GUEST EDITORIAL PREFACE

Special Issue on New Space Entrepreneurship and Additive Manufacturing (3D Printing) as Challenges to Actor-Network Theory

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The idea of this special volume was triggered by an astonishment that came to me more than a year ago and that took of the key question behind the IJANTTI call for papers, announced in the spring of 2014: why there are so few analyses of emerging and yet unestablished firmly technologies? I was surprised that we, the community of actor-network theory (ANT) researchers, are about to miss two of the profound technological and industrial developments that are taking place in the last decade – *3D printing* and *new private space entrepreneurship,* and which today are fascinating millions of talented young and not so young people all over the world. Are ANT and studies of science and technologies (STS) in general about to score another prominent failure they registered some seven years ago when their offspring – the social studies of finances - missed the evidences of structural tensions and misconduct in trading rooms and financial communities they studied, and practically remained unaware – unlike some dissident stockbrokers - of preconditions that triggered global financial crisis.

Are we locked to the old philosophical stigma to come as the owl of Minerva only at dusk after the battle, being unable to say something important about *now*? - Can we analyze the current efforts of new breed of space entrepreneurs who are literally blowing up the focalized oligopolies in the space industry in USA and Europe? Can we say something valuable on disruptive changes the 3D printing induces in manufacturing and other centuries-old industries, and which are about to revolutionize once again the biotechnologies

and biomedicine? – The four papers answer these questions affirmatively - "Yes, we can!". They are applying and pushing further ANT conceptual frame in these new domains, they identify some interesting challenges to it and the limitations of some of its key concepts. They also offer promising avenues of dialog with other theoretical and methodological approaches to technology.

It appeared that additive technologies (or 3D printing) were paid more attention by the contributors this volume. It is analyzed by two the papers – that of Graham Harman and Tihomir Mitev. The paper of Rachel Armstrong is also related - if indirectly - to the 3D printing, discussing the deeper 'tectonic shift' the modern humanity undergoes, and focusing on 'lifelike technologies' as one of its (possible) cornerstones. The last paper only, written by the guest editor, deals with the transformation of space industry.

In his paper *Graham Harman* offers an original view on additive (3D printing) technology. It is based on object-oriented ontology that points to the limitations, an even question the validity, of ANT relational or 'correlationist' (Meillasoux) conception of actants as methodological position in studying 3D printing. The paper begins with brief outline of three fundamental worries of mass introduction of the new technology, conceptualized by Rachel Armstrong (Armstrong 2014), and of her appeal to bridge this technology with a newer, life-like notion of materiality. Harman traces the deeper roots of the notion of materiality as typical for modern 'materialism'. He juxtaposes Armstrong's and Bruno Latour's views of materiality and identifies number of similarities, such as adherence to relational conception of being, the interest to the multitude of actors of various kind and shape behind the apparent 'stability of things', the common interests in opening the 'black boxes' and illuminating the hidden entities inside (and their interactions). Yet Harman finds Latour's view more sophisticated, defining his "materialism" as 'a polemical term for modern scientific philosophy'. He agrees with Latour's inference that there are too much idealism behind the modern notion of materiality and praises his critique of the 'untenable duality' of modern materialism, which simultaneously provides an eternal 'theoretical' (or designer's) understanding about what the things are indeed, and forgets the conditions/costs of keeping these things existent (Latour later named them reference [REF] and reproduction [REP] modes of existence (Latour 2013)).

Harman claims, however, that ANT penetrating critique of modern notion of materiality is shadowed by its relationist ontology, which fails to recognize with enough rigor the relative independence of actants (and things in general) from the situation where the interaction takes place, their ability to endure various 'trial of strength' and not to be 'slavishly defined by its context'. Which leads the author to appreciate the adherence to certain type of formalism instead of materialism - a formalism 'that is neither holistic nor surface-oriented'.

Harman identify the type of formalism he favored already applied in the theory of technology develops by Marshall McLuhan. Approaching new technology, Harman claims following McLuhan, we better ask about 'it's never fully manifested form' rather than taking the stand of relentlessly recording 'what a thing does'. The paper ends with an endorsement of McLuhan 'tetrad' (principles of enhancement, obsolescence, retrieval, and reversal) and its relevance in anticipating the possible yet hidden and currently unaccountable features of additive technologies, for example those stemming from enhancement principle: "…the potency of an artifact for McLuhan comes from its way of receding from view, dominating consciousness silently from behind the scenes".

Maybe ANT indeed is facing 'particular challenge' with 3D printing technology, Harman tentatively asserts, since with becoming increasingly cheap and widely assessable it eventually "will allow us to bypass the usual painstaking process of assembly... [and] the shapes it produces will be constrained… only by the imaginations of users and template suppliers". And instead to Armstrong's 21st century

materiality we may well find ourselves amidst the 'era of 21st century formalism'.

