Darryl Cressman
Michael Felczak
ACT Lab/CPROST
School of Communication
Simon Fraser University, 2009

# A Glossary of Terms for Philosophical and Constructivist Approaches to Technology

**Actant/Actor:** Within ANT, both actors, and what would later be defined simply as actants, refer to both human and non-human elements. In this conception, the key requirement for an actor is the ability to act upon other actors in a network. In this way, an actor/actant can be anything from a piece of technology, to a document, to an actual person. See Callon & Latour 1981; Latour 1987, 1991, 1996, 1999; Callon & Law 1995.

**Actor-Network:** An attempt to transcend dualisms such as structure/agency and technology/society. An actor-network is both an actor in the sense that it can be understood as a single point (punctualized) entity while at the same time it can also be understood as a network that translates other actors. See Callon, Law & Rip 1986; Law 1992, 1994, 1999; Latour 1996, 1999; Lee & Brown 1994; Neyland 2006.

**Association/Substitution:** In order to follow the path by which inscriptions become materially durable it is necessary to consider the associations between words and materials and the transformations performed by these substitutions. See Latour 1991, 1992.

**Attribution of Responsibility:** Technology construction, a collective process in which all actors are important, needs to be distinguished from the attribution of responsibility to a limited and select few actors. This process often occurs once a technology has stabilized. See Latour 1987, 1988c.

**Black Box:** A concept originally used within information science to make opaque the inner complexity of technologies in order to focus on their function, inputs and outputs, without explaining the inner workings that stand behind the technology. Taken up by the sociology of scientific knowledge, 'black box' refers to the unquestioned acceptance of the scientific method as objective truth. Reflecting the Mertonian tradition in the sociology of scientific knowledge, sociologists undertook investigations of the social relations and processes of science but left unexamined the cognitive basis of science. Adopted for technology studies, a 'black box' is a technical artifact that appears self evident and obvious to the observer and whose inner complexities and history are hidden from view. See Whitley 1972; Callon & Latour 1981; Callon, Law & Rip 1986; Pinch & Bijker 1984; Latour 1987; Pinch 1988.

**Centre of Calculation:** Locations from which translation strategies are attempted in an effort to construct/maintain/control actor-networks. As part of these efforts, new entities may be created, existing entities may be modified or destroyed, and their various relations may be reconfigured. See also obligatory passage point. See Latour 1987.

**Concretization:** A process whereby technology is designed to accommodate its social and natural environment. It foregrounds the possibility and goal of codifying a plurality of interests and needs in the design of a technology instead of trading off certain needs and interests at the expense of others. Within CTT, this technical pluralism corresponds to development that is both technically and normatively progressive. See also instrumentalization theory; technical code. See Simondon 1958; Feenberg 1999, 2002.

**Closure:** Within SCOT, the disappearance of problems marks the end, or closure, of a technological controversy. Closure need not require that a problem actually be solved in the common sense understanding of this term. The key point is that the relevant social groups see the problem as being solved. Recent work in SCOT has investigated closure and the ways in which social groups are able to re-open the black box of technology and redefine the technology after the original process of closure. Thus, closure can be understood as variable over the lifetime of a technology. See also stabilization; black box; punctualization. See Pinch & Bijker 1984; Misa 1992; Bijker 1993, 1995a, 1995b; Kline & Pinch 1997; Oudshoorn & Pinch 2004.

**Context and Content:** This traditional distinction and its boundary is understood within ANT as variable and as an effect of negotiations between actors involved in technology construction. See also local/global network; negotiation space. See Law & Callon 1988.

**Co-Word Analysis:** An early method for mapping the dynamics of science and technology. Co-word analysis focuses on the texts that contribute to and derive from scientific and technological innovation. Co-word analysis can be understood as an early application of ANT to texts. See also inscription; immutable mobile. See Callon, Law & Rip 1986; Latour 1990.

