Infrastructure Space and Platforms as Living Architectures: The Importance of Regenerative Design and Innovation for Bioregional Economic Development

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Throughout the Southeastern region, rural communities are challenged by their low population density, less advanced technology activities, and lower innovative capacity. Stimulating both technological and process innovation requires that rural infrastructure includes roads, waterways, power grids, institutional structures and networks that are tied to a series of central nodes or platforms, acting as incubators for new ideas that draw on collective resources. Collaborations between formal organizations (nonprofit organizations, R&D firms) and informal groups (employees, community stakeholders) can combine knowledge to guide development within the agricultural sector by promoting openness and diminishing the limitations of regional isolation. Taken together, this living ecosystem is the cooperative platform model we are deploying throughout the southeastern region of the US. This platform serves as the primary driver of technological innovation driven by connecting the lived experiences of both community institutions and people to R&D processes of technology that derive their innovation from both the region's agricultural and institutional eco-systems – constituting a living architecture

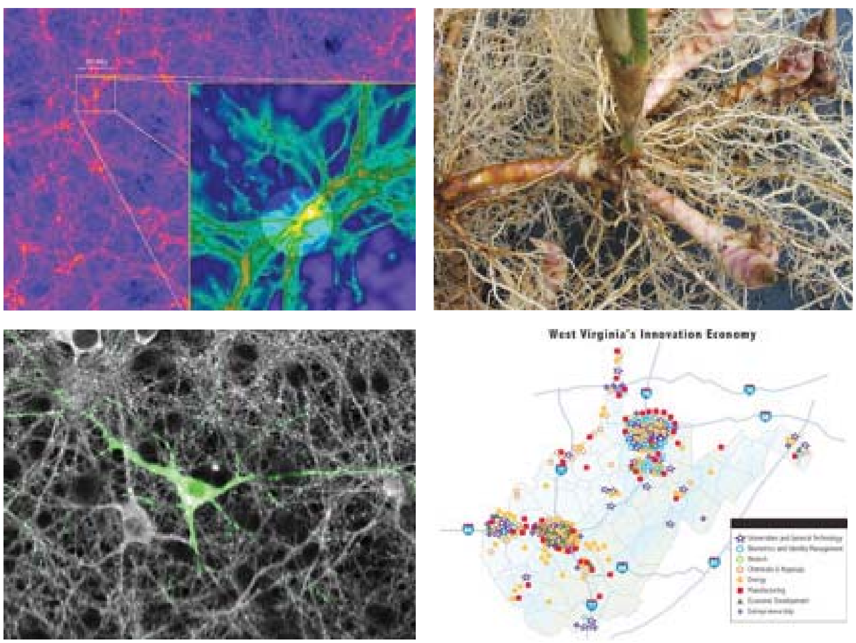

Figure 1 (from top left to bottom right) Galaxy Filament, Rhizome, Cognitive Architecture and Innovation Clusters.

of nested systems comprised of processing-infrastructure/technological-innovation assemblages.[1] Following Deleuze and Guattari, this cooperative platform or regenerative assemblage can be understood as an"increase in the dimensions of a multiplicity that necessarily changes in nature as it expands its connections. There are no points or positions in a rhizome... there are only lines" that connect.[2] Moreover, a kin to the living architecture of a rhizome, these regenerative assemblages not only constitutes external superclusters of the universe or internal cognitive architectures but also make up cooperative-innovation processes found in living market systems that "assumes very diverse forms, from ramified surface extension in all directions to concretion into bulbs and tubers" or in the case of our proposed cooperative platform, the generation of innovation linkages that congeal to form innovation districts which in turn re-generate differentiated cooperative-innovation networks[3] (see Figure 1 above).

This living architecture leverages worker's firsthand knowledge of a particular technology's production processes with community stakeholders living assets (i.e., health and wellness, intuition) derived from local linkages (e.g., local food, soil health, etc) in order to provide valuable insights for improving both infrastructure design as well as the technological innovation platforms that differentiates both. In turn, these densely connected assemblages stimulate solutions-based thinking by linking the tacit knowledge of rural-based agriculture and community stakeholders with the urban-based industry stakeholders and manufacturers of bio-based products.[4] Capitalizing on local/tacit knowledge of living assets in both biodiversity and agriculture ecosystems alike – this economic model could be central throughout the lifecycle of a particular innovation process – in affect, creating a highly reflexive innovation ecosystem leveraging the collaborative nature of cooperative enterprises. These "informal" networks of experienced workers and industry stakeholders can effectively stimulate technological innovation, in turn drawing new industry into the southeast.