The paper of *Tihomir Mitev* offers yet another discussion of the problem of materiality induced by the spread of additive technologies. He frames 3D printing via a rather sophisticated juxtaposition of the resources provided by a Heideggerian type of philosophy of technology with those of ANT. By exposing the old Aristotelian taxonomy of four types of causes contributing to the 'unveiling of the truth', Mitev founds that additive technologies bears on the replacement of the old understanding of matter as a thing-in-itself with a new, flexible, fluid, concept of matter, which is more or less manipulatable and where 'the matter is no more an occasion for object's taking place'. The user imagination embedded into computer-aided design (CAD) software has the potential to become practically omnipotent, thus the 3D printing technology being reduced to intermediary and 'a copier of ideas'.

This leads the author to the discussion about instrumentality and actant-ness of technology and to the more general problem of the status of action in ANT. Comparing Bruno Latour's definition of technology with that of Heidegger, Mitev identifies (following Soren Rijs) some important similarities between the two thinkers: the common refusal of subject-object distinction, considering all beings 'as substitutable with artifacts', emphasis on technologies' ambivalence and continuity (or 'processuality'), on the technologies' ability to unfold humans and non-humans entities, and the most important - that both thinkers elaborate ontologies, i.e. they frame the principles of existence and interaction of all of the entities, inhabiting the world. This makes them especially suitable in accounting for the ontological changes that 3D printing brings about.

In order to better understand the effects of additive technologies Mitev searches of 'how action and interaction is distributed and how actors constitutes themselves as well as their actor-world'. He deepens into Latour notion of technology as domain of 'translation' and 'interference between actants' to find out that 'eventually, there are no pure human and non-human activities, and if there are any, they are consequences of trials of strength and philosophers' efforts of purification'. Since the most important translations and 'trials of strength' in 3D printing are somehow 'behind the scene' and already sedimented into pre-fabricated powder, wires, pellets, biological gel, etc. that are used to 'print' the imagined material objects, Mitev claims, the essence of things fades out. Thus the additive technologies strip out and depersonalize the objects, and 'reduce them to mere raw materials, which does not have their own identity'. Hence by applying ANT point of view the author reconfirms the Hedeggerian inference about additive manufacturing he already made in the first part of the paper – that it 'privileges the freedom of designing and the power to vary and manipulate "the real", regardless of the limitations of the matter'.

The basic claim of *Rachel Armstrong* is that humanity is amidst a transition from an 'object-centered view of reality' towards a kind of Heraclitean reality dominated by 'process-oriented concepts'. In her paper she label the emerging new reality 'Ecological Era' and offers a pragmatic reading of ANT as an important instrument in the ongoing struggles in reframing reality and our human engagement in it. In a sense, as one of the reviewers pointed out, Armstrong elaborates "…a platform for a new innovation policy and outlines a specific type of 'technology democracy' relevant to the 'non-modern constitution'… [including] an initial sketch of a program how this constitution should be implemented". The cornerstone of this platform, however, is not just the transformation of the meanings and the concepts as such in a kind of a new cultural revolution. Rather, Armstrong is pushing towards establishment of ANT based 'technological platform' that is indispensable for transformation of concepts and imaginations into wide range of practical options to be undertaken. She calls it also a set of 'technical avatars', enabling new approach to design and engineering that embraces the uncertainty and 'express probabilistic outcomes'.

Armstrong opposes 20th century Nature with its 'obedient, brute, homogenous substances' subject to modern science and philosophy – on the one hand, to 21st century Millennium Nature, characterized by 'colossal expanses of matter', the enormous shifting of 'air, oceans and land that we recognize through the phenomena of 'climate change', as well as of the 'continent sized toxic entanglements of plastics, wildlife and currents that constitute our Great Ocean Garbage Patches'. To cope with the challenges of Millennium Nature we need technologies substantially different from those of Industrial Age and designed in relation to Nature of previous century.

Bridging the insights of (far from equilibrium) system theory and cybernetics with recent biotechnological developments, the paper sketches some of these new 'avatars' that eventually will lead to development of new 'living technologies', of 'machines' that mimic and even actively behaves like biological organisms. Armstrong points to the limitation of the cybernetics' view on matter and information (including late 20th century developments of Humberto Maturana and Ilya Prigogine) and material experiments with self-organizing matters it inspired (Rosenfield 2014), to justify her approach stemming from biomedical sciences and 'applying the new materialism and agentised matter that has been proposed by Karen Barad, Jane Bennett and Graham Harman'. There she looks for the germs of desired new technology platform that share some properties with living things, 'such as movement, sensitivity and metabolism'.