**Creative Appropriation:** An interpretation and use of a technology in a way that was not accounted for by the actors involved in the technology's design and development. See also interpretative flexibility; relevant social group.

**Delegation:** When we replace the work of a human with a technology or technique, we have delegated this work to the technology. See also translation; displacement. See Latour 1988b, 1991, 1992; Law 1988; Akrich 1992.

**Democratic Rationalization:** Initiative and interventions in the technical sphere that attempt to undermine technocracy and codify needs and interests ignored by existing

technical designs and configurations. See also technical code. See Feenberg 1995a, 1999, 2002.

**Description:** Description is the inventory of pre-inscriptions and prescriptions that give a technology its form and function in a social context. See Latour 1988b; Akrich 1992.

**De-worlding/Disclosing:** A re-interpretation of instrumentalization theory in phenomenological terms. Analytically distinct, yet undifferentiated in reality, technology de-worlds humans from their lifeworld while at the same time disclosing a specific technologically mediated lifeworld. See also instrumentalization theory. See Feenberg 2003.

**Diffusion:** In the context of the nature and functioning of power, the diffusion model endows power with an unexplained force that allows it to extend over time and space. In contrast, the ANT translation model examines how power is taken up, enacted, and transformed through human and non-human actors. In the context of technology development, the diffusion model endows technology with an inner force that autonomously propels it in time and space. In contrast, the ANT translation model focuses on how human and non-human elements are associated to enable the technology to move in time and space. See Latour 1986, 1987.

**Displacement:** When one introduces another actor in order to extend the network, the original intention is displaced through the new actor. In Latour's examination of Pasteur he notes how Pasteur is able to displace one program of action (Pasteur's desire to improve wine making in France) into another program of action (France's desire to increase trade with England). See also delegation; translation. See Latour 1988c, 1991. Of note is also Misa's use of the term which refers to the way that certain choices about technology influence the social and cultural paths that societies take. See also technological frame. See Misa 2004.

**Engineer-Sociologist:** Developed by Michel Callon to account for the ways in which engineers not only design technologies but also attempt to define society in such a way as to accommodate these technologies. Implies that it is important to study the technical features of engineering work, since it is here that the technical and the social are simultaneously shaped. See also heterogeneous engineer; system builder. See Callon 1986a, 1987; Law & Callon 1988.

**Enrolment:** A strategy by which actors, their roles, and their interests are defined through translation. An attempt to durably situate and fix actors in a sociotechnical network. Understood as a contingent process where success is never guaranteed. See also translation; interessement; sociotechnical scenario. See Callon 1986b; Callon & Law 1982; Callon, Law & Rip 1986.

**Formal Bias:** The de-contextualized elements of a technology are, in and of themselves, neutral. But, technologies never exist in this form. Rather, it is the arrangement of these elements in a technical configuration that results in bias. For example, the bricks of Bentham's panopticon are not themselves biased. It is their arrangement that is biased. See also technical code; instrumentalization theory. See Feenberg 1999, 2002.

**Funnel of Interests:** A series of translations that begins with a problem that is generally understood as valid or important and which is used as the basis for equivalence between other problems. This series of equivalences constitutes a dependency such that at the end of the series, a particular problem must be successfully solved in order for the original problem to also be solved. See Callon, Law, & Rip, 1986.

**Generalized Agnosticism:** A methodological requirement (most prevalent in ANT and also evident in SSK) that demands that the researcher not look to conceptions of society to explain the outcome of a controversy, since the make up of society is the product of the controversy and is itself in need of explanation. This has been one of the most debated aspects, along with generalized symmetry, of much ANT work in technology studies. See Callon 1986b; Law 1986b; Callon & Law 1989; Latour 1987.

**Generalized Symmetry:** Extending the concept of symmetry from SSK, generalized symmetry requires that the researcher account equally for the social, technical and natural elements that make up a sociotechnical network. In this way, neither humans nor non-humans are given precedence at the outset. See Callon 1986b; Law 1986b; Callon & Law 1989; Bijker 1993.

