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Sustainability, system innovation and the laundry

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Introduction

Despite insisting on the sociotechnical character of change, studies of system innovation tend to focus on the organisation of supply: on the structuring of systems through which resources are delivered and on the institutional relationships involved. Conceptualised in this way, the challenge of sustainability is a challenge of shifting towards less resource intensive regimes built, for example, around fuel cells, renewable energy sources, localised organic food production, or more refined modes of demand side management and service provision. Hence debate, including that inspired by this conference, on the theory, practice and technology of transition and on the institutional and political arrangements required in support. In this sense, the focus is indeed sociotechnical. However, there is another sense in which the agenda is lopsided, skewed around provision rather than consumption and for the most part oblivious to the parallel sociotechnical configuring of conventions and expectations.

This paper seeks to recover some of that missing ground. In the process, it identifies a menu of theoretical challenges that have yet to be given the attention they deserve. The strategy of paying attention to the collective transformation of environmentally significant habits brings a different perspective to bear on a) familiar models of phased progression through which novel systems become normal, b) the relation between novel configurations, regimes and sociotechnical landscapes, and c) the relation between systems. However, the arguably more important contribution is in switching the focus of enquiry around and attending not only to

resources, however efficiently or effectively they may be provided, but also to services, that is to expected standards, practices and conditions of everyday life, maintenance of which engenders more or less sustainable patterns of demand.

This reversal introduces new questions about the dynamics system innovation. Approached in this way, the issue is not just that of conceptualising and steering pathways of infrastructural development like those associated with energy supply, but of also understanding the transformation of comfort. What ideas and expectations underlie the fact that around half of domestic energy consumption is now devoted to the tasks of heating and cooling? How is it that personal bathing and laundry currently account for around a third of domestic water consumption and that demand for water has risen by seventy per cent over the last thirty years (DEFRA 2002)? And in terms of mobility, how is it that social obligations have come to require the forms and patterns of co-presence that they do? Routinely taken for granted conventions of comfort, cleanliness and convenience are surely not static, nor are they free from commercial and government influence or from the scripts embedded in specific devices or in more encompassing regimes and sociotechnical landscapes. But in analysing the creep of conventions that sustain what are ultimately unsustainable ways of life, it is, I argue, necessary to push the agenda on and to think more systematically and more systemically about the relation between consumption, provision and practice.

Although I want to pay attention to the transformation of consumption and practice and although I argue this is crucial when thinking about transitions to a more sustainable society, I do not want to do so through reference to environmental values or to the beliefs and actions of self-consciously green consumers (Hobson 2001). Nor do I take the job to be one of topping up on human agency; of slotting consumers into the frame alongside recognised system builders and institutions; giving free reign to consumer oriented design, or enhancing opportunities for (presumably green) citizen-consumer involvement in the shaping of provision (Spaargaren 1997).

What matters in practice is the big sweep of shared understandings of 'normality'. This is so because notions of what it is to be a normal and acceptable member of society have far reaching environmental implications: they carry in their wake a trail of inescapable resource requirements like those associated with daily showering, with wearing freshly laundered clothing, with not having a siesta, with eating imported food or with having foreign holidays. There are, of course, important social divisions in what constitutes 'normality' and persistent differences between nations, social classes and sub-cultures. Equally, there are observable currents of convergence about which I will have more to say in due course. For present purposes, I take normal practices to be those in which collective identities are anchored (Douglas and Isherwood 1996; Bourdieu 1984), which constitute a form of social glue, and which are - at any one point in time and in any one culture - seen to be obligatory, non-negotiable conditions of everyday life.

Future constructions of ordinary practice may (or may not) prove to have less resource intensive consequences than those of today, but there is as yet little evidence that the processes through which such conventions change are themselves marked by a global preoccupation with sustainability. By implication, long term transitions to more sustainable concepts of service (as opposed to techniques and institutions of provision) are as likely to be an indirect consequence of the social-symbolic and sociotechnical re-writing of routine as they are of deliberately environmental management and planning. This argues for temporarily setting explicitly environmental concerns aside in order to better understand the mechanisms of cross cultural, social and historical change and the manner in which sociotechnical systems and taken for granted habits co-evolve. In taking this route and in taking it with an eye to the respecification of normal practice, this paper has the further ambition of highlighting properties and problems of symbolic and sociotechnical integration routinely overlooked by those who study bounded domains of innovation and who analyse the unfolding of such developments within specific national and social contexts.

