discovered closed-chest cardiac massage in 1960,⁴³ they envisaged a protocol in which people would resuscitate victims by performing only heart massage. However, other researchers and other agencies almost immediately incorporated the new technique within existing protocols.⁴⁴ Also, performance of CPR by the general public involved a long struggle in which different actors such as patient organizations, the Red Cross, and utility organizations argued with medical professionals. The first obstacle was surgeons who, up until 1960, had exclusively performed open-heart cardiac massage. The surgeons were sceptical that closed-chest cardiac massage would be as effective as open-heart massage, and they were unwilling to give up their privileged practice.⁴⁵ However, the fact that closed-chest massages were not plagued by serious infection problems was an important advantage over open-heart massage.⁴⁶ A second difficulty arose when medical researchers published an alarming number of case studies in which closed-chest massage caused broken ribs and punctured lungs, livers, and other organs.⁴⁷ Along with the argument that the general public could not be trusted to assess a patient and would endanger the victim by applying the technique in improper situations, this posed long delays in opening up the technique for the general public.⁴⁸ Only in 1973, after many studies by different researchers and lobbying work by several organizations, were 'lay' people allowed to perform CPR.⁴⁹ In 1977, the American Heart Association made resuscitation protocols central to its mission, and became one of several spokespersons for the technique. Even today, many researchers make a career out of improving resuscitation techniques and protocols, while right-to-die proponents attempt to challenge the default character of resuscitation protocols. Several groups now act as spokespersons for the technique.⁵⁰

The protocols here discussed indeed 'managed to raise the world'.⁵¹ Resuscitation protocols now are a default option for sudden deaths, and FRAM-6 and its contemporaries have shaped

the appearance of modern oncology. All importantly latched on to (and transformed) existing trajectories of other actors. The resuscitation protocols replaced previous protocols and guidelines, and were inserted in a pre-existing educational infrastructure. Sceptical surgeons and the entire medical profession were convinced that universal lay CPR was a better alternative than merely mouth-to-mouth ventilation or open-chest cardiac massage. In addition, the CPR protocol hooked up with the emergency medical system, and the protocol became established in and through the rapid growth of this system. The creation of a protocol, then, is the result of work widely and loosely dispersed through space and time. Neither its origin nor its development can be traced back to singularities — whether a central actor or a central historical event. It is a struggle fought on many different fronts, in different times, by many different network-builders. The protocol *itself* materializes contingently out of the crystallization of multiple trajectories, yet its ‘universal’ content can never be wholly traced back to the interests, hopes, or goals of any of these.

The creation of a protocol is open-ended; closure is never really achieved. Creators often end up as the first users of their inventions, systems, or protocols. Users blend together with creators when they record their experiences, send feedback to researchers, and modify the protocol itself. Next, we examine the protocols in practice, demonstrating the multiplicity of local universality. Taking our analysis one step further, we demonstrate that this multiplicity is *essential* for the protocol to operate.

Practices of Local Universality

Discussions about introducing and using protocols in the medical literature abound with images of domination. Critics argue that by determining the path of action, the protocols render physicians’ skills superfluous. Physicians would merely have to be able to understand directions, and do what they are told; they would certainly not be expected to think for themselves. The doctor would be reduced ‘to a mindless cook’.⁵² The American Heart Association literally warns: ‘The team leader must be ever observant. Though the algorithms provide a good “cookbook”, the team leader must remain a “thinking cook”’.⁵³ In short, protocols can become a form of ‘tyrannical domination’ against which physicians’ discretion

should be protected.⁵⁴ Universality, in this view, necessarily comes about through domination, through unequivocally subjecting the course of involved trajectories to the network-builder's goals — that is, to the protocol designers. On this issue of domination, actor-network accounts often produce similar tales. Although such accounts would oppose simplistic 'deskilling' stories and rather speak of skills that are redelegated (see further), creating universality implies extending the network by enrolling and 'tying together' more and more allies. As the central network-builder gains strength, as the network tightens, the individual elements in the network are made increasingly docile.⁵⁵

We have shown already how the origin of universal standards is the result of historically situated, distributed work of a multitude of actors. Similarly, we want to draw attention to *mutuality* in the real-time process of making and maintaining the links of the trajectories to the protocol's script. In observing the utilization of research protocols in medical practices, the first thing that becomes obvious is how patients and medical personnel are *not* turned into mindless followers of some pre-set script. On the contrary, seen from their perspectives, it is the *protocol's trajectory which is secondary* and which is aligned to their own goals and trajectories, if need be. For all those involved, the protocol is an additional, sometimes highly relevant, factor in the shaping of their own trajectory, but it is dealt with in terms of local specificities.⁵⁶

For example, viewed from the trajectory of patients, a protocol such as FRAM-6 is a source of hope, often the only perceived means to combat the disease that has stricken them. For many patients enrolled in FRAM-6, the research protocol in which they participate is the last Western medical therapy possible with (albeit little) chance of cure. They rarely care about the research goals of the protocol (although some patients sometimes do); all they care about is preserving life and creating a possible future. Drawing upon the protocol in this way, patients will often negotiate their eligibility for a protocol, try to adjust the times of the chemotherapy courses to their convenience, or skip courses when they no longer see a meaningful link between their own future and the protocol's trajectory. Similarly, some protocols require patients to register the amount of fluids or food they take in, or the quantities of urine they produce. Here as well, patients are sometimes little motivated to fulfil these chores, which they often see as 'superfluous'.