**Heterogeneous Engineer:** Similar to Callon's engineer-sociologist, heterogeneous engineers are those people, groups, or institutions that juxtapose and define diverse elements to form sociotechnical networks. See also engineer-sociologist; system builder. See Law 1986a, 1987a, 1987b, Callon & Law 1997.

**Hybrid Collectif:** On the question of non-human agency, ANT argues that action is an emergent phenomenon deriving from hybrid collectives of human and non-human actors. Thus, action cannot be said to derive from one thing in itself – it is the work of hybrid collectifs. See also relational materialism. See Callon & Law 1995, 1997.

**Immutable Mobile:** Those inscriptions and texts that become standardized and homogenous, plentiful and uniform, and that can be easily spread over great spaces. See also inscription. See Latour 1990.

**Inscribing:** The process by which engineers and designers create a sociotechnical script. See also translation; sociologist-engineer; prescription; delegation. See Akrich 1992.

**Inscription:** In simple terms, a marking of some sort, often figures or text on paper. Within ANT, inscriptions are understood as actor-network translation devices. Inscriptions mobilize countless facts, places and people in one place – making the invisible (i.e. bacteria, GDP, etc.) and distant real and immediate. See Latour 1987, 1990.

**Instrumentalization Theory:** Rooted in the philosophical critique of technological reason, instrumentalization theory is a re-conceptualization of technical rationality that accounts for its social dimensions. The primary instrumentalization of technology reflects the critical theory of Marcuse, Heidegger and Habermas; the secondary instrumentalization integrates the inherent social contingency of these de-contextualizing moments. Of note is the recognition that these moments are only analytically distinct and that in practice they are inseparable. See also technical code. See Feenberg 1999, 2002, 2003.

**Interessement:** Refers to the attempts of heterogeneous engineers to interest, translate, and enroll actors. See also translation; enrolment. See Callon 1986b; Callon, Law & Rip 1986.

**Intermediary:** Intermediaries are those things which pass between actors that define/ translate their relationships. According to Callon, intermediaries include everything from money to technology to software to scientific articles. See also translation. See Callon 1991.

**Interpretative Flexibility:** Within the sociology of scientific knowledge, interpretative flexibility emphasizes the observation that scientific findings are open to more than one interpretation, hence shifting the focus of scientific explanation from the world of science to the social world. Applied to technology, interpretative flexibility highlights both the cultural construction and interpretation of technical artifacts and the resulting flexibility of technical design. See also symmetry. See Pinch & Bijker 1984; Bijker 1993, 1995a, 1995b.

**Investment of Form:** The work necessary to simplify and juxtapose entities in a network. See also translation. See Callon & Law 1989.

**Irrelevant Social Group:** A social group that does not participate in the design and development of a technology. Alternately, a social group that is not able to successfully codify its interests and concerns in technical design. Foregrounds the social, political, and economic circumstances of technology development and how these circumstances influence the ability of certain groups to participate and succeed in this process. See also relevant social group; technical code. See Winner 1993.

**Local/Global Network:** Within ANT, an effect of negotiation strategies and processes between system builders and other actors in the (global) actor-network. The local actor-network corresponds to the space where system builders have been granted relative autonomy for heterogeneous engineering. The boundary between the global and the local as well as its nature and duration is variable and contested during technology development. Within CTT, the global network corresponds to the sociotechnical network of the technology, whereas the local network corresponds to the settings where interventions into and challenges to the technology emerge. See also negotiation space. See Law & Callon 1988; Feenberg 1999.

**Margin of Maneuver:** An ambiguous potential inherent in the implementation of a dominant technical code. Corresponds to the potential actions and tactics of those charged with this implementation, that is, the actions and tactics unaccounted for by the system builders. See also translation; technical code; local/global network; program/anti-program symmetry. See Callon 1986b; Feenberg 1999, 2002.