Systems, cases and questions

I use the case of the laundry as a means of exploring the recent and radical reconfiguration of a loosely coupled system of technology, practice and convention. As this example shows, the

strategy of considering system innovation as a process of service innovation: that is innovation in what are taken to be normal, ordinary and necessary routines of everyday life, generates a fresh set of questions about the dynamics and mechanisms of transition.

At first sight, laundering is a curiously low profile, even boring, example. It has not required significant public or private sector investment; it does not revolve around a clearly identifiable technological complex, it has not obviously passed through distinct phases of development nor are there any recognisable system builders. One might therefore conclude that it does not really qualify as a case of system innovation as that term has come to be understood. On the other hand, the reconfiguration of laundering has all the necessary features: it involves a wide range of actors, including firms, consumers, knowledge producers, NGOs and governments; it is not caused by a change in a single factor but is the result of the interplay of many factors and actors that influence each other and it implies change at various levels: at the micro-level of individual actions, at the meso-level of structuring paradigms and rules and at the macro-level comprising a deep structural level of trends (to paraphrase the definition outlined in the keynote paper).

It has also been subject to recent and radical transformation. Over the last century, techniques and habits of laundering have changed significantly, with long-term consequences for domestic electricity and water demand. In Western European countries and in the USA, something like twenty per cent of household water consumption now relates to the production of clean clothing, and in combination, the main appliances involved (the washing machine and the dryer) account for a still significant fraction of domestic energy use (DEFRA 2000; American Water Works Association 1999). These figures reflect a more than five-fold increase in the frequency with which the laundry is done. No longer a weekly activity, the average number of laundry cycles (that is the number of times that washing machines are run per year) is 274 in the UK (DEFRA 2000), and 392 in America (Biermeyer 2000). At the same time, what it means to wash well has evolved. Not so long ago, boiling was deemed essential in order to get things really clean. Now less than 7% of the (UK) wash is done at 90º C (DEFRA 2000). Mainly because of this, the American Association of Home Appliance Manufacturers reports that the energy efficiency of washing machines increased by 50% between 1981 and 1999 (Association of Home Appliance Manufacturers 2000: 35). These transitions in the meaning and practice of laundry have direct but contradictory implications for resource consumption and the case is interesting precisely because of this ambivalence. This is a field in which increasingly efficient technologies fuel more resource demanding concepts of service. As noted above, it the reinterpretation of normal and necessary service on which this paper focuses.

In addition, and as the case of the laundry illustrates, innovation in the way that 'societal functions' like the production of clean clothing are fulfilled depend upon the practical integration of a variety of what seem to be self-contained systems. The size and content of the laundry basket is, for instance, closely related to the textile and fashion industries and to the mass production of clothing. Meanwhile, the design of domestic washing machines relates to the range of fabrics in circulation, to the availability of detergents of one kind or another, and to contemporary concepts of cleanliness and social/moral order. As these few observations suggest, the exercise of placing laundering - that is the production of 'appropriately' laundered clothing - centre stage, and of viewing this as a system or, more accurately, a system of systems in transition, has the conceptually useful effect of questioning elements of what are becoming 'orthodox' discussions grounded in the analysis of bounded, supply oriented, domains like those of energy, water, food and mobility.

Laundering and the analysis of system innovation

As Mary Douglas has famously observed, 'dirt is essentially disorder' (Douglas 1984: 2): it is matter out of place. Understood in these terms, washing is part of a more encompassing system of social order with the effect that transitions in this practice match developments in the specification and policing of social-symbolic boundaries and distinctions. It is undoubtedly the case that however people define standards of cleanliness, and definitions vary widely, their reproduction is an important part of another kind of system, namely that of self identity. Kaufmann puts it this way: 'there can be no construction of identity without the affirmation of

cleanliness: to be oneself, to be a self-respecting individual, is to be clean' (Kaufmann 1998: 16). I do not want to lose sight of the symbolic significance of washing but nor do I want to see it in these terms alone. The habits and concepts on which perceptions of self and society depend are also structured by the hardware involved and by the material properties of what there is to wash. Taking all these elements into account, the next three sub-sections reflect on the qualities of laundry-related system innovation.

In what follows, I use the case of laundering to explore three issues in particular. First, what are the units of system innovation, how are system boundaries conceptualised, and what does this mean for the representation of phases of system development? Second, how do systems unfold between as well as within societies? In other words, what are the 'horizontal' as well as the 'vertical' dynamics at play in the formation of sociotechnical regimes and landscapes. Third, what are the modes and mechanisms of system integration, and how do these relate to the co-evolution of concepts of service?

