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DEBATE

(Re)thinking Repairs in the *Longue Durée*

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ABSTRACT: The history of repairs underscores the complexity of time through the practices of reusing and adapting objects. While this research field primarily focuses on the contemporary period, its close ties to present-day life risk obscuring the historical depth of these practices and the stakes they hold in various societies. How can we incorporate a truly historical perspective into our understanding of repairs? This article, a product of collective reflection, aims to broaden the analysis of repairs by embracing the concept of *longue durée*, a term coined by Fernand Braudel to describe an extensive span of historical time. Rather than striving to construct a grand narrative, this article addresses the challenge of acknowledging the diverse contexts and the discrepancies in how individuals interact with the lifespan of materials, artifacts, and their functionalities.

KEYWORDS: repair; collections; *longue durée*; archeology; temporality

Introduction

In 2019, we organized an international conference in Paris titled "Les réparations de la préhistoire à nos jours: Cultures techniques et savoir-faire." Drawing on Braudel's idea of the *longue durée* and by holding sessions at the Musée des arts et métiers and at the Musée de l'air et de l'espace, we wanted to explore the theme of repairs by integrating anthropological, archaeological, and museographic dimensions, an unusual approach in this field of study, and then open up chronological perspectives for the study of these technical practices. Recent historiography has tended to focus on

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the contemporary period, aiming to "rethink this decline-and-fall story" of repair in the industrial economies of the "throw-away society."[1] Despite the great merits of this historiography, we felt it necessary to bring a long-term perspective to the debate that would allow us to demonstrate the diversity of technical cultures, skills, and values mobilized to repair objects through which repair contributes to the transformation of a material economy and the organization of production, as well as to develop a cultural interpretation of the broken or out-of-order object. The repair of tears in medieval manuscripts, the seventeenth-century Japanese art of *kintsugi*, the work of eighteenth-century artisans, and the African objects presented in the 2007 *Objets blessés* exhibition at the Musée du Quai Branly in Paris are a few examples of the diversity of technical repair practices. These require studies with a long-term perspective.[2]

Other questions we raised at the conference concerned historical methodology. As Stéphane Lembré noted with regard to the ethnology of technical action, "repairs are more a matter of experience, of know-how or savoir-voir," and are not very formalized, which makes them difficult to observe and identify.[3] The study of repairs through the exploration of practices, photographs, films, objects, excavation sites, and physicochemical analyses incorporates the methodological challenges of research into the history of techniques.

This disciplinary openness also seemed to us to guarantee a better understanding of the place of repairs in technical cultures, thus contributing to a growing body of research suggesting that the knowledge of practices and techniques is constitutive of human societies, down to their symbolic expressions. In short, we see repairs as relevant to multiple axes on the current spectrum of the history of techniques: from materiality to intelligence to symbolic power. Our starting point for the conference was the observation that in the consumerist universe fostered by capitalism, repair is associated with exceptionality: with the exception of a few rare everyday objects, such as bicycles or cars—and even then less and less—the expected life cycle of an object includes purchase, use, and disposal. And yet, as studies of the long course of history have shown, maintenance, alteration, and repair have been the norm rather than the exception. The development of mass consumption itself was accompanied by a supply of repair services. Retail shops, for example, offered repair services for standardized products like shoes, and dry cleaning shops took care of ready-made garments.[4] As Juan Vincente

1. Krebs, Schabacher, and Weber, eds., *Kulturen des Reparierens*; Krebs and Weber, eds., *The Persistence of Technology*; Krebs and Weber, "Rethinking the History of Repair," 32.

2. Mariaux, "De la matière au sens, ou comment l'objet médiéval se perd entre bricolage, remploi et réparation"; Keulemans, "The Geo-cultural Conditions of *Kintsugi*"; Hilaire-Pérez, *La pièce et le geste*; Speranza, *Objets blessés.*

3. Lembré, "Savoir réparer au village." On the ethnology of technical action: Chevallier, ed., *Savoir faire et pouvoir transmettre*.

4. Mitchell, "Waste in the Manufacture of Men's and Boys' Ready-to-Wear Clothing."

García Marsilla has recently argued, repairs—in shops, on the street, and at home—were part of the experience of the urban and rural classes:

> The European and American cities of the nineteenth century and a good part of the twentieth century were still the scene of the activities of numerous tile repairers dedicated to mending and recomposing earthenware pots, shoemakers, grinders, darners, chapmen, and ragpickers, among many other trades dedicated to making objects last, for which the famous "programmed obsolescence" had not yet been conceived.[5]

On the one hand, durable economic patterns aimed at preserving manufactured goods and natural resources were effective in the long run. Repairs were part of an economy of scarcity, but they were also made to valuable goods like books.[6] Studies also show that not only consumers but also workers, artisans, and entrepreneurs continued to reuse materials and repair equipment and artifacts. Florian Téreygeol and Catherine Verna show that in medieval mining sites in the Pyrenees, iron tools were reshaped and resharpened in special forges ("mining forges") from the thirteenth to the sixteenth centuries.[7] According to Verna, the entrepreneurs' willingness and ability to control the consumption of raw materials, to reuse or transform waste, and to recycle materials that were reintegrated into the production cycle can sometimes be understood in terms of the "circular economy" model.[8] Raphaël Morera, who studied mills around Paris in the sixteenth and seventeenth centuries, has shown that owners increasingly required millers to cover the cost of expensive repairs to wheels, for instance.[9] These actions and choices, which have been brought to light thanks to the practice of interdisciplinarity, confirm the existence of managerial skills, the organization of labor for the purpose of repairing equipment and tools, which also demonstrates an environmental knowledge.[10]

On the other hand, the early modern expansion of markets for complex, composite items (clocks, instruments, furniture, carriages) in Europe promoted a new relationship between consumption and repair. Repairs were part of the emergence of a consumer society. Product technology underpinned an

5. "Las ciudades europeas y americanas del siglo XIX y buena parte del XX fueron todavía el escenario de actuación de numerosos lañadores, dedicados a reparar y recomponer cacharros de loza, de zapateros remendones, de afiladores, de zurcidoras, de quincalleros o de traperos, entre otros muchos oficios dedicados a hacer perdurar unos objetos para los que no se había conce-bido aún la famosa "obsolescencia programada" (García Marsilla, "Las siete vidas de las cosas," 9). Also García Marsilla, ed., "Los origines de la 'economia circular.'"