**Mobilisation:** The attempts of system builders to oblige heterogeneous elements to enact roles and positions in the system builder's sociotechnical scenario. See also sociotechnical scenario; translation; enrolment; juxtaposition. See Callon 1986b; Law 1988.

**Negotiation Space:** A private area or space where system builders are able to plan, explore, and test ideas, designs, and possibilities. See also local/global network; centre of calculation/translation. See Law & Callon 1988, 1992; Law 1992.

**Non-Reductionism:** Refers to both social and technical reduction. The idea, that in the last instance, either the social determines the technical or the technical determines the social. In both ANT and systems theory, social and technical reductionism is avoided by accounting for both the social and the technical on equal terms. See Latour 1987.

**Obligatory Passage Point:** A product or effect of successful translation. Taken from military terminology, the location through which all enrolled actors must pass through. Understood in terms of power, forcing actors along certain paths and channels and barring access to others. See Callon 1986b; Law 1986b; Latour 1987, 1988b, 1992.

**Participant Interests:** The interests shared by individuals who are enrolled, either intentionally or unintentionally, in sociotechnical networks. These individuals have a stake in the impacts of technical activity and, hence, its design and configuration. These impacts vary from technology to technology and include the requirements imposed on people and the environment, unintended side effects, as well as other benefits and costs associated with technical activity. See also local/global network. See Feenberg 1999.

**Pre-Inscription:** The skills and knowledge embodied in the actor prior to its/his/her enrolment in a technical script. For example, in the technical script of a computer, the user is assumed to be pre-inscribed with the basic knowledge to understand the letters on the keyboard or the function of the mouse. See Latour 1988b; 1992; Akrich 1992.

**Prescription:** Because technology is inherently social, prescription refers to the social and ethical behaviour imposed by technology back onto humans. Prescriptions are constructed in the sociotechnical script. See also translation. See Latour 1988b, 1991, 1992, Akrich 1992.

**Problematization:** To problematize is to define a specific problem and solution, enroll and define the actors within the sociotechnical network in which this problem will be undertaken, and co-relate the interests of needed actors so that they match the interests of the system builder/engineer-sociologist/heterogeneous engineer. See interressement; funnel of interests; translation. See Callon, Law, & Rip 1986; Callon 1981; Callon 1986b.

**Program/Anti-Program:** In Latour's description of a European hotel key, the "program of action" *Please Bring Back Your Key* enunciated by the hotel manager is met by the anti-program of not bringing back the key enacted by hotel customers. By adding signs and attaching a weight to the key, the manager has displaced/delegated/translated the program in such a way that the customers have abandoned their anti-program and surrendered to the manager's program. See Latour 1988b, 1991, 1992; Akrich 1992.

**Program/Anti-Program Symmetry:** Feenberg suggests that the anti-program should not be understood simply as a negation, but instead should be considered as an alternative program. That is, if the network can be taken up and reconfigured by actors incompletely enrolled or fixed by the original program then this effort to reconfigure the network appears as a disaggregating tendency only from the viewpoint of the original network builder. What is needed is an account that symmetrically considers the programs and activities of all actors. See Feenberg 1999, 2002.

**Punctualization:** A simplification effect. The attempts of heterogeneous engineers to reduce the complexity of elements. A process that is always precarious and never guaranteed. See also simplification; black box. See Callon 1991; Law 1992; Callon & Law 1997.

**Relational Materiality:** The idea that what entities are and what they do is the result of their relationship with other entities. See Law 1999; Law & Mol 1995; Callon & Law 1997.

**Relevant Social Groups:** Refers to actors, groups, and organizations that constitute the meanings of technical objects. The key requirement is that all members of a certain

social group share a homogeneous meaning with respect to the technology. See Pinch & Bijker 1984; Bijker 1993, 1995a, 1995b; Kline & Pinch 1996.