Protocols also vary in importance in the trajectories of medical workers as individuals and professional groups. FRAM-6 and similar protocols are tied to the research interests of many oncologists and nurses. A major reason why the physicians Peters, Bear, and Pearson go through all the trouble of refining the protocol criteria and drugs is that their careers are tied up with publishing research results. Also, the protocol affords them, and the institution in which they work, status, new patients, and so forth. Protocols allow nurses contact with new drugs, with new possibilities for cure, with a wider variety of patients and treatment plans, and with the status and career-opportunities that come with clinical research work in highly-specialized fields. But all these reasons are no guarantee that the protocol will be followed to the minutest detail.

Thus when a nurse remarks in an interview: 'I don't think that anybody follows the protocol strictly', it should be viewed as an instance of protocol reappropriation by medical personnel. In the case of the resuscitation protocols, several respondents emphasized that the protocols are mainly written guidelines, and that many years of experience or a strong familiarity with the literature supersedes following the protocol to the letter.⁵⁷ The following example underscores how the protocol becomes 'do-able' in light of patient and staff trajectories.⁵⁸

In a regional oncology meeting, Grafson, a young man suffering from Hodgkin's disease, is discussed. He has had an early relapse after MOPP treatment, and the bone-scan shows several infiltrations in his skeleton. The question from the oncologist of a nearby hospital is whether this patient would be eligible for FRAM-6, in which case he can refer him to West University Hospital. The discussion centres around whether bone-infiltrations preclude bone-marrow transplantation: the bone marrow could then itself contain tumorous cells, which would be reinfused *after* the high-dose therapy. The protocol, however, does not exclude such patients: it merely demands that the bone marrow, upon puncture, is 'clean'. Still, the physicians doubt whether they want to take this risk. 'It's safety first', one of them remarks. 'We can also use one of his family-members as a bone-marrow donor'. This, however, is a less established approach in these types of patients — and FRAM-6 would not apply. 'And if we go outside of FRAM-6', the oncologist continues, 'we can think whether we know any better drugs than DHAP. We're out of the protocol now anyway'.

For the physicians discussing Grafson, FRAM-6 was one of the possible things they could do for this patient. Patient interests, here, are primary. Rather than searching for the right patients for the protocol,⁵⁹ oncologists often *search for the right protocol for their*

patient. FRAM-6 did not exclude Grafson — but the physicians chose not to enrol him anyway.⁶⁰

Similar situations, in which protocols are tinkered with in the light of the patient's condition, arise in resuscitative efforts. In certain regions of Belgium, a paramedic and nurse always have to start and continue a resuscitative effort until an emergency physician arrives and decides to quit the life-saving attempt. However, in interviews nurses confided that in certain situations they disregarded those standing orders:

Depending on the physician who is on duty and will arrive in the second ambulance, we will not start the very hopeless resuscitations. This would happen, for example, with a patient who hanged himself and whose mouth is already stiffening. In principle, we should start on those patients.

With certain patients, greater deviation from the protocol's prescriptions is practised. A physician gives an example in which she combines the guidelines of several of the protocols written for specific EKG rhythms in resuscitative efforts:

What we do more is we combine some of the protocols together. All of a sudden you are in asystole and then all of a sudden you go in, what is called, pulseless activity. So you treat asystole and they start gaining a little and they go into a different rhythm, so you are going back and forth. However, I try to stay mainly within the guidelines.

Often, nurses and other health care personnel, although not in charge, grab more control than allotted to them in the protocol, and attempt to influence both the courses and the final outcomes of protocols.⁶¹ For example, during resuscitative efforts, we regularly observed nurses dropping hints to inexperienced physicians that there probably was not much they could do for the patient, or suggesting other treatments instead. A nurse labelled this process 'egging them along'. A house officer⁶² described her task as being 'a constant reminder' to the team, and readily admitted that her reminders were aimed at what she considered fair results. A colleague gave an example:

There was a resuscitative effort not so long ago where the patient was a drug addict and we are going through the code and I say: 'This guy is a known drug addict'. And the doctor turns around and says smartly: 'No kidding'. 'Well', I say, 'you might want to try some N'. And he said: 'Oh, okay yes, that is probably a good idea'.

In this case, the nurse's reminder is a subtle way of prompting the physician to a more aggressive treatment. If a different result is

anticipated, the nurse in charge of the resuscitative effort might choose not to remind physicians of the next step in the protocol or, and this happens regularly, opt for not mentioning variations in physical parameters which warrant a change in the protocol.

Often, medical personnel go beyond the boundaries of the medical protocols in adjusting them to their primary work tasks. The use of magnesium sulphate in resuscitative efforts is such an example. Although this drug is not part of the protocols, it is sometimes given as a last resort. One respondent explained: 'It's like throwing the kitchen sink at them'. Researchers cannot explain the effects of magnesium sulphate, which is labelled a 'voodoo drug' or a 'radical Swedish thing' [physician in interview]. Nevertheless, some cardiologists use the drug in resuscitative efforts, arguing that it appears to be beneficial for certain categories of patients. Similarly, protocols can be primarily a means to obtain drugs free of charge (in the case of industry-subsidized trials, for example), or a place where a patient can be sent for whom 'there is really nothing more to do' — so that the final verdict can be delayed. A protocol to save lives can be used to give family members the opportunity to come to grips with the impending death, rather than being an attempt to revive a patient.⁶³ The cycles of drugs, compressions, and ventilations are then repeated mainly to stretch time, and to allow the physician to 'soften the blow for the family'.⁶⁴ Likewise, an emergency department team might work through the resuscitation protocol in order not to discourage paramedics who brought in a patient on whom they worked very hard, but who is considered non-viable.⁶⁵