6. Mandingorra Llavata, "De poca valor."

7. Téreygeol and Verna, "Metallurgical Entrepreneurship and the Circular Economy in the Pyrénées between the 13th and 16th Centuries."

8. Verna, "Entreprises des campagnes médiévales."

9. Morera, *Paris, une histoire d'eau*.

10. Verna, "Entreprises des campagnes médiévales."

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"economy of identification" in which objects were distinguished by the way they were made, assembled, housed, repaired, and reshaped.[11] The product economy led to the production of parts, components, and fixtures; their resale and storage; and their assembly in finishing workshops specializing in fitting, replacing, and surfacing.[12] Repairs were a major part of the business of craftsmen, who were often subcontracted to repair objects.[13] Business archives suggest the large scale of repairs in the craft and manufacturing industries.[14] Through repairs, artisans and entrepreneurs acquired skills of coordination, forecasting, calculation, and adjustment. These daily, repeated techniques reconfigured labor identities around operational logics as tasks became more repetitive, contributing to the development of connections across trades and sectors long before the factory system introduced interchangeable components.[15]

The *longue durée* reveals the multiplicity of meanings attached to repairs. People had a much richer technical relationship with the world than we have today. In this "anthropotechnical" world, a world in which practices and know-how were the building blocks of *savoir-vivre* and *savoir-être*, human life was no more a given than that of objects. This is the contribution of a recent trend in the history of technology, an empirical and material trend that favors the study of the continuum of uses, appropriations, and adaptations long ignored by grand narratives.[16] If this theme, long absent from historiography, has come to the fore, it is because it challenges the idea of teleological progress and innovation and, more broadly, raises the question of technical temporalities, which has become central today.[17] Repairs imply a constantly updated relationship with the past and thus a temporal plurality, or "heterochrony." As Jonas van der Straeten and Heike Weber have suggested, it is "to make sense of the heterogeneous and interwoven timelines of technology," arguing that "popular metaphors such as the binary notions of 'old' and 'new' technologies or the coinage of a 'simultaneity of the nonsimultaneous' [*Gleichzeitigkeit des Ungleichzeitigen*] are too reductionist and essentialist."[18] Heterochrony, on the other hand, "implies that the temporalities of a technology are not stable but change over time and across different settings." They maintain that we

11. Grenier, "Une économie de l'identification."

12. Hilaire-Pérez, *La pièce et le geste*.

13. Hilaire-Pérez, "Les réparations et l'espace de la technique au XVIIIe siècle"; Bernasconi, "Technische Kulturen des Uhrenreparierens."

14. Girardier, *L'entreprise Jaquet-Droz*.

15. Alder, *Engineering the Revolution*.

16. Krebs, Schabacher, and Weber, *Kulturen des Reparierens*; Krebs and Weber, *Persistence of Technology*; Jackson, "Rethinking Repair"; Cardoso de Matos, Fontana, and Nègre, eds., *Trajectoires des matériaux et des objets*.

17. Vinsel and Russell, *The Innovation Delusion*; Weber, "Sous la pression du temps."

18. Van der Straeten and Weber, "Technology and Its Temporalities," quoting Schmieder, "Gleichzeitigkeit des Ungleichzeitigen," and Landwehr, "Von der 'Gleichzeitigkeit des Ungleichzeitigen.'"

"need to take the full 'life-cycle' of a technology into account, especially the processes of reuse, 'unmaking,' repair, decommissioning, and decay that have received little attention so far."[19]

Mostly overlooked, wear and tear, decay, and destruction—*unmaking*—which have also become the norm in some parts of the world, seriously undermine equipment and infrastructure, a condition that can lead to major accidents.[20] As Ariane Fennetaux puts it, "Being situated in an in-between state—that between the good and the bad—repair thus captures something of the fundamental tension that inhabits the material and technical world, its very essence perhaps."[21] The history of use—but also of difficulties of use, of discontinuities in operation from breakdowns to failures—long on the margins of historiography, is increasingly attracting the interest of researchers.[22]

In cultural terms, repairs reveal the constitutive dimensions of techniques that are irreducible to applied science and defined by the "traditional efficient action," as Marcel Mauss puts it.[23] An understanding of assembly and the use of transposed, resized, and adapted parts and materials often inform the repair process, revealing the synthetic thinking that underpins technical intelligence as a capacity to resolve "universal contrariety."[24] The study of these techniques reflects a growing trend that questions the word "technology" and concept of "technology" and points to the need for an alternative terminology, highlighting the potential of the French word *technique* to rethink technology in global history.[25] As Verna reminds us, drawing on André-Georges Haudricourt's discussion of "artisanal routine,"

> the technical gesture, even the simplest and most conventional, is the expression of an intention and is therefore never a more or less applied repetition. It is the result of a compromise, a series of constraints that must be managed during the creation of the object. The technical gesture is the fruit of the ability to find solutions adapted to specific needs.[26]

Repairs give us access to the texture of techniques and the subtlety of the associated know-how that no guide, manual, or treatise can provide, because

19. Van der Straeten and Weber, "Technology and Its Temporalities," quoting Weber, "'Entschaffen.'"

20. Van der Straeten and Weber, "Technology and Its Temporalities"; Rauhut, "The Non-simultaneous as a Research Tool for Late Nineteenth-Century Construction Sites"; Graham and Thrift, "Out of Order"; Henke and Sims, *Repairing Infrastructures*.

21. Fennetaux, "Réparation textile, reprisage et faire durer," 123.

22. Lambert and Raveux, "Pannes et accidents"; Raveux, "Une mer de désordres"; Fridenson, "L'histoire de l'incertitude technique et ses enjeux."