System boundaries and phases of development

It is not too difficult to describe what laundering involves. As currently configured, it consists of a sequence of interdependent steps and stages: sorting clothes, putting them in a machine, adding detergent, drying (on a line or in a tumble dryer), ironing, folding, and putting away. But as a sociotechnical system, it is harder to pin down. When thinking about the transformation of practice it is, for instance, relevant to take note of what there is to launder, to consider when and why laundering is undertaken, and to analyse the tools and skills involved. From this perspective, the boundaries of the system are indistinct and the edges frayed. There are no system builders in sight, and no obviously unifying or transparently dominant forces in play. Partly because of this, it is hard to discern or describe definite states and stages of transition.

Hughes (1983) and others have written about the typical phases of system development including those of initial exploration, take off, diffusion, and stabilisation. This kind of framework has helped in conceptualising the distinctive institutional dynamics characterising each 'stage', and in giving shape and form to specific historical analyses (see, for instance, Kaijser (forthcoming); Summerton 1994). It is easy to see the relevance of this approach when documenting the development of infrastructural arrangements like those of electric power; mains water; telecommunications, or networks of road and rail. But what about the laundry?

Laundering has a history but not one built around the sequential construction of a readily identifiable system. Although some commentators have argued that laundry standards have increased over time (Cowan 1983, Forty 1986), there is no clear metric of progression. Rather, the history of washing clothes is marked by sometimes substantial shifts in what the process is thought to be about and in how it is evaluated. As a result there are different ways of characterising 'phases' of innovation. One option is to track the history of ideas. Taking this route, Vigarello (1998) distinguishes between periods in which laundering was understood as a means of cleaning the body - though it does not seem to have been a terribly frequent event, changing the shirt reputedly took the place of refreshing and washing oneself in mid-sixteenth century France (Vigarello 1998: 58) - and laundering conceptualised as a form of clothing care (Sams 2001). In this case the contrasting goal is that of restoring clothing that has been contaminated through contact with the body or the outside world. Other histories might focus on what there is to wash. Bode (2000), for example, highlights the practical consequences of the transition from linen to cotton while Handley (1999) documents the development of synthetic fabrics and what this entails for the wash (see also Anson 1988). Attending to the question of how the laundry is organised, Mohun details the rise and fall of the steam laundry and the privatisation of a once collective practice (Mohun 1999).

Although the careers of specific devices - the domestic washing machine, the electric iron or the tumble dryer - can be described and analysed in terms of their development, introduction and establishment (Strasser 1982, Cowan 1983, Parr 1999), this terminology does not work for laundering as a whole. There is no sense in which laundering has become more embedded or entrenched, or in which the practice has stabilised. Instead, the picture is one of a more or less continual de- and re- stabilisation of the different elements that together

make up the enterprise as a whole. In fact, one might even conclude that it is this continual iteration between contributory systems that drives transitions and transformations in the