Akin to Phillip Beesley's Hylozoic Ground, these regenerative assemblages are "far from transcendent perfection," but rather produce a "formwork that organizes the space…out of local circumstances." They add "links within linked rows… producing warped surfaces that expand outwards in three dimensions," infusing architectures that constitute living market systems.[5]

Markets as Living Architecture Systems

Economist Adam Smith identified the division of labor and specialization as the two key ways of achieving larger financial returns on production. Through specialization, employees would not only be able to focus on specific tasks, but also improve the skills necessary to perform tasks. Tasks performed better and faster lead to increased production levels. While Smith describes a model for increased efficiency through economies of scale, his model fails to account for the efficiencies present in regional cooperative ecosystems and their ability to stimulate innovation, specifically the efficiencies associated with economies of agglomeration.[6]

This white paper explores the economic benefits of technological innovation by highlighting network effects in relation to entrepreneurship and the strength of institutions (i.e., an endogenous growth model) as opposed to the reverse, understanding market flows on the level of price (i.e., neo-classical growth model), with technological innovation acting as a secondary condition for maintaining a thriving market. Neo-classical growth model maintains that the long-run rate of growth is exogenously determined by either the savings rate or the rate of technological change, both of which remain ubiquitous to the model.[7] Due to the oblique nature of these market forces, savings rate and technological change are typically assumed to be subject to diminishing returns due to the decoupling of long-term rates of growth from rates of investment. In short, long-run growth of personal income necessitates that exogenous improvements in technology generate innovation.[8]

Endogenous growth theory tries to overcome this shortcoming by locating rates of change (differentiation) within microeconomic forces that, in turn, generate macroeconomic trends. Limitations of the neo-classical model include its failure to take account of entrepreneurship (catalyst for growth) and the strength of institutions (facilitate economic growth). In addition, it does not explain how or why technological change occurs. These limitations have led to the rise of endogenous growth theory, which locates technological change internally. Unlike previous classical models of economic development, endogenous growth model does not see technology as a given, but as a product of economic activity. In addition, this theory holds that growth is due to increasing returns characterized by knowledge and technology – as opposed to the diminishing returns characterized by physical capital.[9]

The proposed bio-regional model expands upon the endogenous model by situating its knowledge/technology nexus within a model of regenerative design by linking this nexus directly to embodied or tacit experiences via cooperative enterprises that are linked to farmer and industry stakeholder "know how."[10] Along with an emphasis on regenerative design, this model for markets will help practitioners of regenerative design negotiate development by synthesizing a resource-based economy with a knowledge-based economy to form a cohesive whole that cannot be reduced to either one.

This approach underscores the point that the economic processes that generate and diffuse new knowledge are critical to shaping the growth of urban-rural communities and individual firms. In this light, practitioners should consider the importance that institutions play as providers of a framework or assemblage for technological change. In "Clio and the Economics of QWERTY," economic historian Paul David describes ways to conceptualize institutions in such a manner by viewing them as actors minimizing unwarranted technological lock-in or path dependence which, in turn, ensures the creation and maintenance of a network of cooperative-innovation platforms or iNetwork.[11] Technological lock-ins typically occur because of technical interrelatedness and the quasi-irreversibility of innovation.[12]

As such, lock-ins takes place both in merited and unmerited situations. In the case of inefficient technological lock-ins and arrangements, it is not necessary for market forces to automatically correct these inefficient outcomes. In addition, while lock-ins typically adhere to one particular physical piece of technology, the same routine adherence can be seen on a larger economic level. Some economic theorists see business firms, managers, and other economic stakeholders as creatures of routine who follow certain successful beliefs and only change when their routines fail to succeed – in essence constituting a negative feedback loop. Therefore, an alternative method of correcting inefficiencies due to lock-ins and industrial routine is needed – facilitating the emergence of positive feedback loops. If cooperative enterprises were utilized to decrease the occurrence of these inefficiencies, there would be room for additional innovation and, in turn, accelerate bio-regenerative economic development. In short, our proposed cooperative platform is ultimately essential for achieving "regenerative innovation."[13]

Sources of Innovation

There are several sources of innovation. In the dominant linear model of innovation, the creative source are private firms or highly centralized R&D laboratories where an agent (person or company) innovates in order to sell a given product. Within this model, large companies not only function to make a profit, but also formalize various R&D processes to routinize them and increase profit margins. However, as Cortright discovers, "the traditional solution to dealing with spillovers, granting strong property rights for the fruits of an invention, may also have negative consequences."[14] As such, this white paper will develop the precursors to a theory of innovation which punctualize informal networks of industry stakeholders that stimulate the diffusion of innovation and retains the participant's active role in the production of technological change through the iNetwork.[15] It is also paramount not to limit the production of knowledge to a specific group of firm participants (i.e. a specific, isolated R&D department).