23. Mauss, "Techniques of the Body," 75.

24. Hilaire-Pérez, "Les réparations"; Vérin, *La gloire des ingénieurs*.

25. Carnino, Hilaire-Pérez, and Lamy, "The Global History of Techniques and the Globalization of the History of Techniques"; Camolezi, "Technique, *technics*, *technik*, substantifs"; Camolezi and Hilaire-Pérez, "Technology and Technique."

26. Verna, *L'industrie au village*, 20.

they presuppose familiarity with the object, the material, the process.[27] Such familiarity reflects a symbiosis between the technique and its environment, resulting in a process of individuation, according to the philosopher Gilbert Simondon.[28]

Familiarity is a way of relating to objects. Taking into account the interventions involved in the maintenance of objects helps us develop a new way of looking "at the relationships humans have with these things, which are always more—or less—than symbolic totems or functional tools."[29] To consider them repairable, viable, is to recognize their technicality, to give them a consideration that the mass consumerism and programmed obsolescence that characterize our times do not typically afford them.[30] The history of repair has become central to the critique of consumer society and to the justification of an economic model that aims to reduce the social and environmental impacts of growth on a global scale.[31] It is inseparable from the growing mobilization of social groups around these issues. A wide range of research on techniques, the life of objects, and material culture is finding new ground and greater legitimacy. Several studies that focus on repair, maintenance, reuse, and recycling attest to the fruitfulness of this interrogation of consumer society and, more broadly, how the rise of an alternative social economy and citizen science has contributed to a reassessment of techniques, modernity, and innovation.[32] Such studies emphasize the durability of objects, both to counteract the economy of waste and consumption and to show how such an economy fosters the loss of know-how and proximity to technology that have long been part of everyday work, in workshops and in the domestic sphere.[33] By virtue of their commonplace, shared nature and their similarity to techniques associated with bodily care, such as applying cosmetics, styling hair, and using prostheses, repairs are emblematic of technique as constitutive of the human and as a producer of social bonds, which explains why they have long been invested with symbolic meanings.[34]

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27. In a context of innovation, one uses techniques already mastered to make repairs. In the navy, during the transition to electricity, cable repairs were made by borrowing the splicing technique (Robineau, "L'introduction de l'électricité dans la marine militaire, 1880–1935," 103).

28. Simondon, *Du mode d'existence*.

29. Pontille and Denis, *Le soin des choses*, 15.

30. Bihouix, *L'âge des low-tech*; Goyon, "L'obsolescence déprogrammée."

31. Packard, *The Waste Makers*; Slade, *Made to Break*; Bihouix, *L'âge des low-tech*; Corteel et al., "Des fripes, des restes et des champignons"; Becker-Leifhold and Heuer, eds., *Eco-friendly and Fair*.

32. Martínez and Laviolette, eds., *Repair, Brokenness, Breakthrough*; Furniss, Joulian, and Tastevin, "Réparer le monde"; Grimaud, Tastevin, and Vidal, eds., "Low Tech?"

33. Anstett and Ortar, eds., *La deuxième vie des objets*; Borg, "Les sens perdus du garagiste"; Werrett, *Thrifty Science*.

34. Lanoë, *Les ateliers de la parure (France, XVIIe–XVIIIe siècle)*; Speranza, *Objets blessés*.

However, current research is also generating new hypotheses that make clear that history matters, and not just as background. We propose to use this new research to reassess the history of repair from antiquity to the present, highlighting the multiple and overlapping meanings of repair in past societies, as well as contexts that are ignored by the linear, teleological, and Eurocentric narratives in history of technology. Finally, we highlight new trends in heritage studies that challenge the epistemology of duration for archival technical artifacts whose histories are invested with meanings that link them to sometimes-conflicting representations and attitudes toward memory and history.

Repairs in Ancient and Medieval Studies

Bringing to light the ambiguity and multiple meanings of repair is also one of the major contributions of recent archaeological research, which provides data fundamental to the history of techniques. This research is significant not only because it identifies past objects and techniques but also because it contributes to our understanding of what these objects meant.

The material register is rich in examples of repairs from all eras. Recently, construction history has provided a strong framework for research. The ReMArch (Remploi et Recyclage des Matériaux de l'Architecture; https://remarch.hypotheses.org) research network, founded in 2019, has created a database of "reuse events," a large diachronic, historical corpus covering all building materials that provides qualitative and quantitative data on the practice of reuse in ancient times (materials, contexts, practices, nature of operational chains). This initiative, launched at a time of burgeoning archaeological projects and studies on the history of reconstruction, has partly encouraged research on repairs based on archaeological data.[35] The relationship between repair and salvage practices is sometimes close, as demonstrated by the excavations of the fifth-century Mandirac shipwreck, which suggested that dismantled and adapted naval framework elements were used to construct a new boat.[36] Similarly, the excavation by archaeologists Marc Guyon and Laure Meunier of a Gallo-Roman barge discovered in 2003 on the banks of the Saône in the Saint-Georges district in Lyon revealed the many repairs, both textile and wooden, that kept this vessel afloat.[37]

Archaeological research on repairs is also characterized by object-specific approaches, which were widely represented at the 2019 international conference. As far back as the Paleolithic, societies repaired carved flint, whether

35. ANR RECAP project (*REConstruire après un séisme: Expériences antiques et innovations à Pompei*), 2014–18, directed by Hélène Dessales, http://recap.huma-num.fr/; Dessales, ed., *Ricostruire dopo un terremoto*; Bernardi and L'Héritier, "Recyclage et remploi."