**Reverse Salient:** In the development of sociotechnical systems, reverse salients are those elements, or components, that have fallen behind or are out of place with the other components in the system. In order to be successful, system builders need to address reverse salients. See also system builder. See Hughes 1983, 1987.

**Script/Scenario:** Like the enclosed narrative of a story, a technology defines a framework of action together with the actors and the space in which they are supposed to act. See also prescription. See Latour 1988b; Akrich 1992.

**Seamless Web:** Describes a conception of the sociotechnical that attempts to overcome traditional internalist/contextualist, science/technology, background/foreground divisions. In this way, research and writing does not adhere a priori to traditional categories that define what is technical, scientific, economic, political, or social. Instead these become overlapping, dynamic, and soft categories. See also sociotechnical ensemble and actor-network. See Hughes 1979, 1983, 1987, 1988; Bijker 1993.

**Simplification & Juxtaposition:** Describes how it is that complex entities are reduced to single point actors and combined with other simplified actors in a network. Once actors are simplified and juxtaposed with other actors the resulting network can in turn be simplified and juxtaposed with other actor-networks. Simplification and juxtaposition is a contingent process and its success is never guaranteed. See Callon 1987; Law 1988.

**Social Reductionism/Determinism:** Stems from the critique of sociology by ANT and systems approaches to technology. Proponents within these approaches argue that one cannot look to social factors exclusively to understand how it is that technologies come into being. In addition, critics argue that social reductionist explanations take social factors as unchanging and not in need of explanation themselves. See also non-reductionism. See Latour 1987; Law 1987.

**Sociogram/Technogram:** The process of technology construction over time may always be observed from two angles, or by considering technology in terms of its sociogram or its technogram. In the former, one looks to see who the technology is designed to enroll. In the latter, one examines what the technology is tied to so as to make this enrollment inescapable. See also translation; instrumentalization theory; technical code. See Latour 1987, 1988b, 1991, 1992.

**Sociotechnical Ensemble:** The unit of analysis, or subject matter, of technology studies. By way of the principle of generalized symmetry, the concept attempts to move beyond a fixed distinction and separation of the social and the technical. To avoid the

pitfalls of indiscriminate empiricism, the concept suggests the application of technological frames to better understand the multiple historical frameworks in which sociotechnical innovation is embedded. See also generalized symmetry; technological frame. See Bijker 1993, 1995a, 1995b.

**Sociotechnical Scenario:** A proposal for a revision of an existing actor-network and the structure/distribution of technical and social roles. See Law & Callon 1988.

**Stabilization:** Refers to the degree to which a technology is in flux relative to a social group. A technology is said to be stabilized with respect to a relevant social group if its design addresses the problems and understandings of that group. See also closure; black box; punctualization. See Pinch & Bijker 1984.

**Symmetry of Explanation:** Developed within the 'strong programme' in the sociology of knowledge, the principle of symmetry refers to the belief that within the sociological investigation of scientific knowledge, the same types of causes should be used to explain both true and false beliefs. The principle suggests that 'nature' is never the cause of scientific truth, but is instead the product of science. Applied to technology, the principle of symmetry suggests that researchers should explain technological successes and failures in the same manner. That is, both technology successes and failures should be explained in the same terms. See Bloor 1979; Pinch 1988; Law 1984; Pinch & Bijker 1984; Bijker 1993, 1995a, 1995b.

**System Builder:** In order to account for the heterogeneous activities of the people behind technological systems, Hughes employs this term to account for the management and interconnectedness of the entrepreneurial, financial, promotional, inventive, and lobbying efforts needed to build sociotechnical systems. Like all other actors, system builders are constituted in the course of technology construction and the interaction with other actors. See also seamless web; heterogeneous engineer. See Hughes 1979, 1983, 1988; Law 1988.