Case studies of the automobile industry have shown the importance of worker-led teams for continuous innovation and process improvement.[16] With our coop model it is believed that this active role will assure the participation of farmers and in the processing infrastructure (e.g., cotton gin) by securing a financial share in the firm that is maintaining a competitive edge via technological innovation. This inclusion into the innovation process would effectually lead to a larger investment in innovation in which the technology is operating. It would also address the lack of incentives for entrepreneurs to distribute or invest in more knowledge creation.

The second source of innovation is end-user innovation, whereby an agent (person or company) innovates for their own (personal or in-house) use because existing products fail to meet their particular needs. In Sources of Innovation, Eric von Hippel identifies end-user innovation as one of the most important aspects for understanding the emergence of innovation. More recent theories of innovation have traversed the simple dualism of the private firm and end-user models – although both are still accounted for. These studies show that innovation does not just happen within the industrial supply-side, or as a result of the articulation of user demand, but through a complex set of processes that links many different players together.[17] This iNetwork is composed of not only developers and users, but also a wide variety of intermediary organizations such as consultancies, Standard Development Organizations, technology developers, entrepreneurs and, in the case of this research, informal industry participant and community stakeholder networks by and through platform strategies centered around agricultural development.

The third source of innovation is an essential part of creating an iNetwork and involves how the processing infrastructure itself is designed. In systems engineering, modular design subdivides a system into smaller parts (modules) that can be independently generated and then regenerated in different systems to drive multiple functionalities and sustain differentiation. As Brian Arthur and other scholars have demonstrated, new products are the outcome of a process based on the principle of novelty by combination.[18] Benefits of modularity include: reduction in cost due to less customization, a reduction in learning time and flexibility in design, as well as augmentations that add innovative solutions by merely plugging in a new module and exclusion of unpractical designs. Examples of modular systems are computers and agricultural infrastructure – all, according to Benjamin Bratton, constitute an accidental megastructure or platform. [19] Moreover, "perhaps these parts align into something not unlike a vast (if also incomplete), pervasive (if also irregular) software and hardware stack" where agriculture infrastructure also uses modularity to overcome changing consumer demands and to make the manufacturing process more adaptive to change.[20] In sum, modular design attempts to combine the advantages of standardization and compatibility (i.e., high volume normally equals low manufacturing costs) with those of customization.

When situating modular design within an urban economy of agglomeration and its partial relocation within a rural setting, we can begin to construct a comprehensive understanding of the particular development model we are proposing.[21] In regards to agriculture, the production of processing infrastructure typically found within economies of agglomeration are internalized by way of vertical integration. This is usually a repercussion of the firm's approach to reduce various transaction costs associated with externalizing the production of the component parts of the processing infrastructure.
For example, there may be four component parts involved in producing a particular technology (See Figure 2). More often than not, if the profit margin is large enough, the firm that is producing the particular processing infrastructure will remain static and the emergence of new components will not

occur. However, if the design of the processing infrastructure is compatible with other technologies and adopts certain industry standards, then the original firm is forced to cooperate in order to sell their particular product on the market. This competitive atmosphere increases a particular technology's ability to adapt to a rapidly changing market – within both the demand and supply side – through component integration, expansion of knowledge stocks, R&D spillovers, and an increase in returns. To put it another way, the positive feedbacks of encouraging compatibility through industry standards stimulate technological change and innovation.[22]

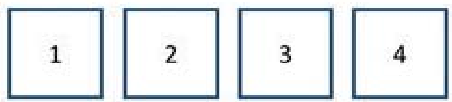

Figure 2 Components of Processing Infrastructure.

The production of new processing technologies would then come to resemble Figure 3 only if the larger firm decides that internalizing the production of components 6 and 7 is beneficial.