In all of these examples, the protocol's explicit written demands are tinkered with to make the protocol workable in practice — to articulate the protocol's demands to heterogeneous actors' own trajectories. The strict guidelines of protocols are thus considerably loosened in light of the multiplicity of trajectories which were brought together by the protocol in the first place. This tinkering with the protocol, however, is not an empirical fact showing the limits of standardization in practice. We do not point at these instances in order to demonstrate the 'resistance' of actors to domination. Rather, we argue that the ongoing subordination and (re)articulation of the protocol to meet the primary goals of the actors involved is a *sine qua non for the functioning of the protocol in the first place*. Leaving the enrolled actors some leeway or discretion is often the preferred way to ensure their cooperation.⁶⁶ For example, total control of physicians' doings and non-doings is

impossible in current medical practice; they would simply not cooperate, or sabotage the protocol by not entering patients. Without the pulmonologist Pearson's support, Peters' protocol would lie dormant forever; nobody would be deemed 'eligible' by the pulmonologists. So Bear is quick to get rid of some drugs mentioned in the protocol when Pearson seems to disagree. Whether Bear agrees with Pearson's doubts is irrelevant. For nurses, similarly, attempting total protocol control can lead to subtle sabotage. By 'working to the rule', nurses can create total chaos; or by informing patients in the 'right' way, they can ensure that no patient gives permission for a certain research protocol to be used on them.

Attempting to control too tightly is infeasible for many of the non-human elements as well: white blood cells can behave erratically; X-rays can show unexpected results; drugs can cause rare side effects; machines might break down — all matters which, when too tightly prescribed, would continually explode the meticulously prescribed path of the protocol.⁶⁷ Finally, as ethnomethodological texts have repeatedly shown,⁶⁸ full control in specifications is impossible. Even if one stipulates in 347 pages how two workers need to change a light bulb in a nuclear plant,⁶⁹ the guidelines simply cannot capture the full extent of the requisite work in the finest details. All such attempts are necessarily at once overcomplete *and* continually indeterminate.⁷⁰

Granted the practical infeasibility of a network which consists of fully docile elements, given the phenomenon that all these elements are themselves already part and parcel of cross-cutting trajectories, standardization cannot be seen as the extension of increasingly tight and irreversible networks. Standardization does not necessarily emerge out of an ever increasing docility of the individual entities which constitute the network involved. Yet how does standardization then emerge? How can non-docile elements result in something which, at the overall level, warrants the label 'universality'? The point is that the looseness of the network we witnessed here can be turned into a stabilizing feature.⁷¹ In the practices studied here, standardization was achieved, in part, through delegating the task of maintaining and producing the protocol's requirements in real time to medical personnel. Their active (*not* mindless) support is crucial to maintain the protocol's trajectory on course. Continually, unforeseen contingencies occur, threatening the protocol's path; continually, nurses or physicians have to take *ad hoc* measures to keep the protocol functioning:

John, senior resident, is doing some paper work when a nurse comes up to him. 'John, look here, they messed this up. FRAM-6 says you need this drug dissolved in 500 ml NaCl — and the pharmacy dissolved it in 1000 ml. What do I do now?'. John checks the protocol's drug-schedule: 'Well . . . I don't think it's too problematic . . . look, if you must reduce that 1000 ml of NaCl to 500, he will get the same total amount'.

Dispensaries dissolve drugs erroneously, protocols can exert too high demands on a patient's veins (doing four blood cultures a day requires puncturing a vein four times), doctors' mistakes have to be corrected by nurses, and so on. A sudden dip in the white blood cell counts can require *ad hoc* intervention to keep the patient's trajectory linked to the protocol. Here, a nurse sums up in an interview what is involved in making a protocol work with patients, families, residents, and getting to *know* a new protocol:

Look, all those protocols. It's interesting stuff. But they [the physicians] tend to just dump these things on us. I mean, they tell us we're such a great ward, so capable and all that. But then they just hand us the protocol and tell us that 'they'll hear from us when there is a problem'. They don't realize the extra work it takes, the extra time you have to spend with family. And if it is a new protocol, and they don't give us the details, what *can* we tell the family? How sick are they going to be? When? If they don't tell us, if we don't *know* how these protocols tick, we're at a loss when we've got to inform them. Also, you get more insecure when, say, a fever develops. If you know the protocol, you know, for instance, that a brief fever at time X is nothing to worry about; that you don't need to do a blood culture (which you're supposed to according to our in-house protocols), since that will be lots of wasted work for nothing. And even if there is an inexperienced resident, who is unsure about this fever, we can still steer them in the right direction. That's no problem. They ask us for the right dosages for medication all the time. But if you don't *know* the protocol, again, we also do not know what to expect — and you end up doing more blood cultures, harassing the patient sometimes four times a day, doing more X-rays, and so forth.

Tinkering, having the leeway to adjust the protocol to unforeseen events and repair unworkable prescriptions is a *prerequisite* for the protocol's functioning.⁷² In these practices, the overall stability of the network is at the same time challenged *and* dependent upon the instabilities within its configuration. This often comes down to actors repairing *each others'* interpretations of, or deviations from, the protocol: respiratory therapists intervene whenever a patient interprets a protocol's guidelines too liberally, or when a physician mistakenly attempts to inject a drug instead of adding it to the intravenous lines. Residents repair the omissions of their superiors, of the pharmacy, or of nurses, and so forth. The required compliance with the protocol's script is continually eroded by the

tendency to adjust the tool's demands to the exigencies of the actors' own trajectories; on the other hand, the different actors also continually repair appearing cracks when adherence to the protocol helps them to shape their own trajectory.