**Technical Code:** The way in which the design, construction, and interpretation of a technology mediates the dominant interests of the society in which it is developed and embedded. Political representation in the technical sphere is achieved through technical codes, which embody particular interests and values as seemingly neutral and rational features of technical designs, practices, and institutions. Technical codes also set the boundaries and limits of future designs and developments by providing standard and accepted ways of conceiving of problems, solutions, and designs. See also technological frame. See Feenberg 1995a, 1995b, 1999, 2002.

**Techno-Economic Network:** Another reconfiguration of complex sociotechnical networks that examines their role in the production and distribution of goods and services. See Callon 1991.

**Technological Momentum:** Hughes recognizes both the initial contingency and eventual durability of technical systems. As sociotechnical systems are conceived of and designed they are open to many aspects of social shaping, but as these systems grow in size and enroll more heterogeneous actors within them, they become more durable and in turn shape future developments and society. See Hughes 1969, 1994, 1987.

**Technological Frame:** Developed to enable comparisons between technology case studies. The three characteristics of a technological frame are its recognition of the heterogeneous character of technology, its analysis of both sociotechnical change/ contingency and sociotechnical continuity/durability, and its account of the strategies of actors working within specific sociotechnical structures. Among other things, its components include exemplary technologies, cultural values, and knowledge. Technological frames are dynamic in the sense that they are built-up and modified as part of the stabilization process. They provide ways of thinking about problems, solutions, and goals and in so doing define the limits and boundaries of possibility. A technological frame is largely external to any particular individual but wholly internal to a relevant social group. See also sociotechnical ensemble; stabilization; closure; relevant social group. See Bijker 1993, 1995a, 1995b.

**Translation:** Originally developed by the French philosopher Michel Serres. In the most general sense, translation involves the relation of things that were previously not related. In terms of concerns and interests, translation begins with inequivalences and differences and aims to arrive at equivalences based on an affirmation of unities. The establishment of these equivalences also implies drift or displacement and the movement from one place to another. If successful, actors are tied together and channeled in particular directions. See Callon 1981, 1986a; Callon & Latour 1981; Latour 1987; Brown 2002.

Bibliography

Akrich, Madeline. (1992). "The De-Scription of Technical Objects." In Bijker & Law (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Bijker, Wiebe. (1993). "Do not Despair: There is Life After Constructivism" *Science, Technology & Human Values* 18 (1) pp.113-138.

Bijker, Wiebe. (1995a) "Sociohistorical Technology Studies" in Jasanoff, Markle, Petersen & Pinch (eds.) *Handbook of Science and Technology Studies*. London: Sage Publication.

Bijker, Wieber. (1995b). *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge: MIT Press.

Bloor, David. (1976 [1991]). *Knowledge and Social Imagery: Second Edition*. Chicago: University of Chicago Press.

Brown, Steven D. (2002). "Michel Serres: Science, Translation and the Logic of the Parasite." *Theory, Culture & Society* 19(3) pp.1-27.

Callon, Michel (1981). "Struggles and Negotiations to Define what is Problematic and what is not: The Socio-logic of Translation." In K. Knorr, R. Krohn & R. Whitley (eds.) *The Social Process of Scientific Investigation*. Dordecht, Holland: D. Reidel Publishing Co.

Callon, Michel. (1986a). "The Sociology of an Actor-Network: The Case of the Electric Vehicle." In Callon, Law & Rip (eds.) *Mapping the Dynamics of Science and Technology: Sociology of Science in the real World.* London: MacMillan Press.

Callon, Michel. (1986b) "Some Elements of a Sociology of Translation: The Domestication of the Scallops and the Fishermen of St.Brieuc Bay." In Law, J. (ed.) *Power, Action & Belief: A New Sociology of Knowledge?* London: Routledge & Kegan Paul.

Callon, Michel. (1987). "Society in the Making: The Study of Technology as a Tool For Sociological Analysis." In Bijker, W., Hughes, T., & Pinch, T. (eds.) *The Social Construction of Technological Systems*. Cambridge: MIT Press.