36. Jézégou, "L'art de réparer et d'entretenir les navires méditerranéens."

37. Guyon and Meunier, "Lyon Saint-Georges 4."

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to sharpen cutting tools, replace broken parts of an assembly, or make other tools. Archaeologists have begun looking more closely at these techniques that combine reuse, recycling, and repair. This research aims to bring together not only history and archaeology but also the experimental sciences, which are often absent from current studies that are more focused on the modern and contemporary periods. When presenting their findings on the repair of broken pots in Late Neolithic southern France at the 2019 conference, a group of archaeologists and biochemists led by Pauline Debels observed that

> given the complex nature of repair operations and the intents hidden behind its materiality, it is only natural that their study requires a multiscalar analysis from different disciplines. First and foremost, repairs should be analyzed technically by the identification of the nature of the intervention. . . . Other elements can provide insights into the reason of the breakage, such as the observation and characterization of use wear (macroscopic and microscopic analysis).[38]

When it comes to analysis and interpretation, we need to distinguish between repair work done to preserve the object's intended use and true recycling using a partially shaped raw material. Excavations in Roman Gaul show that the life of metal objects, from blades to cauldrons, was punctuated by maintenance and repair and that repair work done to preserve an object's *raison d'être* was done cold, often in a domestic setting, while recycling was often done hot in a marketplace, where objects were not produced solely for one's own use.[39] The analysis of repaired objects also allows us to understand the reasons for repairs and the values that each society attached to the objects in question. In some cases an object had to be saved for practical reasons, for example, its indispensable role in the everyday farming (even if it required a considerable amount of work), while in others objects were preserved for their symbolic value. Repair itself may have been seen as a means of strengthening community ties through the intangible mediations that underpin it, as in the case of the reuse of cult objects in the first millennium BC.[40] The repaired ancient object survives the centuries, asserts the strength of its heritage, transcends the present, and acquires the value of a medium. In ancient Greece, repaired and maintained weapons were seen as emblems of civic virtue.[41] Research on jewelry in early medieval necropolises also shows that repair practices, long overlooked by the field of archaeology, made jewelry "memory objects" among elite groups who consolidated their

38. Debels et al., "Repairing the Broken Pots of the Late Neolithic in the South of France (3500–2300 BC)."

39. Huitorel, Leconte, and Pagès, "Objets réparés, équipements d'entretien et forges de maintenance dans les campagnes de Gaule romaine."

40. Quillien, "Le cycle de vie des objets de luxe (joaillerie et textile) dans les temples babyloniens au premier millénaire avant notre ère."

41. Warin, "L'entretien et la réparation des armes de guerre en Grèce dans l'Antiquité."

power through the circulation of wealth, whose traces of use "conveyed the memory of their previous owners."[42] The symbolic dimension of repair and replacement underpinned the medieval cult of relics. Pierre-Alain Mariaux has studied the replacements and repairs carried out on two reliquaries from the Abbey of Saint-Maurice d'Agaune in Valais, Switzerland, which contain the remains of the founder, the Burgundian king Sigismund, and those of Maurice, the local saint.[43] The shrine of Saint Maurice appears as "a construction in time that dares to show itself as such, layer after layer, in short," a building "where the connections, the 'seams,' the patches are not concealed, whose function would be to inscribe the passage of time in the very matter of the object." In Mariaux's words, "replacements are temporal indicators that mark the age and origin of relics, which are the criteria of their authenticity."[44]

This work invites us to take stock of worlds in which technology may have played a central role in spirituality and representation.[45] Such considerations lead us to dissociate repair from mere utility. If the interventions identified in the Bronze Age on various objects, from tableware to swords, are "economic gestures" that respond to the need to preserve valuable objects or artifacts invested with know-how, cultural-economic concerns were not the only driver.[46] Furthermore, functionality was not necessarily the first priority. Léonard Dumont mentions repairs to damage to the cymbal fibulae caused by the weight of the side discs, which were prized despite the pressure they exerted on the closure, suggesting that aesthetics could trump functionality.[47] In fulfilling an aesthetic function, repairs can also fail to achieve their goal, as in the case of patches on swords where the blade remains defective. Repair as artifice serves to symbolize functionality and thus transcends it. Another, more familiar example is Japanese *kintsugi*.

But it would be futile to pit the rational against the material. In this respect, the work of Daniel Roche is an important milestone. Inspired by Braudel's *Civilisation matérielle* and the *Annales*, and rejecting "a simple materiality," Roche locates objects "in networks of abstraction and sensibility essential to the understanding of social facts," for "any object, even the most ordinary, encloses ingenuity, choices, and culture."[48] The goal of positioning objects between materiality, sensibility, and intellection, an approach that he adopts throughout his work, is, as he describes in the introduction to *Cultures*

42. Renou and Poignant, "Des bijoux brisés, trajectoire d'objets précieux durant le haut Moyen Âge."

43. Mariaux, "De la matière au sens."

44. Mariaux, "De la matière au sens," 503.

45. Schäfer, *The Crafting of the 10,000 Things*.

46. Dumont, "Quelques réflexions sur la réparation et la réutilisation des objets métalliques à l'âge du Bronze," 492.

47. Dumont, "Quelques réflexions sur la reparation," 490–91.

48. Roche, *A History of Everyday Things,* 11.

et formations négociantes, "to understand the interactions established between social and economic structures and the modes of action, intellection, and representation of a milieu defined by its ways of acting and doing."[49] Taking the historical measure of reparations in the long term means restoring the multiple articulations between these spheres of human activity.

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Repairs and the Eighteenth-Century World of Goods

Rather than pitting one against the other, recent scholarship on consumption and repair shows how the consumerist boom in Europe from the modern era into the twentieth century was accompanied by the establishment of a strong repair sector that includes a variety of trades and contributed to the redefinition of occupational identities.[50]

Studies in the history of consumption have stimulated interest in the subject of repair, along with interest in the history of techniques and anthropological, ethnological, sociological, and archaeological approaches.[51] In the long run, archives suggest that the scale of repairs carried out in craft and manufacturing enterprises, sometimes along intercontinental circuits, was extensive.[52]

Studies of the modern era in particular have embraced these new approaches to the links between consumption and repair. Following Roche's example in *Choses banales* (translated as *A History of Everyday Things*),[53] authors such as Ariane Fennetaux and Simon Werrett have highlighted the specificity of the eighteenth century. It was characterized both by an economy of scarcity and frugality and by a consumerism that valued innovation and product renewal.[54] Simon Werrett in his article "The Oeconomy of Repair" shows that in the modern era the notion of economy in the domestic sense ("thrift") justifies a moral economy of goods steeped in Christian principles and aimed at making the Creator's gifts bear fruit.[55] Maintenance and repair were associated not with poverty but with virtue, as evidenced by their practice in aristocratic households, as Ariane Fennetaux also shows in the case of textile mending. The rise of consumerism in both authors' accounts in no way calls into question the preservation of objects. Werrett explains