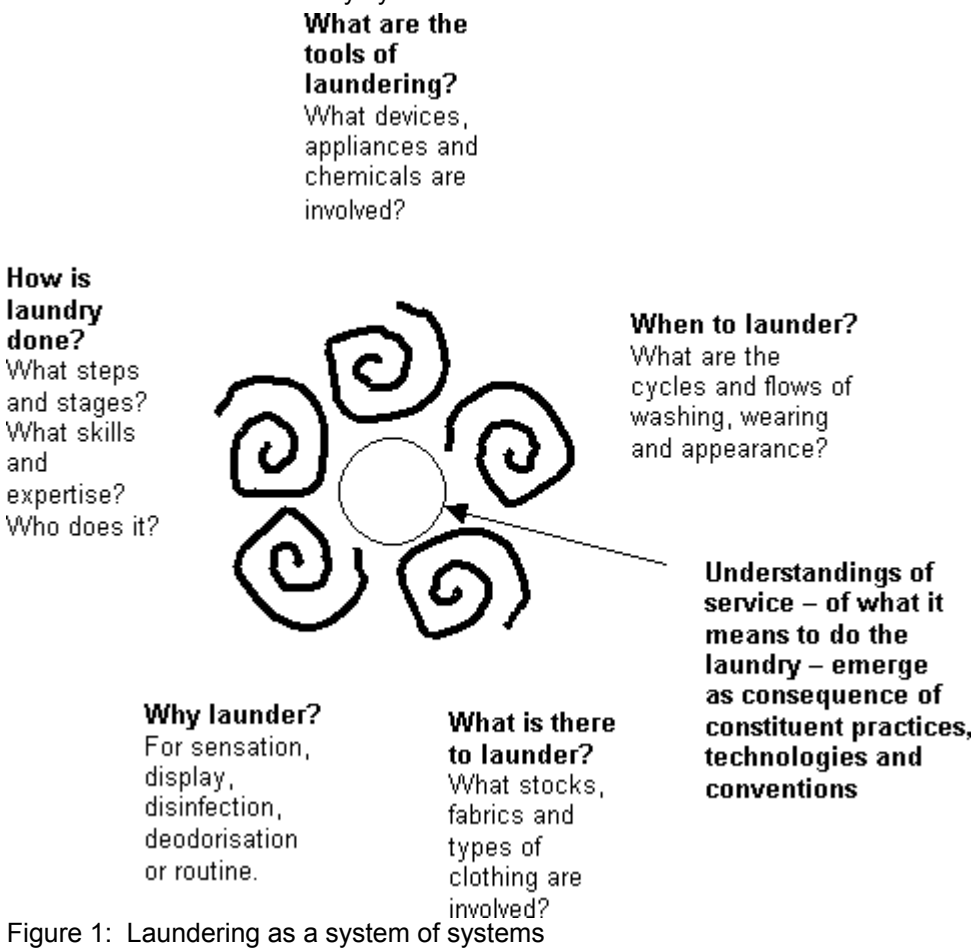

Figure 1: Laundering as a system of systems

meaning and practice of washing well.

Figure 1 illustrates these points, showing laundry to be a system of systems driven by the relationship between one whorl and another.

This figure has the misleading effect of suggesting that each contributory whorl is of equal weight, and of playing down important constraints associated with the structures and ideas of past and present practice. In other words there are elements of path dependency and certain features do set the scene in which others do (and do not) develop. The image nonetheless underlines the need to analyse the transition of emergent concepts and understandings of service. The points made above suggest that in this case, analysis in terms of 'phases' and stages of system innovation will not suffice and that other ideas are needed to capture and characterise the dynamics involved in the transformation of what amounts to a system of systems.

In thinking further about how services and systems of systems unfold it may be useful to review laundering in terms of the levels and layers of 'transition theory'.

Laundering and systems of vertical and horizontal integration

Rip and Kemp (1998) and Rip and Groen (2001) consider the dynamics of innovation with the help of a three layered model in which the development of novel arrangements and configurations structures and is structured by a patchwork of sociotechnical regimes that in turn defines and is defined by the contours of a macro-level sociotechnical landscape. This tiered model promises to be of real value in analysing the sociotechnical co-evolution of what people take to be normal and necessary forms of laundering. Composite concepts of service -

of what it is to wash well - appear to have a comfortable and intelligible home at the meso-level plane of the sociotechnical regime.

The layered scheme is, for sure, useful in analysing the relationship between developments in washing technology, and in users' and consumers' understandings of cleanliness. To give just one example, washing machines have proved themselves to be effective instruments in the reclassification of dirt. An historical analysis of British Consumers' Association and American Consumers Union reports on the qualities and properties of new models shows quite clearly how manufacturers have defined cleanliness as whiteness rather than an absence of bacteria, and how they and the machines and categories they produce, have reconstructed laundry regimes around new concepts like those of freshness (Shove, forthcoming). As illustrated here, novel technologies have re-shaped important aspects of the laundry regime. Meanwhile, Parr (1999) and Kaufmann (1998) describe how new devices like the tumble dryer have been accommodated and appropriated within existing logics of laundry. In the course of her research Joy Parr found that 'many who owned dryers continued to use their lines regularly even after they had invested in a machine' (Parr 1999: 264). As she explains, the availability of both line and dryer set the scene for inventing new 'rules' and sometimes idiosyncratic practices. The women she spoke with might, for example, put cotton and linens outside to dry, but run children's clothing through the machine, or they might partially dry sheets and towels on the line outside and bring them in for a final finishing in the machine. Rather than replacing the line, the dryer offered distinctive qualities of its own, hence its adoption was not just a matter of trading between convenience, speed, fragrance, texture and ease of ironing. Instead, users' rationales and actions demonstrated the positioning of both devices (and attendant practices) within highly elaborate systems or regimes of personal and domestic propriety.