Callon, Michel. (1991). "Techno-Economic Networks and Irreversibility." In Law, J. (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge.

Callon, Michel & Latour, Bruno. (1981). "Unscrewing the Big Leviathan: How Actors Macro-Structure Reality and How Sociologists Help Them Do So." In K. Knorr-Cetina & A.V. Cicourel (eds.) *Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies*. Boston: Routledge & Kegan Paul.

Callon, Michel & Law, John. (1989). "On the Construction of Sociotechnical Networks: Content and Context Revisited." *Knowledge & Society: Studies in the Sociology Of Science Past and Present*, Vol.8, pp.57-83.

Callon, M & Law, J. (1995). "Agency and the Hybrid Collectif." *The South Atlantic Quarterly* 94 (2): 481-507.

Callon, Michel & Law, John (1997). "After the Individual in Society: Lessons on Collectivity from Science, Technology and Society." *Canadian Journal of Sociology* 22 (2): 165-182.

Callon, M., Law, J., & Rip, A. (1986). *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*. London: MacMillan Press.

Feenberg, Andrew. (1995a). "Subversive Rationalization: Technology, Power and Democracy." In Feenberg & Hannay (eds.) *Technology and The Politics of Knowledge*. Indianapolis: Indiana University Press.

Feenberg, Andrew. (1995b). *Alternative Modernity: The Technical Turn in Philosophy & Social Theory*. Los Angeles: University of California Press.

Feenberg, Andrew. (1999). *Questioning Technology*. New York: Routledge.

Feenberg, Andrew. (2002). *Transforming Technology: A Critical Theory Revisited* New York: Oxford University Press.

Feenberg, Andrew. (2003). "Modernity Theory and Technology Studies: Reflections on Bridging The Gap." In T. Misa, P. Brey & A. Feenberg (eds.) *Modernity and Technology*. Boston: MIT Press.

Hughes, Thomas P. (1969). "Technological Momentum in History: Hydrogenation in Germany 1898-1933." *Past & Present*, 44, pp.106-132.

Hughes, Thomas P. (1979). "The Electrification of America: The System Builders." *Technology and Culture*, Vol.20 (1), pp.124-162.

Hughes, Thomas P. (1983). *Networks of Power: Electrification in Western Society 1880-1930*. Baltimore: Johns Hopkins University Press.

Hughes, Thomas P. (1987). "The Evolution of Large Technological Systems" in Bijker, Hughes & Pinch (eds.) *The Social Construction of Technological Systems*, Cambridge: MIT Press.

Hughes, Thomas P. (1988). "The Seamless Web: Technology, Science, Et Cetera, Et Cetera." In Elliott (ed.) *Technology and Social Process*. Edinburgh: Edinburgh University Press.

Hughes, Thomas P. "Technological Momentum" in Merritt Roe Smith & Leo Marx (eds.) *Does Technology Drive History: The Dilemma of Technological Determinism*. Cambridge: MIT Press.

Kline, Ronald & Pinch, Trevor. (1996). "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States." *Technology and Culture*, Vol. 37 (4), pp.763-796.

Latour, Bruno. (1986a). "The Powers of Association." In Law, J. (ed.) *Power, Action and Belief: A New Sociology of Knowledge*. London: Routledge & Kegan Paul. pp.264-280.

Latour, Bruno. (1987). *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge: Harvard University Press.

Latour, Bruno (1988a). "The Prince for Machines as Well as Machinations." In Elliott, B (ed.) *Technology and Social Process*. Edinburgh: Edinburgh University Press.

Latour, Bruno. (1988b). "Mixing Humans and Nonhumans Together: The Sociology Of a Door-Closer." *Social Problems*, Vol.35, No.3, pp.298-310.

Latour, Bruno (1988c). *The Pasteurization of France* Trans. Alan Sheridan. Cambridge: Harvard University Press.