49. Roche, introduction to *Cultures et formations négociantes dans l'Europe moderne*, 12.

50. Hilaire-Pérez and Clifford, "Le monde artisanal et la sous-traitance à Londres au XVIIIe siècle."

51. Strebel, Bovet, and Sormani, *Repair Work Ethnographies*; Pink, Salazar, and Duke, "Everyday Mundane Repair."

52. Girardier, *L'entreprise Jaquet-Droz*.

53. Roche, *A History of Everyday Things*.

54. Fennetaux, Junqua, and Vasset, "The Many Lives of Recycling," 2; Werrett, *Thrifty Science*.

55. Werrett, "The Oeconomy of Repair."

that repair as a virtue complemented consumption. People didn't just want to avoid throwing away items that had taken a lot of work to make in the first place; they also wanted to improve them, embellish them, and modify them to suit new tastes and fashions, "blurring the boundary" with finishing, as Sébastien Pautet says, and in a way innovating, transforming while preserving.[56] Replacement, transposition, and circulation were valorized, as recovery and recycling prevailed in a society where the used object was not a waste but a resource in the making and where waste itself participated in a circular economy.[57] What's more, repairs and "fixes" fostered customer loyalty and consumer sociability—interactions that contributed to the establishment of a consumer society. These repeated interventions strengthened the social ties that made up the economy that enlightened minds valued.

Repair was not only about reuse but also about improving the quality of production. Gaëlle Laire, Patricia Moitrel, and Serge Le Maho, for example, show how the history of the refinement of ceramics used to form sugar loaves from the seventeenth to the nineteenth centuries blurs the boundaries between production, repair, and the acquisition of know-how.[58] In fact, sugar molds that were worn and had undergone various repairs were better (smoother, easier to use) and were therefore favored by sugar makers. Our contemporary mindset, which considers the new to be the ultimate in production and any repair to be the downgrading or even scrapping of an object, may make it difficult for us to understand the nature of the operations carried out in these workshops, where technical know-how and tool efficiency were mutually constructive. Far from being a second-best solution, repair is a prerequisite for ensuring optimal technical action. Several studies emphasize repair as a habitual way of relating to things in preindustrial societies, from the highest social spheres (the queen of England's dresses were repaired and recycled for her ladies-in-waiting or to cover her cushions) to the most impoverished milieus, such as certain groups of Parisian ragpickers.[59] In contrast to our contemporary approach to object design, where each form must embody the optimization of a function, multifunctionality and reuse were often the norm in earlier societies.[60]

Recent studies of eighteenth-century Europe also reveal the role of these daily and repeated techniques in the reconfiguration of trade identities around repair knowledge and the emergence of transversal production

56. Pautet, "Une identité matérielle en suspens"; Hilaire-Pérez, *La pièce et le geste*.

57. Barles, *L'invention des déchets urbains*; Strasser, *Waste and Want*; Zsuzsa and Lepawsky, eds., *The Routledge Handbook of Waste Studies*.

58. Laire, Moitrel, and Le Maho, "C'est dans les vieilles formes à sucre que l'on fait les meilleurs pains."

59. Borman, *The Private Lives of the Tudors*, 319–23; Compagnon, *Les chiffonniers de Paris*.

60. Bernardi and Dessales, "Les réemplois en architecture, entre Antiquité et Moyen Âge."

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sectors, for example, for the supply of spare parts and fasteners.[61] At the 2019 international conference, Pautet emphasized both "the transfer of knowledge from the workshops of craftsmen to the public sphere and to the domestic economy" and the place of repairs in "a growing pluriactivity and in the development of operational knowledge."[62] The history of repair thus connects with the history of the rationalization of work, as studies on artillery and shipbuilding have already shown. To borrow an expression coined by Hélène Vérin, "from mending comes industry" (*du raccommodage naît l'industrie*).[63] The work on ship repairs confirms the link between these banal, "routine" techniques and the standardization of parts, such as lead plates, tapes, and *pelardeaux* (pieces of wood, often wedge shaped, surrounded by oakum, which were inserted into holes in the hull to prevent water ingress), including their prepunched holes.[64] Repair techniques are part of "technology's middle ground," "an ambiguous space between production and consumption" that technology can be said to occupy.[65] The economy of interchangeable parts is not limited to the history of the standardization of labor and machine tools but also figures in the long history of repair, irreducible to the demands of profitability alone, as it is also sustained by the know-how of fitting, assembly, and composition developed in craft and working-class environments, outlining a genuine operating culture that was subsequently erased by the rise of engineering sciences.

Repairs in the Age of Industrialization and Empires

Whereas in the nineteenth century the transformation of production methods through the interchangeability of parts led to a "discipline" of repair, in the twentieth century programmed obsolescence established a new relationship with objects that was designed to discourage repair, which transformed the tasks assigned to engineers. This undermining of repair has attracted the attention of sociologists since the 1960s, and more recently of journalists and even manufacturers concerned with a sustainable economy, and has provoked a backlash from consumer groups (and their lawyers, for example, against Apple in 2003).[66]

However, another model developed in the Communist Bloc, which placed repair at the heart of the economy and the techno-technical regime.[67] We had

61. Hilaire-Pérez, *La pièce et le geste*; Bernasconi, "Technische Kulturen des Uhrenreparierens."

62. Pautet, "Une identité matérielle en suspens," 145.

63. Alder, *Engineering the Revolution*; Vérin, *La gloire des ingénieurs*, 396.

64. Veyrat, "Le mobilier en plomb dans la marine en bois (XVIe–XIXe siècle)."

65. Borg, *Auto Mechanics*, 2.

66. Packard, *The Waste Makers*; Slade, *Made to Break*; Warner et al., "Evaluation of Zero Waste Places Projects 2009–2010 in England."