In the key section of her paper titled 'Dynamic droplets as living technology' Armstrong presents the results of her own research with Bütschli system, formed by strong alkali drops into a field of olive oil that reveal fascinating life-like behavior. She claims that this 'experimental model through dissipative structures' (Glansdorff and Prigogine, 1971) can server as one of the precursor on the way to develop the aimed new material platform. Armstrong also proposes a methodological frame to account for the behavior of the droplets in the Bütschli system based on the techniques of natural computing, and able "to shape the outputs of the droplet 'hardware' through chemical programming, or 'software', which 'converses' with the droplets through the assemblages that constitute their soap-producing metabolism". According to her the advantage of natural computing is that 'it orchestrates the creative agency of matter through soft control systems that encourage horizontal coupling between chemical bodies, to open up new design and engineering possibilities'.

Last sections of the paper present even more fascinating futuristic projects for life-like technologies some of which are yet to be realized, such as Philip Beesley's cybernetic installation 'Hylozoic Ground' (Armstrong herself has been experimenting with); 'Future Venice' project aiming to 'grow an artificial limestone reef under the city using a giant natural computer that consists of droplets similar to the Bütschli system'; and Jon Morris and Phil Watson 'Project Persephone' aiming at designed ecosystem in the planetary scale. In all these and other possible projects, representative for intended new technological platform, ANT may serve as critically important methodology able to generate new kinds of converging technologies offering 'something potentially revolutionary to our existing design and engineering methods'.

Ivan Tchalakov paper tests the ability of ANT to account for the impressive processes of shaking the old government-lead model of rocked design and use that originated in the late 1930s and which is still dominant in many countries. It applies the conceptual framework developed in the well-known ANT studies of John Law on Portuguese long-distance sea travel and Michel Callon analysis of the states of socio-technical networks. The paper demonstrates their heuristic potential in analyzing the processes that are currently going on in the space rocket technology, but also identifies two specific problems that ANT approach ignores. The first concerns the asymmetrical importance of human actors at the earlier stage of actor-networks emergence and development, expressed by figures such as Henry the Naviga-

tor in Portuguese expansion, Werner von Braun in rocket technology development, and Bob Rutan and Elon Musk in the resent sweeping changes in space industry.

Tchalakov claims that ANT pays minor attention to the key phenomena of *passion, endurance, persistence and suffering*, inherent to human actors, and which are crucial for the success of innovations, especially of the radical ones – not only to cope with uncertainties in the process of design and making the new devices work, but also in breaking the old 'actors-worlds' and in overcoming the distrust, hostility and even resistance of the fellow communities.

The ANT 'flat', unidimensional notion of translation allows crossing the Cartesian divides and building a powerful unified account of all entities in the actor-network. However, by ignoring the ontological differences between these entities and by adopting the relationist ontology Graham Harman is talking about, some radical versions of ANT are less sensitive to the subtle processes going on in the socio-technical networks. The author refers to those miniscule, 'quantum-level' gestures and interactions in the heterogeneous communities where the passion, endurance, and persistence of human actors are manifested, but which often are overlaid by the conventional descriptions of 'trials of strength', 'making interested', etc. The paper provides evidences of such minuscule interactions and of their crucial importance for the transformation of the sociotechnical networks.

Hence, the author claims, ANT needs an 'expanded frame' or complementary concepts that also go beyond the intentionality and Cartesian oppositions of old philosophy of consciousness, but which account to the old problems of 'ethos' that ANT has forgotten. The proposed new framing is based on the notions of *heterogeneous coupling* between human and non-human agencies, *of inter-corporeality* (late Merleau-Ponty), *familiarity* (Thevenot), *attachment* (Hennion), and *passive notion of responsibility* (Levinas), as well as on a new interpretation of Aristotle's theory of human action, that distinguishes between 'causal' and 'existential' actions (or, stated in Aristotle's terms – between *kinesis* and *energeia*).

These may heuristically complement the ANT 'military' semiotics', making ANT sensitive to the human's ability to pursue a 'higher' line of behavior that goes beyond the concrete goals of practical utility, of the asymmetrical responsibility towards the (non-human) Others, and of the acting with 'joy' or 'pain', and 'letting the material tell you where to go'.

The paper ends with short discussion about the methodological potential of the notion of 'thread of heterogeneous networking activities' in the analysis of the early stages of innovation, introduced by Juan Rogers and outlined in a recently published paper of him and the author (Rogers and Tchalakov 2014). The important issue here is that 'threads' of networking activities' better account for the asymmetrical role of human actors, since they are 'precisely driven by some individual and localized initiatives'. This notion preserves the analytical distinction between autonomous networking efforts and their openness during the course of analysis, which eventually helped to identify the historical points at which these "threads" converged, causing major technological transformation that eventually stabilizes as established socio-technical network.

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