Latour, Bruno (1990). "Drawing Things Together" in Lynch, Michael and Woolgar, Steve (eds.) *Representation in Scientific Practice*. Cambridge, MA: MIT Press, pp.19-68.

Latour, Bruno. (1991). "Technology is Society Made Durable." In Law, J. (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*. London: Routledge.

Latour, Bruno. (1992). "Where are the Missing Masses? The Sociology of a Few Mundane Artifacts." In Bijker & Law (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Latour, B. (1996). "On Actor-Network Theory: A Few Clarifications" *Soziale Welt* pp.369-381.

Latour, Bruno (1999). "On Recalling ANT," in Law and Hassard, eds., *Actor-Network Theory and After*. Oxford: Blackwell Publishers, pp. 15-26.

Law, John. (1986a). "On the Methods of Long-Distance Control: Vessels, Navigation, And the Portuguese Route to India." In J.Law (ed.) *Power, Action and Belief: A New Sociology of Knowledge?* London: Routledge & Kegan Paul.

Law, John. (1986b). "On Power and It's Tactics: A View From the Sociology of Science." *The Sociological Review*, Vol.34, No.1. pp.1-39.

Law, John. (1987a). "On the Social Explanation of Technical Change: The Case of the Portuguese Maritime Expansion." *Technology & Culture*, Vol.28 (2), pp.227-252.

Law, John. (1987b). "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion." In Bijker, Hughes & Pinch (eds.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge: MIT Press.

Law, John. (1988). "The Anatomy of a Socio-Technical Struggle: The Design of the TSR 2." In Elliott, B. (ed.) *Technology and Social Process*. Edinburgh: Edinburgh University Press.

Law, John (1992). "Notes on the Theory of the Actor-Network: Ordering, Strategy, and Heterogeneity." *Systems Practice* 5(4): 379-393.

Law, John. (1994). *Organizing Modernity*. Oxford: Blackwell Publishers.

Law, John. (1999). "After ANT: Complexity, Naming and Topology." In Hassard, J & Law, J. (ed.) *Actor-Network Theory and After*. Oxford: Blackwell Publishers.

Law, John & Callon, Michel. (1988). "Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change." *Social Problems*. Vol.35, No.3 pp.284-297.

Law, John & Mol, Annemarie. (1995). "Notes on Materiality and Sociality." *The*

*Sociological Review*, Vol.43, No. 2, pp.274-295.

Lee, Nick & Brown, Steve. (1994). "Otherness and the Actor Network: The Undiscovered Continent." *American Behavioral Scientist*, Vol.36 No.6, pp. 772-790.

Misa, Thomas (1992). "Controversy & Closure in Technological Change: Constructing Steel" in Bijker & Law (eds.) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: MIT Press.

Misa, Thomas. (2004). *Leonardo to the Internet: Technology & Culture from the Renaissance to the Present*. Baltimore: Johns Hopkins University Press.

Neyland, Daniel. (2006). "Dismissed Content and Discontent: An Analysis of the Strategic Aspects of Actor-Network Theory." *Science, Technology & Human Values* 31 (1), pp.29-52.

Oudshoorn, N. & Pinch, T. (2004). *How Users Matter: The Co-Construction of Users And Technology*. Cambridge: MIT Press.

Pinch, Trevor. (1988). "Understanding Technology: Some Possible Implications of Work in the Sociology of Science." In Elliott (ed.) *Technology and Social Process*. Edinburgh: Edinburgh University Press.

Pinch, Trevor & Bijker, Wiebe. (1984). "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and Technology Might Benefit Each Other." *Social Studies of Science*, Vol.14, No.3. pp.399-441.

Simondon, Gilbert. (1958). *Du Mode d'existence des Objects Techniques*. Paris: Aubier.

Whitely, Richard D. (1972). "Black Boxism and the Sociology of Science: A Discussion of the Major Developments in the Field." In Eric Ashby (ed.) *The Sociological Review Monograph: The Sociology of Science*, No. 18, pp.61-93.