67. Siegelbaum, *Cars for Comrades*.

been preparing this international conference with our friend and colleague Larissa Zakharova, who passed away in March 2019, just a few months before the conference. As we discussed sociologists' responses to the decline of repair work, Larissa pointed out that while the age of mass consumption in the West led to the rise of a throwaway culture, communist ideology, on the contrary, emphasized a technical culture that emphasized the use of objects for as long as possible in the name of ingenuity, rationalization, and the value of human labor. In Communist Bloc countries, secondary schools trained girls to make and repair clothes and taught boys to tinker with objects made of wood and other materials. Magazines and clubs promoted repair skills among hobbyists, while repair centers offered workshops specializing in appliances, clothing, shoes, and more. The malfunctioning of the planned industry, with its systematic stockouts and rejects, was thus compensated for by amateur and professional repair circuits and the black-market trade in spare parts. In short, the efficiency of the production system depended on common repair skills that were integrated into society as a specific technical culture and rooted in a socialist ideology, highlighting the profoundly political dimension that techniques can assume.[68]

The central role of repair in economic systems has been fully recognized in other contexts. In the nineteenth century, at a time when mechanization and the race for power and speed led to the sacralization of technology and the displacement of the human factor, the repairer was presented by socialist thinkers as the ideal of modern man because he was capable of mastering machines.[69] For Thomas Hodgskin, machines were the result of the work of designers and builders, on the one hand, and operators and repairers, who ensured their effective use, on the other.[70] The role of repair in the age of mechanization reveals a bias in favor of human appropriation of the machine.[71] From then on, it was technologists who, concerned with the quality, reliability, and safety of objects (as at the Conservatoire des arts et métiers in Paris), reintroduced descriptions and analyses of repair work into technical writing and developed an interest in the most varied technical collections, embracing the everyday innovations and micro-inventions that emerged with the new profession of mechanic.[72] Jean-Hugues Barthélémy recalls that a century later Simondon pinned all his hopes on the role of "the one who watches over, the one who repairs, the one who understands what a machine is," believing that "machines will be able to work by themselves within a society that will no longer be one of work but of the sharing

68. Zakharova, "Le quotidien du communisme"; Golubev and Smolyak, "Making Selves through Making Things."

69. Hilaire-Pérez, "'Sauver l'objet technique.'"

70. MacLeod, *Heroes of Invention*, 167–68.

71. Barron, *Edmond Pâris et l'art naval*; Raveux, "Une mer de désordres."

72. Dufaux, *L'amphithéâtre, la galerie et le rail*.

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of work, because it will have become a society of invention and information."[73] Repairing, maintaining, understanding, and inventing go hand in hand here, satisfying the desire to regulate and limit the inconveniences of industrial society. This technical culture of repair, which accompanied the intensification of production (artisanal and industrial), has been theorized since the nineteenth century. Works on repair in Africa provide a good illustration of this.[74] Scouring, sanding, and varnishing are traditional acts that anticipate deterioration and contribute to a maintenance economy; they are activities that offer a way to combine the study of the short- and long-term life of objects.[75] Joshua Grace shows that the "histories of motor vehicles in West and East Africa" and "histories of farming and cooking technologies, bicycles, radio, and telecommunications tell similar stories about Africans adopting tools with their own logics in mind and forming their own cultures of innovation to repair and remake each technology," although he adds that "these repair cultures often came with sharp political critiques of the political and economic context that had made breakdown normative and which had delegated repair onto users, especially during the neoliberal period," reminding us that "creativity within colonial rule does not preclude the destructive nature of European technopolitics."[76] In this situation, "the technological repair of systems often offered individuals and societies opportunities to remake political and economic systems, and it thus provides fruitful ground to rethink the relationship between technological function/dysfunction and political decline/repair."[77] Similarly, Gabrielle Hecht urges historians not to be "seduced by the romance of creativity" and not to underestimate the conditions associated with lack of means: "Those conditions matter. Inequality matters, to these mechanics and to many others."[78] Recent studies on infrastructure in Latin America show that in certain neighborhoods of Mexico City people live in a permanently degraded technical environment, where structural decay constantly threatens functionality and where repairs are part of decisions regarding the social inclusion of marginalized users.[79] A close analysis of the same problem in Colombia reveals the role of institutional processes in the construction of marginality.[80]

73. Barthélémy, "L'humanisme ne prend sens que comme combat contre un type d'aliénation," 60, 65.

74. Grace, *African Motors*; Gewald, Luning, and van Walraven, eds., *The Speed of Change*; Mavhunga, *Transient Workspaces*.

75. Roulon-Doko, "Les mots de la réparation," 19–23; Dupré, "La réparation en Afrique."

76. Grace, "African Technological Pasts since 1800," 153.

77. Grace, "African Technological Pasts since 1800," 153.

78. Serlin, "Confronting African Histories of Technology," 97.

79. Velho and Ureta, "Frail Modernities."

80. Acevedo-Guerrero, "Light Is like Water."

These dynamics of segregation and domination have a global dimension. Repair and recycling are part of a production sector that is linked to global economic and political power relations. The current situation in countries like Ghana, where electronic products from developed countries are dumped, repaired for resale, or recycled, raises the question of how these intensive repair and recovery practices—an expression of apparent economic domination—fit in with traditional practices based on different logics. Finally, while it is customary to consider repairs as part of the so-called informal economy, in recent decades the boundary between rich and poor countries in this regard has been blurred by the emergence of the culture of repair as an ecological approach and a civic commitment to "slow consumption," the economy of recycling and recovery.[81]