This is all very well but in environmental terms, analysis of the vertical relation between novel configurations, niches, regimes, and landscapes misses a hugely important part of the picture. Just seven manufacturers (Weiss and Gross 1995) make around seventy per cent of all laundry appliances. Although machines are customised and detergents coloured to suit the traditions and preferences of different markets, the mechanisms through which commercial interests colonise meanings of cleanliness are much the same. In the UK, over ninety per cent of households own a washing machine (DEFRA 2000) and, as hinted at above, those who use such devices are bought into an increasingly dominant technological repertoire. Unpublished market research for Unilever confirms the point that 'clean' has comes to be anything that emerges from the machine. Since similar machines are used and sold in, for example, Brazil, Japan and Norway (Wilhite 1996), these technologies exert a powerful force for convergence, slicing across what are routinely if implicitly analysed as nationally or at least culturally bounded sociotechnical regimes and landscapes.

Consistent with its roots in innovation studies, the three tiered model offers important and useful insights into the trajectory of novel arrangements born of and diffused through what are conceptually self-contained environments. But what when something like a fully formed washing machine, complete with inscribed concepts of cleanliness, comes crashing sideways into such a scene, as it does in parts of Brazil today? How does the vocabulary of niche, regime and landscape help in making sense of the consequent sociotechnical standardisation of laundering and the convergence of attendant notions of service (and resource demand) around the world? Likewise, how might these ideas be used in explaining standardisation in other co-determining parts of the laundry system like the global proliferation of light-weight machine washable clothing, or the valuing some but not other fragrances (Corbin 1986)?

These questions point to other, also relevant, trajectories that have to do with the circulation of standardised system-relevant, regime-shaping ingredients (i.e. ideas and/or technologies) between societies. In thinking about system innovation and transitions to sustainability there is, thus, another agenda to take into account. This has to do with the dynamics of configuration and appropriation (how are standardised washing machines, automobiles, and convenience foods in fact deployed in different societies?), and with the specification of the horizontal mechanisms of cross cultural regime formation. As the laundry example suggests, sociotechnical regimes and even landscapes may converge between societies, with unfortunate environmental consequences, despite exhibiting and being held in place by

distinctive, locally and historically specific path-dependencies and forms of 'vertical' integration. The risk is that in focusing on the vertical dimension we miss these horizontal movements, as illustrated in figure 2.

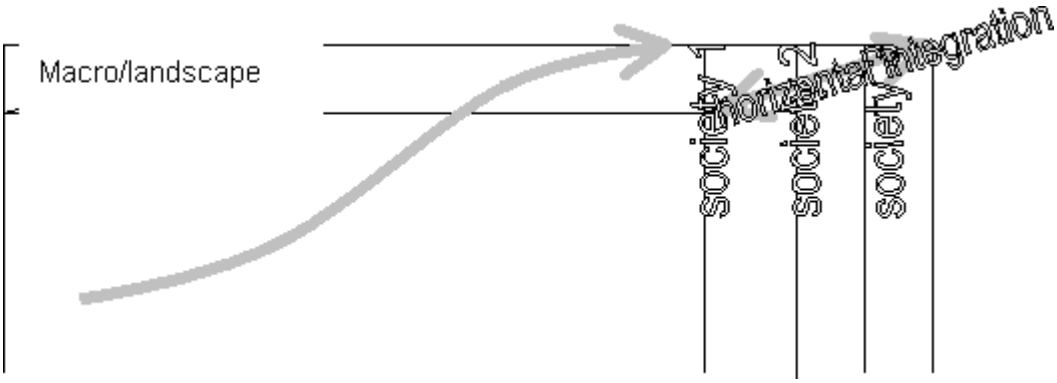

Figure 2: Horizontal and vertical dimensions of sociotechnical change

The practical ramifications of such horizontal trends are inherently unclear for local contexts of appropriation are of defining importance. Yet the basic point is simple: machines carry with them concepts, classifications, scripts and framings of problems and situations, and these circulate between and across cultures and otherwise distinct sociotechnical regimes and landscapes. Developing this point, it is important to pay close attention to the so far uncharted relation between the horizontal and the vertical structuring of system innovation.

These observations, together with my previous representation of laundering as a system of systems, imply that the transition to more sustainable conventions of everyday life depends partly on system innovation but also on system integration. The two are, of course, related but as I suggest below, there is much to be gained from a more explicit emphasis on this latter aspect.

Systems of systems and modes of integration

What is it that holds systems of laundering together, and do the mechanisms of integration themselves differ over time and between one society and another?