One form this repair and maintenance often takes is *reminding* — most often done by physicians and nurses.⁷³ Reminding becomes an issue in resuscitation situations where the (non-recovery) outcome of the effort is often known after a couple of minutes, but where the protocol prescribes ten to fifteen minutes of action. In order to counteract the lack of motivation (and to avoid a self-fulfilling prophecy), a nurse or physician will remind the team that they are supposed to follow protocols. Here is one example of such a cueing during a resuscitative effort:

The patient arrives with the ambulance. When the nurse sees the condition the patient is in, she sends a respiratory therapist back to the Operating Room, saying: 'You can go. He's pretty much . . .'. She makes a slicing movement with her hand under her head. [Next, the patient is shocked twice and given medication.] The physician in charge asks: 'Do we have a temperature for this patient?' The nurse puts the thermometer in the ear and says: 'It's 99.8'. On the monitor the patient seems to go back into ventricular fibrillation. The physician asks to shock again. When the nurse and technician keep talking about a class they are taking, he exclaims: 'Come on, people. This is a code'.

The statement, 'this is a code', is a disciplining reminder to the team that although the patient might not make it, the physician wanted the basic step of the protocol (ventricular fibrillation needs to be defibrillated) executed.⁷⁴ Similarly, machines might need a recalibration or replacement when they fail or fall out of sync with the expectations specified in protocols. In all those situations, the protocol's trajectory has become too subservient to the primary trajectory at hand. Instead of coordinated unison, the result may become a cluttered disarray or no action at all. The common ground that the protocol provided is lost. No crystallization will occur. This not only threatens the issue of standardization or universality, but also, more profoundly, the ontology of the protocol. A resuscitative effort in which protocols are not followed is no longer a life-saving attempt. Oncological treatments which stray too far from protocols lose their reasons for existence. Reminders to protocol users by other users is a real-time means of maintaining the protocol's structuring role.⁷⁵

Discussion: The Legacy of Local Universality

The functioning of these protocols rests on distributed work: protocol designers, medical personnel and patients (among others) are all crucial in achieving the temporary articulation of the diverse, heterogeneous trajectories involved — including their own. The outcome of all this work is a crystallization of an already existing world, and simultaneously also a crystallization of a changed world. The world is the same because protocols feed off existing infrastructures and power relationships. In the protocols we studied, the physician remained in charge and carried the final responsibility, while nurses provided the necessary repairwork so that the hierarchical impression could be maintained.⁷⁶ The physician's permission had to be secured before the protocol could be introduced on the oncology ward or in the emergency department; nurses administered the drugs and, more generally, provided the direct patient care at the bedside. Technicians, pharmacists, respiratory therapists, chaplains and social workers were all enrolled in the protocols in ways that reinforced pre-existing institutional relations. Similarly, the research protocol itself is grounded in a well-established research tradition in which prestige and status is measured in publications in highly acclaimed journals, and resuscitation protocols are aligned with an elaborate emergency medical system.

The world also remains the same in the sense that it preserves and perpetuates local variations and cultural traditions. The same American CPR protocol is, in Belgium, aimed at 'reanimating' a patient, while in the US the goal is to 'resuscitate' a patient.⁷⁷ Reanimation (bringing back the *anima*) includes reviving cerebral functioning, while resuscitating is limited to restoring cardiac and respiratory functions.⁷⁸ Research protocols consolidate the hierarchical divisions between hospitals, and more often than not carry local definitions of 'appropriate therapies' or 'suitable diagnostics' which are not accepted by others. North-American protocols are often dismissed by European oncologists as overly aggressive, while within Europe the Dutch perceive the French as highly interventionist, and so on. Similarly, US oncology centres sometimes cannot participate in European clinical trials. For some types of cancer, for example, bone-marrow therapy was already a 'standard therapy' in the US, so that it could not be compared to 'conventional' chemotherapeutic treatment, which was still feasible in Europe.⁷⁹

But the world is also changed with medical protocols: through the continuous infrastructural work of all those involved,⁸⁰ the protocol allows more complex and detailed treatment plans to become possible. Once implemented, the protocol can articulate activities and events over time and space — staff members can delegate coordinating tasks to it, transforming the nature of their work. With CPR some lives are saved, and with FRAM-6 a new treatment plan is being tested. The protocol, in this network, is an active transformative agent, articulating and revising the involved trajectories in novel ways.

A protocol can be depicted as a *coordinating tool*.⁸¹ throughout its path, it contains explicit criteria on whether, when and how next steps are to be taken. Personnel delegate some of their coordinating tasks to it, and the protocol appoints specific tasks to them. It is there to create (a new) order, to realign the heterogeneous elements of the practice so as to reproduce some 'optimal' approach. It articulates activities over different sites and times: nurses know when to do which laboratory tests, when to shift from one chemotherapeutic drug to another, and when to start which emergency procedure. Likewise, physicians know when what is expected of them, and how their actions fit in the overall picture.

Through this redelegation of tasks, several goals can be served. In addition to being a carrier of prescriptions for 'good medical practice', a protocol can, and typically does, *increase the overall complexity* of activities through taking coordinating tasks out of the hands of the medical staff. Both the highly complex oncological treatment schedules and the intricate procedures of the emergency department's resuscitative effort, for instance, are only possible through the protocol's core role. Only through its continual presence as coordinator, as a 'list' of pre-set articulations,⁸² can these complex tasks be smoothly fulfilled.

Finally, protocols can create *comparability of activities over time and place*. Latour has drawn the attention of students of science to the work involved in transporting a fact out of the laboratory. Alliances have to be forged in order to turn a lab into an obligatory point of passage, and once the 'facts' have left the hands of their creators, controlling their usage or interpretation is even more difficult. This is the art of metrology, as Latour has aptly named it, the work of constructing the infrastructure without which a 'fact' or 'technology' would not travel very far.⁸³ In this light, the resuscitation protocols and FRAM-6 are remarkable metrological tools.