Figure 3 Components of Improved Processing Infrastructure.

If this is not the case and the larger firm decides not to internalize the production of components 6 and 7, then firm 2 and 3 are then created from the knowledge spillovers (see figure 4).

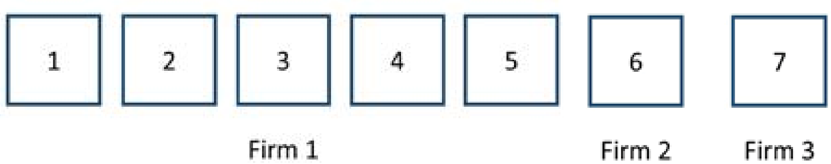

Figure 4 Firms Involved in Improved Processing Infrastructure.

The emerging cooperative ecosystem would then create alternative components that were once found in the larger firm such as component 4 (see figure 5). This could occur for a variety of reasons, such as a customer deciding to purchase a technology with the traditional components of 1, 2, 3, and 5, while finding that particular attributes of component 4, which is produced by a competing firm, fits within their particular interests (see figure 5). This could occur if the alternative component 4 is better suited to a particular need found in the customer's' region – here customers being the workers as well as farmer and industry stakeholders.

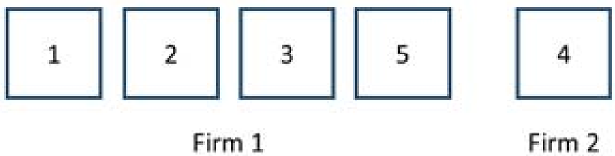

Figure 5 Production of Processing Infrastucture with Changing Component 4.

When situated within a supply side, these demand-side attributes of technological innovation encourage knowledge spillovers and the establishment of an informal iNetwork between producers. The first type of network that will emerge is a centralized cluster akin to the aforementioned rhizome bulbs in which suppliers are tied to lead supply firms as in the typical Japanese R&D firm; these firms integrated their R&D labs with factory floor workers in order to close the knowledge gaps that are found in the typical U.S. high technology firms. The U.S. structure of disintegration or spatial separation stifled the competitive advantages found in the Japanese model. The centralized firms found in the Japanese model pioneered new modes of integration that enabled them to generate a continuous flow of new products (i.e., total quality management, keiretsu, etc.). While recognizing the competitive advantages of the flat/integrative approach, these centralized firms did not account for the positive feedbacks found within modular design, specifically compatibility. Although this research notes the importance of the integrative model utilized by Japanese firms, it seeks to expand these integrative effects into an iNetwork (see figure 6) or economy of agglomeration with the hope of increasing technological innovation within the agriculture sector.

For example, in figure 6, W1, W2, and W3 represent the localized knowledge stocks – local infrastructure owners/users and workers – at a particular processing facility with three different types of technologies that are suited for

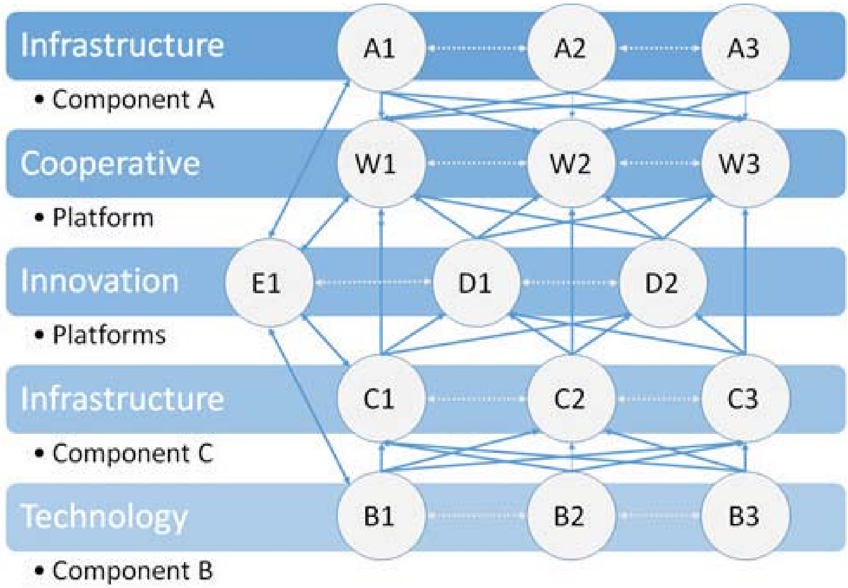

Figure 6 Cooperative Innovation Platform.