In some cases there are clear patterns of interdependence. For example, washing machines are currently designed to cope with a contemporary diet of machine washable clothing. As international systems of 'fabric care' symbols indicate, textiles and garments are in turn designed to be washed. These networks of technical coherence have arguably removed much of the skill required in literally doing the wash. Providing fabric labels and washing machine programmes match up, and providing the right doses of detergent are added (and even these now come in pre-packaged tablet form), the scene is pretty much set for a standardised result. Or at least it would be if people followed the instructions and guidance provided. Studies of how laundering is in fact done demonstrate the existence of other forms of system integration.

A 1988 survey showed that people in the UK rarely used more than three programmes, that fabrics were routinely mixed in a single load, and that users persistently disregarded or failed to read instructions. Of those questioned, forty five per cent admitted to washing items labelled 'dry-clean only', thirty-seven per cent did not isolate woollens and fifty-seven per cent failed to separate 'delicate' items (Anson 1988). While laundry technologies have undoubtedly re-scripted the options on offer, these insights into practice suggest that analysis of technology is not in itself enough to explain recent trends like the decline of boiling or the establishment of laundry as an almost daily operation.

Going round their home with an interviewer in tow, respondents involved in a recent market research study for Unilever variously explained that they washed their curtains once, or twice or four times a year. Towels were laundered after every use, after every three baths or after a

couple of days. Some distinguished between jeans and other trousers. Pyjamas were, or were not, viewed as underwear and therefore changed (or not) on a daily basis. Beds were often, but not always, stripped each week. Meanwhile cushion covers deserved a wash 'every so often', or every other Thursday. Taken as a whole, this material reveals an array of individually distinct, and in detail, unique packages of practice which are nonetheless held together, case by case, by coherent - if usually tacit - classifications of need and equally compelling 'injunctions'. Kaufmann defines an injunction as 'a social construction (historical, family based, personal) which has produced the framework of assumptions triggering the action - the thing that simply has to be done' (Kaufmann 1998: 21).

The perfect injunction, that is the perfect trigger to action, is silent, invisible, and buried deep in the layer of what Giddens (1984) refers to as practical consciousness. While some actions seem optional and some figure on mental lists of things to do, many others - like showering, ironing, or washing hair - are accomplished without further thought or reflection. Social norms are, Giddens argues, sustained and recreated through practices like these. It is all very well to appreciate this 'duality of structure' (Giddens 1984: 19) but how do new injunctions arise and how do new patterns of cleanliness, broadly defined, break through the sedimented bedrock of engrained habit? How does system transition operate at the level of practical consciousness?

The notion of 'doing it my way' usefully accommodates elements of stability and change. In talking of their response to new appliances, new products and even new ideas of what it is to wash well, Unilever's respondents explained that they have their own 'way' of doing the laundry. As their accounts show, considerable conceptual and sometimes practical effort is invested in appropriating and tailoring new commodities and methods in terms of what each takes to be their own style of laundering. In this case, the very complexity of the system - what is to be washed, when and why - permits extensive customisation of practice around a range of standardised products and appliances. Thus washing machines may be running at an increasingly uniform 40º C all around the country, but they are each locked into distinctive domestic regimes of sequence, timing and theories of purpose, performance, hygiene, freshness and appearance. In documenting their arrangements, tricks and strategies the Unilever respondents made it clear: they were deliberately and selectively deploying an array of standard tools in constructing seemingly personalised categories and routines out of which piles of appropriately laundered clothing emerged. In milling together meaning and practice, they were quite literally building the laundry system, day in, day out.

The micro and macro definition and reproduction of services like those of domestic laundering involves the orchestration of devices, systems, expectations and conventions. What counts as appropriately laundered clothing depends, in this analysis, on the coordination of otherwise bounded sociotechnical arrangements and on their integration in terms of an also coordinative