They collapse the two problems of constructing a fact and of exporting it to the outer world into one, by finding a means to construct knowledge in the very place where the protocols will have to be used.⁸⁴ Only through the performance of actions relatively standardized over space and time does the generation of knowledge about the effectiveness of resuscitation, or the effect of the experimental chemotherapeutic combination, become possible. Equally, only through the presence of these same protocols can the facts become a part of everyday medical practice. The protocols, thus, turn *practice itself into a laboratory*: by prescribing highly detailed sequences of action, they become the means through which facts can be *produced* and, at the same time, a crucial part of the networks through which the facts can be *performed*.⁸⁵

The core of universality lies precisely in the changes built up on local infrastructures. *Universality is always local universality*. We have chosen this ironic, seeming contradiction in terms to express the fundamental ambiguity of 'universality', and to avoid resorting to a dichotomous emphasis on 'locality' as the only 'true' reality. Local universality is the alignment of protocols which is collectively achieved through the converging of different trajectories. CPR and FRAM-6 are *made* universal when previously existing trajectories are sufficiently crystallized, and when the distributed work required to get and keep the tool functioning is constantly performed.⁸⁶ In this dynamic, uncertain reality, stability is a consequence of a continuous balancing of temporary agreements, suspended disbeliefs, or mini-social contracts (in the Rousseauian sense of that term). To claim that something — a protocol, a scientific fact, or a technical artefact — is 'universal' *tout court*, means that one assumes highly improbable — and undesirable — *ceteris paribus* conditions. Local universality, then, is about being in several locales at the same time, yet being always also *located* as a product of contingent negotiations and pre-existing institutional and material relations. It is simultaneously about transcending locales and about being constantly collectively produced. It is about potentially large-scale consequences and about the awareness of *different* universalities, of inevitable partiality. It is about distributed medical knowledge, which could have been different. It is about the need to take the transformative power of these tools seriously (both analytically and politically), while simultaneously remaining aware of what is left out, what is omitted.⁸⁷ In sum, local universality depends on how standards manage the tensions among transforming

work practices while simultaneously being grounded in those practices.

Local universality, then, implies a context of practice, of multiple crystallizing and dispersed trajectories, of reappropriation, repairing, combining, and even circumventing the protocols and standards, of leaving margins of freedom, of reminding, of long processes of negotiation, of diverse interests, and so forth. It points at the distributed origins of standards, and at their distributed production and maintenance. Editors of prominent medical journals are afraid that medical protocols will stifle decision-making, and imprison expertise in written guidelines enforced by the medical profession's 'natural enemies' — insurance clerks, government officials, lawyers. In the everyday practices of constructing and using science, protocols, and technology, however, expertise is not 'captured' and skills are not 'depleted'. The construction of medical protocols shifts the expertise of being and becoming a resident, patient, or nurse to a different plane, making some skills obsolete and requiring others. This is similar to what happens when new automated or information technology is introduced in the workplace. In contrast with many studies of such processes,⁸⁸ however, we have indicated that not only the work of medical practitioners changes, but that the protocol *itself* is also constantly in a flux, and emerges as both the result and the cause of crystallization of multiple trajectories. Like the trajectories of patients in hospitals,⁸⁹ the protocol is managed by, and in turn manages, the trajectories with which it intersects. No one actor (including the protocol itself) or mastermind can be said to be *in control*: rather, universality *emerges from* this seemingly chaotic interaction of multiple trajectories. The crystallization of these trajectories in the protocol is an ongoing process in which all actors are actively involved, and all are continuously transformed — including the protocol itself. The illusion of total bureaucratic supervision and control, prevalent in too many tales (both dystopian and utopian), is a chimera: the multiplicities and contingencies embedded in the workings of a protocol cannot themselves be controlled. Rather than attempting to implement more guidelines and enhance control, standardization is achieved in and through the intersecting of disciplining efforts and the real-time work of medical personnel. Rather than being the product of ever increasingly tightened networks, medical protocols can coordinate activities over space and time *because* of the non-docility of the actants which populate these practices.

• NOTES

We would like to thank Geof Bowker, Laura Neumann, Andy Pickering, Evelleen Richards, Leigh Star, Irma van der Ploeg and four anonymous reviewers for their helpful comments.

1. Geoffrey Bowker, 'How to be Universal: Some Cybernetic Strategies, 1943–70', *Social Studies of Science*, Vol. 23 (1993), 107–27; Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993); James O'Connell, 'Metrology: The Creation of Universality by the Circulation of Particulars', *Social Studies of Science*, Vol. 23 (1993), 129–73.

2. Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Milton Keynes, Bucks.: Open University Press, 1987), 287.

3. Bruno Latour, 'Give Me a Laboratory and I will Raise the World', in Karin D. Knorr-Cetina and Michael Mulkay (eds), *Science Observed* (Beverly Hills, CA: Sage Publications, 1983), 140–70, quote at 152.

4. *Ibid.*, 155.

5. See also Annemarie Mol, 'What is New? Doppler and its Others: An Empirical Philosophy of Innovations', in Ilana Löwy (ed.), *Medicine and Change: Historical and Sociological Studies of Medical Innovation* (Paris: INSERM, 1993), 107–25.

6. Bruno Latour (personal communication, letter dated 22 October 1995).

7. Michel Callon, 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay', in John Law (ed.), *Power, Action, and Belief: a New Sociology of Knowledge?* (London: Routledge & Kegan Paul, 1986), 196–233, quote at 203.

8. Latour, *op. cit.* note 2, 143.

9. Joan Fujimura, 'On Methods, Ontologies and Representation in the Sociology of Science: Where do We Stand?', in David Maines (ed.), *Social Organization and Social Processes: Essays in Honor of Anselm Strauss* (Hawthorne, NY: Aldine de Gruyter, 1991), 207–38; Susan Leigh Star, 'Power, Technologies and the Phenomenology of Conventions: On Being Allergic to Onions', in John Law (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination* (London: Routledge, 1991), 25–56.