independent variables. These variables are found within the specific context that the facilities are operating (e.g., feedstock variability, economic constraints, ecological conditions, etc.). These local knowledge stocks are connected to R&D facilities (D1, D2), both public and private, as well as a centralized information trader (E1). A1, A2, A3, C1, C2, and C3 are the manufactures of component A and C which are found in a standardized production and processing infrastructure and future processing technologies that are suitable to all applications. Based on the collective nature of standardization and its relation to modular design, subassembly B, which is a product of technological innovation, needs to be compatible only with component C and not directly with other components. The continual splitting of components (technological innovation) and a sustained emergence of new component manufacturers and community-based production and processing strategies is a result of the relation between W and the respective public (D1) or private (D2) R&D firm. This relationship fosters knowledge spillovers and, in turn, cultivates a functioning iNetwork. Taken together, all the "component" product manufacturers (A,B,C), the localized knowledge stocks (W), the public and private R&D firms (D), and the centralized information trader (E) make up a cooperative-innovation ecosystem – the rhizome or Living

Architecture System. In contrast to centralized innovation networks in which one dominant firm establishes the standards of compatibility, the iNetwork jointly determine standards by establishing a precedent for negotiations between product manufacturers, R&D departments and firms, and localized knowledge stocks. No single actor in this network has control. Additionally, any actor who tries to dictate standards risks being isolated if other network actors decide not to follow.[23]

Conclusion

When situating the above iNetwork within a cluster of manufacturers or a rural/urban economy of agglomeration, the development of skill and know-how along with the easy communication of ideas and experience allows the cooperative-innovation actors/networks to converge on a "plane of consistency assuring their selection."[24] By enhancing the formation of an iNetwork and their strengths, rural/urban agglomeration may affect the southeast in the following ways:

- Accelerate the rate at which new technologies and regenerative practices are developed in within the agriculture sector and beyond;
- Accelerate the rate at which the knowledge of new production and processing technologies enters into and are diffused throughout the region;[25]
- Accelerate the rate at which these new technologies are incorporated into the products of manufacturers;
- Accelerate the rate at which these new or renewed products are adopted by the potential customers;
- Accelerate the rate at which the southeast can mitigate the negative economic effects of America's transition from an economy of scarcity to an economy of abundance.

References

1. It is important to note that we use Keller Easterling's distinct between active and object form to draw a distinct between infrastructure (object) and technology (active). Easterling provides additional insight regarding the linkage between a kind of active/living architecture that we are attempting to elucidate by formulating a regenerative assemblage between the object form of processing-infrastructure and the active form of platform-innovation in both "Extrastatecraft: The Power of Infrastructure Space" as well as an interview in Metropolis Magazine where she describes a kind of living architecture that "was designed as active form rather than object form. There was no town plan, but rather instructions for the town to grow by wards. Each ward had a quotient of public, private, and green space, and the appearance of each ward also triggered a reserve of agricultural space outside the town. It was a growth protocol. It was a time-released form that wasn't just making one thing, but rather controlling a flow of things over time. That seems to me so powerful. Keller Easterling, "Urban Software," Metropolis Magazine 2015: accessed October 21, 2016.

2. Gilles Deleuze and Félix Guattari. A Thousand Plateaus: Capitalism and Schizophrenia. Bloomsbury Publishing, 1988, 8.

3. Deleuze and Guattari, A Thousand Plateaus, 7. Our use of "flat-structures" is largely informed by Manuel DeLanda's flat ontology. Additionally, rizomatic bulbs and tubers are found in both physical cosmology with galaxy filaments (subtypes: supercluster complexes, galaxy walls, and galaxy sheets) that are the largest known structures in the universe as well as the flat-structures found in cognitive plasticity/architecture. For more concerning cognitive architecture see: Sussman, Ann, and Justin B. Hollander. Cognitive Architecture: Designing for How We Respond to the Built Environment. Routledge, 2014. For more concerning innovation districts see: Katz, Bruce, and Julie Wagner. "The Rise of Innovation Districts: A New Geography of Innovation in America." Metropolitan Policy Program at Brookings, May 2014.

4. Beesley, Philip, Pernilla Ohrstedt, and Rob Gorbet. Hylozoic Ground: Liminal Responsive Architecture: Philip Beesley. Edited by Hayley Isaacs. Riverside Architectural Press 2010, 17.