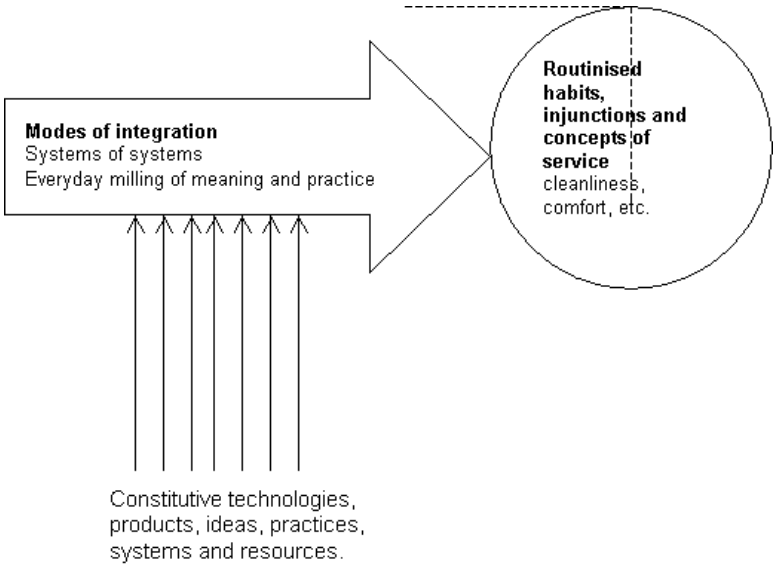

Figure 3 Modes of integration

framework of meaning and rationale. Figure 3 illustrates some of these features. It shows how products and practices are combined in the course of everyday life and it positions personal and societal concepts of service as the outcome of these integrative processes.

In figuring out how services change the key questions have to do with how suites of technology interact, how are they actively deployed together and with what consequence for expectations and specifications of normal practice.

In the previous section, I acknowledged the global diffusion of washing machines and noted that this might have the horizontal effect of standardising at least parts of otherwise societally specific systems of laundering. There is, however, another more pernicious possibility in which standardised technologies have the effect of changing not just the outcome: that is the meaning of what it is to wash well, but of also functioning as conduits of further change, acting as integrating mechanisms in their own right. Pointing to the complex of economic interests at stake in promoting washing as a private activity and in undermining other more collective arrangements, Susan Strasser writes as follows: 'Home laundering - which encompassed not only the washing machine industry but also those that produced detergents, textiles, electrical parts and plumbing supplies - demonstrates the interconnections between segments of the economy that facilitated its continual expansion' (Strasser 1982: 122).

Sold as devices to which laundry responsibilities could be delegated, domestic washing machines have challenged and sometimes entirely eliminated other systems of provision. Having positioned washing machines as normal and necessary appliances, and having established that what emerges from them is properly laundered, manufacturers have together tightened what amounts to a collective corporate grip on the meaning of cleaning. As such they have some power over the process of integration for the washing machine itself influences how elements are combined, and the rhetorics and rationales involved. In this, appliance manufacturers function as meta-system builders, providing the terms and tools with which personal and societal concepts and practices are constructed.

Integration, standardisation and transition

I chose to consider transitions in laundering as a means of exploring the qualities and properties of service-related innovation. Instead of looking the development and institutionalisation of infrastructures and systems of supply I turned the tables round in order to consider the systemic reconfiguration of consumption and demand. This meant dealing with different elements and questions. In practice, people do not consume energy, water or gas. Instead, units of consumption and change relate to the specification and reproduction of normal conventions like those of comfort and cleanliness. From this analytic perspective, the transition to a more sustainable society is not just a matter of fulfilling stable and taken for granted needs in a more efficient manner. It is, in addition, a question of understanding what people take to be the necessary conditions of everyday life and of understanding how these concepts change and how they are sociotechnically configured.

In this final section I reflect on what this exercise has revealed, and what it has added to the discussion of system innovation. I also comment on how policy makers and others might intervene to shape transitions in systems of service and convention.

Taking a long term view, it is clear that firmly held concepts of comfort and cleanliness are immensely malleable. A couple of hundred years ago it was quite normal (for certain social groups) to sew children into their clothes for the winter. Less than a hundred years ago, 'boiling was considered essential for getting the wash really clean and germ-free' (Zmroczek 1992: 176). Laundering is today represented as a process of freshening up tired or stale clothing, and who knows what it might become tomorrow. In environmental terms, this essential fluidity is encouraging. There is no inescapable logic of escalatory pressure, and no unremittingly path-dependent narrative of increasing demand.

This apparent lack of path dependency is, however, a bit of a puzzle. If infrastructures and systems of provision can be usefully analysed with reference to phases of emergence, development and stabilisation, how is it that systems and conventions of consumption, which

might be expected to co-evolve with systems of provision, do not fit these frameworks? Part of the answer lies in the fact that meanings of what it is to wash well are generated through the interaction of a number of interdependent yet relatively self-contained systems. As described here, laundering is best understood as a system of systems that has an emergent dynamic of its own.