10. Importantly, the notion 'distributed activity' does *not* imply that there is a central distributor doing the distributing. The way that we use the word here draws upon usages which emphasize the *lack* of such a central actor — either in the distributing or in the distributed activity itself. See, for example, Susan Leigh Star, 'The Structure of Ill-Structured Solutions: Boundary Objects and Heterogeneous Distributed Problem Solving', in Marc Huhns and Les Gasser (eds), *Distributed Artificial Intelligence*, Vol. 2 (London: Pitman, 1989), 37–54; Edwin Hutchins, *Cognition in the Wild* (Cambridge, MA: MIT Press, 1995).

11. Madeleine Akrich, 'The De-Scriptio of Technical Objects', in Wiebe E. Bijker and John Law (eds), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, MA: MIT Press, 1992), 205–25; Akrich and Bruno Latour, 'A Summary of a Convenient Vocabulary for the Semiotics of Human and Non-human Assemblies', *ibid.*, 259–65. See also Stephen Hill, *The Tragedy of Technology* (London: Pluto Press, 1988).

12. Michel Callon, 'Society in the Making: The Study of Technology as a Tool

for Sociological Analysis', in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (eds), *The Social Construction of Technological Systems* (Cambridge, MA: MIT Press, 1987), 83–107, see especially 84–85.

13. It is important to note that we do not want to reify the distinction between designers and users. Everyone is both user and designer, the difference is gradual. Some people are more of the latter, some more of the former.

14. Akrich, op. cit. note 11, 222.

15. Anselm L. Strauss, *Continual Permutations of Action* (New York: Aldine de Gruyter, 1993).

16. Everett Hughes, *The Sociological Eye* (Chicago & New York: Aldine de Gruyter, 1970), 316.

17. Another important dimension of trajectories is that they are partly unique to the individual and partly collective. In the case of medical protocols, the collective dimension refers to the background of the actor. For example, during resuscitative efforts, technicians have well circumscribed job responsibilities which differ vastly from the tasks of, for example, chaplains or social workers. However, the personal experiences with death of either a particular chaplain or the technician will colour their trajectories. See Stefan Timmermans, *Saving Lives? A Historical and Ethnographic Study of Resuscitation Techniques* (Urbana, IL: unpublished PhD dissertation, University of Illinois, 1995).

18. Callon, op. cit. note 7, 219.

19. These are international protocols because they form the basis of resuscitative care in many countries where Western medicine is practised.

20. American Heart Association, *Textbook of Advanced Cardiac Life Support* (Dallas, TX: American Heart Association, 1990).

21. James D. Heckman (ed.), *Emergency Care and Transportation* (Park Ridge, IL: American Academy of Orthopaedic Surgeons, 1987).

22. Archer S. Gordon, 'A History of Cardiopulmonary Resuscitation', in Gordon (ed.), *Cardiopulmonary Resuscitation Conference Proceedings* (Washington, DC: NRC-NAC, 1967), 3–26.

23. Stefan Timmermans, 'Saving Lives or Saving Multiple Identities: The Double Dynamic of Resuscitation Scripts', *Social Studies of Science*, Vol. 26, No. 4 (November 1996), 767–97.

24. A type of cancer of the lymphatic tissues. We are using the pseudonym 'FRAM-6' to protect the confidentiality of the protocol designers.

25. MOPP stands for a combination of drugs.

26. BCNU stands for a combination of drugs. Dosage is expressed in mg per square metre of body surface.

27. William B. Kouwenhoven, James R. Jude and Guy G. Knickerbocker, 'Closed Chest Cardiac Massage', *Journal of the American Medical Association (JAMA)*, Vol. 173 (9 July 1960), 1064–67, quote at 1064.

28. This therapy is a recent alternative for bone-marrow transplantation, where bone-marrow cells are harvested from the patient's pelvic bone. The advantages of this new technique are claimed to be more convenience for the patient, and a more rapid restoration of normal blood cell levels.

29. Marc Berg, 'Order(s) and Disorder(s): Of Protocols and Medical Practices', in Berg and Annemarie Mol (eds), *Differences in Medicine: Unravelling Practices, Techniques and Bodies* (under review).

30. Michael Lynch, *Art and Artefact in Laboratory Science: A Study of Shop*

Work and Shop Talk in a Research Laboratory (London: Routledge & Kegan Paul, 1985), 147.

31. Marc Berg, *Rationalizing Medical Work: A Study of Decision Support Techniques and Medical Practices* (Cambridge, MA: MIT Press, forthcoming).

32. Eveleen Richards, *Vitamin C and Cancer: Medicine or Politics?* (London: Macmillan; New York: St Martin's Press, 1991); Geoffrey Bowker, *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920–1940* (Cambridge, MA: MIT Press, 1994); Bowker and Susan Leigh Star, 'Knowledge and Infrastructure in International Information Management: Problems of Classification and Coding', in Lisa Bud (ed.), *Information Acumen: The Understanding and Use of Knowledge in Modern Business* (London: Routledge, 1994), 187–213; Joan H. Fujimura, 'Crafting Science: Standardized Packages, Boundary Objects, and "Translation"', in Andrew Pickering (ed.), *Science as Practice and Culture* (Chicago, IL: The University of Chicago Press, 1992), 168–211; O'Connell, op. cit. note 1.

33. This is especially true in comparison with the period before World War II, when a range of manual resuscitation methods was used to restore life, or in the previous centuries when an amalgam of methods were being employed: see Heather P. Liss, 'A History of Resuscitation', *Annals of Emergency Medicine*, Vol. 15, No. 1 (January 1986), 65–72.