But domination is not the only configuration of this globalized history of repair. David Plouviez shows that colonial logistics on distant seas were such that naval repairs from the eighteenth century onward required the integration of European techniques with local ones.[82] Zakharova brings repair into the history of international relations in her paper "L'insertion des techniques étrangères de communication dans l'environnement industriel soviétique," included in the 2017 conference proceedings *Les techniques et la globalisation au XXe siècle*, and in her 2020 book *De Moscou aux terres les plus lointaines: Communications, politique et société en URSS*. Through a study of the Aurore Rouge factory in Leningrad, a nationalized plant of the Swedish firm Ericsson, she shows that repairs were inseparable from the technical transfers that the Soviet Union sought to modernize its telecommunications.[83] The issue of repairs was a critical part of the balance of power between the Soviet authorities and Ericsson, as was, more generally, the management of imported technologies, including their refinement and adaptation to local conditions. When the contract with Ericsson ended in 1931, other problems arose as the USSR sought to emancipate itself from Swedish tutelage:

> The equipment bought abroad, from companies other than Ericsson, turns out to be of very poor quality: it is constantly repaired and even "perfected" by the factory workers, to the point where a supplier company (Flek) incorporates the modifications into the equipment it manufactures. . . . With this type of equipment, the factory is supposed to produce telephone exchanges for the entire country.[84]

81. Cheneau-Loquay, "Rôle joué par l'économie informelle dans l'appropriation des TIC en milieu urbain en Afrique de l'Ouest"; Monsaingeon, *Homo detritus*.

82. Plouviez, "The Maintenance, Repair and Construction of Ships in the French Empire during the Eighteenth Century."

83. Zakharova, "L'insertion des techniques étrangères de communication dans l'environnement industriel soviétique."

84. Zakharova, "L'insertion des techniques étrangères," 94.

The question of national autonomy depended on the ability of the workforce to appropriate imported techniques. It is precisely this capacity to act that is at stake in current reflections on the growing sophistication of technology.

Repairs in the Digital Era

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In 1989, sociologist and photographer Douglas Harper published the results of his ethnography of a mechanic's shop in rural New York State run by Willie, a colorful, loudmouthed, mechanically gifted character who could fix almost anything.[85] Willie's technical mastery enabled him to fix most of the malfunctions he encountered, but as electronics—a technology that requires the use of materials and specialists specific to each operation—became more widespread, he could no longer repair everything.

The book describes the technological mutation then underway: "Willie's method tells us we have come from a technology that can be confronted by a single human mind. As we have moved beyond this stage we face an imbalance in the human/machine relationship that makes us impotent captives of our own creations."[86] This trend toward complexity, which renders Willie's mechanical know-how obsolete, is embodied by the field of electronics, which is characterized by printed circuits that operate on a spatiotemporal scale radically different from that accessible to human perception. When technical devices are controlled and driven by the power of the electron, the relationship between human beings and their techniques changes radically.

Computing is based on the principle of decomposing any operation into a sequence of logic gates that produce output states that are different from the input states: for example, binary addition can be implemented with two "exclusive or" gates, one "or" gate, and two "and" gates. Physically, this is how transistors work, receiving an input signal and producing a low-impedance output voltage. The heart of a computer's operation is opaque to human experience: we can grasp its principle and operation, but we will never be able to comprehend the magnitude of the four billion state changes that a 4 GHz processor performs in a second.

Electronic miniaturization and acceleration are the conditions of the possibility of computation, and they preclude in principle any human possibility of intervention at such a spatiotemporal level. Arguably, it is possible to use other devices to detect malfunctions or resolve certain failures, but today's integrated circuits are so close to infinitely small (and fast) that there is hardly any other solution than to produce them industrially using electronic machines and to replace them purely and simply in the event of failure.

85. Harper, *Working Knowledge*.
86. Harper, *Working Knowledge*, 201.

In other words, we have now reached such a point of complexity that it is difficult to exercise any physical control over these components; the only way we can intervene with them is through a series of intermediate layers (machine language, assembly language, then higher-level language, graphical interfaces, input/output peripherals, and so on, which include "low-level" elements such as register addresses). The structural complexity of electronic devices reveals their own spatiotemporal limitations to both engineers and high-level programmers. Even the best developers don't have direct access to what's going on at the lowest level of the machines they operate.

The archaeologist Timpoko Helène Kienon-Kabore shows that the tens of thousands of scrap metal dealers working in the Abidjan junkyard demonstrate impressive mechanical mastery (restoring a radiator with the prongs of a fork, replacing a headlight with an identical one made of heated pieces of plastic, and so on).[87] But while they can repair almost anything on a car, the recovered European vehicles (nicknamed "France au revoir") always have to be "adapted" before they can be handled by these experts in dismantling and mechanics. "Adapting" a car means stripping it of its electronic and computer components. In other words, removing the electronics is a prerequisite for regaining technical power over these vehicles. Once again, reparation embraces technology, conceived as everyday, shared knowledge, which anthropologists have shown to be a creator of social bonds and thus the cement of societies.[88] From a philosophical point of view, the link between this idea and Simondon's notion of progress as slowing down due to the development of easily adoptable techniques is obvious: "slower at each point and much more profound in its totality, therefore much more truly a progress."[89] In other words, repair invites us to think about the technical object in terms of its material culture and biographical trajectories, which are much more intertwined than we might at first think.

Repairs and the Biography of Objects

Repair is a particular moment in the "biography of an object" that, having left the market circuit at the time of purchase, returns to the world of exchange as a result of an accident, wear, or defect due to shortages or political commitments to sustainable consumption.[90] This movement generates knowledge and know-how, creates professions (often gendered), promotes sociability, and reveals the organization of a production system that is still

87. Kienon-Kaboré and Jacob Kobenan, "La culture de la réparation chez les 'ferrailleurs' des casses de la ville d'Abidjan."