When thinking about service transition it is, it seems, necessary to consider how relatively self-contained systems relate to each other and how they are related together in the course of everyday life. More specifically, it is important to investigate mechanisms and modes of integration involved in shaping and specifying normal standards and concepts of service. In addition, my review of laundering has drawn attention to the cross cultural standardisation of technologies (and attendant scripts), and to the contexts and conditions in which these devices and messages are appropriated. This suggests that there may be distinctively 'horizontal' mechanisms of regime and even landscape-level convergence between societies that have yet to be analysed in any detail. If such lateral processes are in fact underway, they are likely to have important but again unexplored implications for the possibility of local, national or international transitions toward more sustainable specifications of service.

As these questions indicate, the example of 'the laundry' has proved useful as a means of challenging and expanding the reach and scope of debate about system innovation. Along the way, it has also generated a number of practical, policy relevant insights.

The first concerns the relation between resource and service. In this arena as in others, governments and environmental groups focus on efficiency and patterns of resource consumption, for instance, introducing energy labelling schemes, offering consumer advice, setting technical regulations, fostering the development of more efficient appliance standards, facilitating investment in renewable energy, and so on. Meanwhile, commercial activity revolves around the construction of new concepts of service: new ideas of hygiene, new concepts of 'freshly laundered' clothing, new visions of domesticity and propriety.

This split between resource and service has important implications for the types of actors involved in different forms of system innovation. Though willing to advise consumers to wash a full load at a time, national policy makers rarely venture into the domain of fashion, appearance and body odour. That is not to say that governments have no interest in the provision and social construction of cleanliness. As histories of sanitation and public health reveal (Melosi 2000, Ogle 1996, Tomes 1998), such institutions have been extremely important in promoting technologies and ideologies that, in combination, sustain what Cowan describes as the 'senseless tyranny of spotless shirts' (Cowan 1983: 216). Even so, contemporary policy makers are unlikely get involved in directly specifying the 'sniff test' despite the fact that this measure is of immediate significance for the amount of washing done and so for the total consumption of energy and water. Because of this reluctance, a good part of the potential for system innovation lies beyond their normal reach.

On the other hand, there is some connection between the definition of service and how it is achieved. The fact that boiling laundry is no longer normal practice, and that the majority of UK laundry is now done at 40º C is a good example. Since washing machines have never been able to sustain a prolonged simmering of the kind traditionally required for a 'proper' wash, the first manufacturers introduced and established other criteria of cleanliness - measures of whiteness being the most common. With whiteness, not heat, as the point of reference a more environmentally benign, or at least energy efficient, range of technological options came into view, including those that depend on the use of detergents especially designed to operate at low temperatures. Because manufacturers have been obliged and able to disassociate laundering from disinfection, governments have been able to push for more resource efficiency. In this instance, resource efficiencies have gone hand in hand with the reconstruction of service.

It is, however, clear that commercial rather than government organisations dominate the specification of service. This has further consequences for the scope and scale of possible intervention. Major appliance manufacturers and detergent producers are typically focused on constructing and developing mass markets around the world. That is the lateral arena in which they operate. By comparison, resource-based initiatives are generally national, or at

best European. This is of immediate relevance for the mode and manner in which efforts are made to introduce and engender new practice. There is a tendency to think about ways of engineering and managing resource-based system transition through the careful cultivation of sociotechnical experiments located within protected spaces and strategic niches. Approached in this way, the policy challenge is to build the networks and alliances requred to gradually embed novel arrangements into the regimes and landscapes of wider society.

But in so far as new concepts of service are deliberately fabricated, this appears to involve the often rapid, horizontal, and quasi-parasitic diffusion of convention leaping, culture defying, commodities, use of which draws consumers into new paradigms (in this case of laundering). What part do policy makers have to play in this alternative dynamic of typically trans-national service specification? Do they contribute at all to the formation of collective conventions of normal and ordinary practice and if so, how? This is not a question I am about to answer now, but it is one that lies at the heart of any debate about the kinds of intervention government agencies might make in pursuit of sustainability. As framed here, it directs attention towards a relatively unfamiliar set of possibilities. Never mind government involvement in steering modes of provision, or in managing markets and forms of system innovation, how do national and international modes of policy making shape and structure the formation of routinised and taken for granted expectations, conventions and habits? Following this question through, and doing so with respect to mobility, to diet, to personal hygiene and to laundering, would help to determine both the limits and possibilities of deliberately engendering regime and landscape-level transitions toward sustainability.

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