5. Manuel DeLanda provides further clarification regarding a successful regional cooperative ecosystem in both "A Thousand Years of Non-Linear History" as well as a Switch Interview where he states that "there are alternatives to the corporate model, such as a region of contemporary Italy called Emilia-Romagna, dominated by small businesses competing against each other not in terms of costs and reaping economies of scale, but in terms of product design and a concentration of creative people in a region (a model known as "economies of agglomeration"). Manuel Delanda, "Interview with Manuel DeLanda," Switch Interviews Vol. 5 Number 1 (1994): accessed October 21, 2016.

6. Note that both exogenous and endogenous models are not always mutually exclusive. For more see: Ryuzo Sato, "The Harrod-Domar Model vs the Neo-Classical Growth Model," The Economic Journal 74, no. 294 (1964): 380-387; Steven N. Durlauf, Andros Kourtellos, and Artur Minkin, "The Local Solow Growth Model," European Economic Review 45, no. 4 2001: 928-940.

7. Nicholas Crafts, "Exogenous or Endogenous Growth? The Industrial Revolution Reconsidered," Journal of Economic History 55 (1995): 745-772.

8. Joseph Cortright, "New Growth Theory, Technology and Learning: A Practitioner's Guide." Reviews of Economic Development Literature and Practice 4, no. 6 (2001): 1-35.

9. Gilbert Ryle, "Knowing How and Knowing That: The Presidential Address." In Proceedings of the Aristotelian society, vol. 46, pp. 1-16. Aristotelian Society, Wiley 1945.

10. Actor-Network Theory (ANT) provides a useful model for creating a regenerative network by maintaining a distinction between intermediaries and mediators. Intermediaries are entities which make no difference (to some interesting state of affairs which we are studying) and so can be ignored. They transport the force of some other entity more or less without transformation and so are fairly uninteresting. Mediators are entities which multiply difference and so should be the object of study. Their outputs cannot be predicted by their inputs. From an ANT point of view sociology has tended to treat too much of the world as intermediaries.

11. Paul A. David, “Clio and the Economics of QWERTY” The American Economic Review 75, no. 2 1985: 332-337.

12. Cooperation Winston Salem is an example of intentionally creating a community-based model of development which utilizes cooperative-innovation or user-based feedback through the use of community-based design charrettes.

13. Cortright, New Growth Theory, 7.

14. Rao K. Usha, Kishore V.V.N., 2010 A review of technology diffusion models with special reference to renewable energy technologies, Renewable and Sustainable Energy Reviews, 2010;14: 1070–10

15. Ibid., 29.

16. Eric Von Hippel, Democratizing Innovation (Cambridge: MIT Press, 2009); Henry William Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology (Harvard Business Press, 2003); Don Tapscott and Anthony D. Williams, Macrowikinomics: New Solutions for a Connected Planet (New York: Penguin, 2010)

17. Nicholas Georgescu-Roegen, “The Economics of Production,” The American Economic Review 60, no. 2 (1970): 1-9.

18. Earlier examples include looms, railroad signaling systems, telephone exchanges, pipe organs and electric power distribution systems. Benjamin Bratton, “The Black Stack,” e-flux Journal #53 (2014): accessed October 21, 2016.

19. For more about partial relocation as it relates to establishing rural-to-urban linkages see: Lambooy, J. G., “Locational Decisions and Regional Structure,” Human Behaviour in Geographical Space. Gower, London 1986: 149-165; Dosi, Giovanni, Technical Change and Industrial Transformation (New York: St. Martin’s Press, 1984)

20. Here, the component parts are the object forms that are assembled into an active form forming a technology that can be considered to have a higher state of plasticity due to its integration into a cooperative-innovation platform. The further the technological enters the platform the more differentiated it becomes thus intensifying the active form it represents. This may also be considered an abstract machine ala Gilles Deleuze.

21. Richard N. Langlois and Paul L. Robertson, “Networks and Innovation in a Modular System: Lessons from the Microcomputer and Stereo Component Industries,” Research Policy 21, no. 4 (1992): 297-313.

22. Deleuze and Guattari, A Thousand Plateaus, 4.

23. Meade, N., & Islam, T. 2006. Modeling and forecasting the diffusion of innovation — A 25 year review. International Journal of Forecasting, 22(3), 519—545.

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