34. In 1889, Professor Schafer developed a resuscitation method where intermittent pressure was exerted on the thorax of the patient in the prone position.

35. Julius H. Comroe, 'Retrospectroscope. "... In Comes the Good Air"'. Part I: Rise and Fall of the Schafer Method', *American Review of Respiratory Disease*, Vol. 119 (1979), 803–09; Comroe, 'Part II: Mouth-to-Mouth Method', *ibid.*, 1025–31.

36. Kouwenhoven, Jude & Knickerbocker, op. cit. note 27.

37. Stefan Timmermans, 'From "Out Goes the Bad Air" to "ABC": A Sociohistorical Analysis of the Development of Resuscitation Techniques' (paper presented at the Annual Meeting of the Society for Social Studies of Science [4S], Purdue, IN, 18–21 November 1993).

38. Peter Safar, 'Ventilatory Efficacy of Mouth-to-Mouth Artificial Respiration', *JAMA*, Vol. 167 (17 May 1958), 335–41.

39. Archer S. Gordon, Max S. Sadove and Frank Raymon, 'Critical Survey of Manual Artificial Respiration', *JAMA*, Vol. 147 (8 December 1951), 1444–53.

40. Peter Safar, 'Cerebral Resuscitation', *Annals of Emergency Medicine*, Vol. 22, No. 2 (February 1993), 324–50.

41. Hugh E. Stephenson, *Cardiac Arrest and Resuscitation* (St Louis, MO: The C.V. Mosby Company, 1958).

42. 'CPR–ECC, Standards for Cardiopulmonary Resuscitation and Emergency Cardiac Care', *JAMA*, Vol. 227 (18 February 1974), 836–68.

43. Kouwenhoven, Jude & Knickerbocker, op. cit. note 27.

44. Peter Safar, Torrey C. Brown and Warren J. Fiolety, 'Ventilation and Circulation with Closed-Chest Cardiac Massage in Man', *JAMA*, Vol. 176 (20 May 1961), 574–76.

45. The Alan Mason Chesney Medical Archives of the Johns Hopkins Medical Institutions, Kouwenhoven papers, Box 917.

46. James R. Jude, William B. Kouwenhoven and Guy G. Knickerbocker,

'External Cardiac Resuscitation', *Monographs in the Surgical Sciences*, Vol. 1 (1964), 59–119.

47. See, for example, Robert R. Morgan, 'Laceration of the Liver from Closed-Chest Cardiac Massage', *New England Journal of Medicine*, Vol. 265 (13 July 1961), 82–83.

48. Gordon, op. cit. note 22.

49. CPR–ECC, op. cit. note 42.

50. See, for example, the special issue of *Annals of Emergency Medicine*, Vol. 23, No. 2 (February 1993), 275–511.

51. Latour, op. cit. note 4.

52. Franz J. Ingelfinger, 'Algorithms, Anyone?', *New England Journal of Medicine*, Vol. 288 (19 April 1973), 847–48.

53. AHA, op. cit. note 20, 238.

54. William E. May, 'Consensus or Coercion', *JAMA*, Vol. 254 (23/30 August 1985), 1077.

55. For such explications of actor-network theory, see, for example, Latour, op. cit. note 4, and Michel Callon, 'Techno-Economic Networks and Irreversibility', in Law (ed.), op. cit. note 9, 132–61. Perceptive critiques of this tendency of actor-network theory are: Donna J. Haraway, 'A Game of Cat's Cradle: Science Studies, Feminist Theory, Cultural Studies', *Configurations*, Vol. 1 (1994), 59–71; Nick Lee and Steve Brown, 'Otherness and the Actor-Network: The Undiscovered Continent', *American Behavioral Scientist*, Vol. 37 (1994), 772–90; John Law and Annemarie Mol, 'On Hidden Heterogeneities: The Design of An Aircraft' (Keele, Staffs.: Department of Sociology & Social Anthropology, Keele University, unpublished manuscript, 1995).

56. In Leigh Star's terms, protocols are boundary objects: Susan Leigh Star and James R. Griesemer, 'Institutional Ecology, "Translations" and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39', *Social Studies of Science*, Vol. 19 (1989), 387–420.

57. Nurses often explicitly referred to the work of Pat Benner, who in her writing legitimized the value of accumulating clinical expertise: see, especially, P. Benner, *From Novice to Expert: Excellence and Power in Clinical Nursing Practice* (Menlo Park, CA: Addison-Wesley, 1984).

58. Joan Fujimura, 'Constructing "Do-able" Problems in Cancer Research: Articulating Alignment', *Social Studies of Science*, Vol. 17 (1987), 257–93.

59. See the in- and exclusion criteria every medical research protocol begins with.

60. For another example of how standardized protocols function in practice, see Linda Hogle's analysis of the standardization of organ donation in practice: L. Hogle, 'Standardization across Non-Standard Domains: The Case of Organ Procurement', *Science, Technology, & Human Values*, Vol. 20, No. 4 (Autumn 1995), 482–501.

61. David Hughes, 'When Nurse Knows Best: Some Aspects of Nurse/Doctor Interaction in a Casualty Department', *Sociology of Health and Illness*, Vol. 10 (1988), 1–22.

62. A nurse with mainly administrative functions who writes down the events during a resuscitative effort.

63. Stefan Timmermans, 'High Tech in High Touch: The Presence of Family Members during Resuscitative Efforts' (draft manuscript, under review).

64. Physician in interview.

65. David Sudnow, *Passing On: The Social Organization of Dying* (Englewood Cliffs, NJ: Prentice-Hall, 1967).

66. Star & Griesemer, op. cit. note 56.

67. S. L. Star, *Regions of the Mind* (Stanford, CA: Stanford University Press, 1989).

68. Harold Garfinkel, *Ethnomethodological Studies of Work* (Englewood Cliffs, NJ: Prentice-Hall, 1967); Garfinkel, Michael Lynch and Eric Livingston, 'The Work of a Discovering Science Construed with Materials from the Optically Discovered Pulsar', *Philosophy of the Social Sciences*, Vol. 11 (1981), 131–58; Lynch, op. cit. note 30.