88. Lemonnier, *La ritualité des choses*.

89. Simondon, "Les limites du progrès humain"; Bontems, "L'éthique de la technique chez Simondon et chez Gonseth," 65.

90. Kopytoff, "The Cultural Biography of Things."

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largely based on subcontracting networks and decentralized workshops. Even at the heart of electronic processes, which are supposedly resistant to appropriation, there is complex embedded know-how, the cultural cement of established professional milieus.[91] The recent emergence of repair cafés for electronic equipment, the various maker initiatives for repair, do-it-yourself culture, sustainability, and participation in science and technology attest not only to the vitality of these practices but also to the emergence of new consumerist logics associated with a reflection on technological knowledge in a postcapitalist society that raise the question of what knowledge is being appropriated in this way.[92] They are part of a technical humanism advocated by philosophers such as Simondon, who reminds us that

> it is imperative to stop treating technical objects as slaves and perishable commodities and to put in place a new mode of production and consumption that takes into account the entire life cycle of objects, from their design to their recycling, via production and maintenance during use.[93]

Reflections on the restoration of technical objects in museums echo such accounts of the "life of objects" by raising the question of the boundary between repair that results in functional objects and the preservation of traces of use, which creates art objects.[94] In the "biography of an object," museumization represents a particular moment.[95] The object is taken out of the consumer circuit to become part of a collection, either as a single piece or as part of a series. Krzysztof Pomian, who has theorized this transition, argues that the museumized object becomes a "semiophore," that is, a bearer of meaning, and thus loses its usefulness. Useful objects, he argues, "can be consumed, or used to procure sustenance, or transform raw materials so as to make them consumable, or protect against environmental variations. All these objects are manipulated, and all of them exert or undergo physical, visible modifications: they "wear out," while semiophores "are endowed with meaning; not being manipulated but exposed to the eye, they do not undergo wear and tear." According to Pomian, the two categories are mutually exclusive:

> It's only a thing when you use it, but then you don't have fun deciphering its meaning. And when you do, the usefulness becomes purely virtual. While coexisting with each other, the features of form that make the

91. Callén, "Donner une seconde vie aux déchets électroniques"; Carnino and Marquet, "Du mythe de l'automatisation au savoir-faire des petites mains"; Schulz, "Réassemblages marginaux au coeur de la 'Mecque du hardware'"; Baier et al., eds., *Die Welt reparieren*.

92. Strasser et al., "'Citizen Science'?"; Tancoigne and Baudry, "La tête dans les étoiles?"; Baier et al., *Die Welt reparieren*.

93. Bontems, "Sur la classification des objets techniques selon Simondon," 195.

94. Bonnot, *La vie des objets*; Fennetaux, Junqua, and Vasset, eds., *The Afterlife of Used Things*; Ambers, Higgitt, and Harrison, eds., *Holding It All Together*.

95. Kopytoff, "Cultural Biography of Things"; Bonnot, *La vie des objets*.

> object useful and those that make it a bearer of meaning suggest two different and mutually exclusive behaviours.[96]

The distinction between a useful object and a semiophore also raises the question of the technical cultures employed in connection with "wounded objects," whose function and materiality have been compromised.[97] The transition from consumption to museumization implies a change in the practices employed in relation to this state of the object. In a museum, the object, whether in good condition or in a state of disrepair, may be forgotten among the thousands of objects in the collections or, in exceptional cases, subjected to specific practices: preventive conservation or restoration, the principles of which are regulated by international conventions such as the 1931 Athens Charter for the Restoration of Historical Monuments and the 1964 International Charter for the Conservation and Restoration of Monuments and Sites. Repair, which refers to the practical knowledge associated with the do-it-yourself culture of craftsmen or amateurs, or with industries that replace damaged parts, is different from restoration or conservation, which are practices based on the scientific analysis of materials and on professional knowledge that has established itself as a discipline respecting general principles that require analyzing the history of the object, ensuring that any restorations made are reversible, and making legible any intervention in its materiality. Repair is therefore a matter of utility, aimed at restoring the technical function of the object. Conservation and restoration, on the other hand, are concerned with the visual dimension of the semiophore, articulated in a reflection on the object's identity, integrity, and authenticity.

While the concepts of consumption and museumization, of useful object and semi-object, seem to offer the basis for a clear distinction between repair, on the one hand, and restoration/conservation, on the other, the boundaries between these two types of practice are far from impermeable. Despite their differences, they share technical gestures and know-how, as a study of the history of collection care clearly shows. Furthermore, objects are far from being passive agents on which acts of order are performed in the world of use or in that of museumization. In the encounter between specialists from different disciplines, they function as "boundary objects" that have value, the recognition of which leads to negotiations and choices in which utility and meaning are not a priori mutually exclusive.[98] Finally, museum thinking about the epistemic value of the collection has recently evolved, yielding approaches that go beyond an overly rigid one that regards function and meaning as opposed.[99]

96. Pomian, *Collectionneurs, amateurs et curieux*, 42–43.

97. Speranza, *Objets blessés*; Otto, "Repairing Sowei Masks in Circulation."

98. Star and Griesemer, "Institutional Ecology, 'Translation' and Boundary Objects"; Rabier and Beltrame, "Restaurer une aile d'avion Spad VII."

99. Gauvin, "Réparation, restauration, exposition."

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Conclusion

Studying the practices and cultures of repair in the *longue durée* usually consists of examining the sites of repair (not only workshops and factories but also clubs, cafés, garages, households, and so on) and identifying the figures of the repairer (from amateur to professional), the know-how mobilized, and the meaning given to the functionality of objects during repair (restoration, partial intervention, refurbishment, and so on). But if the object—its materiality, circulation, and biography—is often the focus of such studies, allowing us to grasp the cultural, economic, and political contexts in which repair takes place, repair itself appears as a reflexive operation. In fact, the aim of repair is not simply to fix a malfunction but also to investigate the causes of the malfunction; such investigations that the process of improving and refining devices initiates are part of the incremental practices of invention that historians and social scientists are increasingly attempting to characterize.[100]

The act of repair, in the long run, has helped to weave the seamless fabric (to which the etymology of the Indo-European *teks* refers) that runs from beings to things and that constitutes the very matter of the human world, insofar as it is always at once material, cultural, and intellectual, leading to the association—however inappropriate—of "technology" with science applied to industry. This reconfiguration invites us to rethink our conditions of access to reflexivity as originally and always already technological, that is, constitutive of our episteme, as a "concrete history of abstraction."[101]

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100. Jackson, "Rethinking Repair."

101. Crawford, *Eloge du carburateur*; Perrot, "Histoire des sciences, histoire concrète de l'abstraction."

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