69. This example was given in the US television programme *60 Minutes*, in a report by Leslie Stahl titled: 'How many does it take to change a light bulb in . . .?' (CBS television, 18 December 1994).

70. Stefan Timmermans, Geoffrey C. Bowker and Susan Leigh Star, 'The Architecture of Difference: Visibility, Controllability, and Comparability in Building a Nursing Interventions Classification', in Berg & Mol (eds), op. cit. note 29; Berg, op. cit. note 31.

71. We owe this insight to Vicky Singleton and Mike Michael: see their 'Actor-Networks and Ambivalence: General Practitioners in the UK Cervical Screening Programme', *Social Studies of Science*, Vol. 23 (1993), 227–64; Vicky Singleton, 'Stabilizing Instabilities: The Laboratory in the UK Cervical Screening Program', in Berg & Mol (eds), op. cit. note 29; John Law, 'Traduction/Trahison: Notes on ANT' (Keele, Staffs.: Department of Sociology & Social Anthropology, Keele University, unpublished manuscript, 1995). See also Berg, op. cit. note 31.

72. For similar arguments regarding a different type of formal tools, see: H. M. Collins, *Artificial Experts: Social Knowledge and Intelligent Machines* (Cambridge, MA: MIT Press, 1990); Les Gasser, 'The Integration of Computing and Routine Work', *ACM Transactions on Office Information Systems*, Vol. 4 (1986), 205–25; Susan Leigh Star, 'Layered Space, Formal Representations and Long-Distance Control: The Politics of Information', *Fundamenta Scientiae*, Vol. 10 (1989), 125–54.

73. It is important to note that this reminding occurs in the light of the situation at hand, and is not necessarily instigated by the protocol designers, hospital administrators, or outsiders. Also reminding doesn't result in more rules or a stricter set of protocols, but in adherence to or facilitating compliance with the already existing guidelines.

74. Again, too liberal interpretations of the protocol by people other than physicians will most likely result in a warning or order from the physician. When other team members find that physicians interpret the protocol too loosely, they usually vent their concern afterwards and might go as far as to formulate a formal complaint.

75. On other forms of maintenance, on keeping formalisms at work in real time, see the studies cited in note 72; and Berg, op. cit. note 31.

76. Ina Wagner, 'Hard Times: The Politics of Women's Work in Computerized

Environments' (paper presented at 5th IFIP Working Conference on Women, Work and Computerization, Manchester, 2–5 July 1994).

77. This observation was especially apparent in the interview data, when we asked health-care providers from the two countries to define a successful resuscitative effort. Almost without exception, the Belgian health-care providers emphasized the reanimation aspect, while their US colleagues talked mostly in terms of resuscitation.

78. See Safar, op. cit. note 40.

79. Interview with an oncologist; see also Ilana Löwy, '“Nothing More To Be Done”: Palliative Care versus Experimental Therapy in Advanced Cancer', *Science in Context*, Vol. 8 (1995), 209–30; Richards, op. cit. note 32, 112–24, 188–91; Lynn Payer, *Medicine and Culture: Notions of Health and Sickness in Britain, the US, France, and West Germany* (London: Victor Gollancz, 1989).

80. See Bowker, op. cit. note 32.

81. Berg, op. cit. note 31.

82. Callon, op. cit. note 55; Jack Goody, *The Domestication of the Savage Mind* (New York: Cambridge University Press, 1977), Chapter 5.

83. Latour, op. cit. note 2.

84. Our protocols are not the first historical examples of this development. Foucault situates the origin of this particular form of knowledge production in the medical institutional arrangements following the French Revolution, which culminated in the anatomo-clinical gaze of the clinic: see Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception* (New York: Vintage Books, 1973 [1963]).

85. Harry M. Marks, *Ideas as Reforms: Therapeutic Experiments and Medical Practice, 1900–1980* (Cambridge, MA: unpublished PhD dissertation, Department of Political Science, MIT, 1987); Marks, 'Notes from the Underground: The Social Organization of Therapeutic Research', in Russell C. Maulitz and Diana E. Long (eds), *Grand Rounds: 100 Years of Internal Medicine* (Philadelphia, PA: University of Pennsylvania Press, 1988), 297–336.

86. Bowker, op. cit. note 32; Berg, op. cit. note 31; Timmermans, Bowker & Star, op. cit. note 70.

87. See, for example: Donna J. Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991); Susan Leigh Star, *Misplaced Concretism and Concrete Situations: Feminism, Method and Information Technology* (in preparation); Lucy Suchman, 'Working Relations of Technology Production and Use', *Computer Supported Cooperative Work*, Vol. 2 (1994), 21–40. On unraveling differences in medical practices, bodies and techniques, see Berg & Mol (eds), op. cit. note 29.

88. See, for example: David F. Noble, *Forces of Production: A Social History of Industrial Automation* (Oxford: Oxford University Press, 1986); Peter Miller and Ted O'Leary, '“Economic Citizenship” and the Spatial Reordering of Manufacture', *Accounting, Organizations and Society*, Vol. 19 (1994), 15–43; Shoshana Zuboff, *In the Age of the Smart Machine: The Future of Work and Power* (New York: Basic Books, 1987).

89. Anselm Strauss, Susan Fagerhaugh, Barbara Suczek and Carolyn Wiener, *The Social Organization of Medical Work* (Chicago, IL: The University of Chicago Press, 1985).

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