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The Digital Division of Labor: Socially Constructed Design Patterns of Amazon Mechanical Turk and the Governing of Human Computation Labor

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Abstract

From a Social Construction of Technology (SCOT) perspective, this article provides a critical analysis of Amazon Mechanical Turk (AMT), currently one of the major distribution systems in Human Computation labor markets. Drawing from classical Labor Process Theory, AMT's infrastructure, shaped by discourses on digital labor, determines critical power and information asymmetries in favor of employers (Requesters) and enables a specific mode of digital labor division. Its effects (deskilling, pricing, efficiency enhancement) are enhanced by a crowdsourcing-based access to highly fragmented digital workers (Turkers). The SCOT approach uncovers the social construction of digital labor division and hierarchies by means of different qualities of influence on infrastructure and labor process design issues. These capacities depend on different actor-related capacities to enforce and implement meanings and interpretations on the technological artifact. Turkopticon, a browser-extension, mitigates these produced hierarchies by adding a Requester rating system directly on AMT's interface.

Keywords: Amazon Mechanical Turk, human computation, Turkopticon, digital labor, social shaping of technology, social construction of technology

Digitale Arbeitsteilung: Amazon Mechanical Turks sozial konstruierte Designmuster und die Steuerung von Human-Computation-Arbeit

Zusammenfassung

In diesem Artikel wird Amazon Mechanical Turk (AMT), derzeit eines der größten Online-Verteilungssysteme für Human-Computation-Arbeit, aus einer Social-Construction-of-Technology (SCOT)-Perspektive kritisch analysiert. Unter Berücksichtigung der klassischen Labor-Process-Theorie wird gezeigt, dass AMTs Infrastruktur, durchwachsen und geformt von Diskursen zu digitaler Arbeit, beträchtliche Macht- und Informationsasymmetrien zugunsten von ArbeitgeberInnen (RequesterInnen) determiniert und einen spezifischen Modus digitaler Arbeitsteilung ermöglicht. Dessen Effekte (Deskilling, Preissetzung, Effizienzsteigerung) werden durch den crowdsourcing-basierten Zugriff auf hoch fragmentierte ArbeiterInnen (TurkerInnen) verstärkt. Die SCOT-Perspektive zeigt die soziale Konstruktion digitaler Arbeitsteilung und Hierarchien in unterschiedlichen Einflussqualitäten auf die Ausgestaltung der Infrastruktur sowie den Arbeitsprozess. Sie hängt von Kapazitäten einzelner Akteure ab, ihre Bedeutungen und Interpretationen in Technologien zu implementieren. Die Browserextension Turkopticon schwächt diese Hierarchien ab, indem sie ein Requester-Rating-System direkt in das Interface von AMT einbettet.

Schlagwörter: Amazon Mechanical Turk, Human Computation, Turkopticon, Digitale Arbeit, Soziale Konstruktion von Technologie

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1. Introduction

In 1769 the Austro-Hungarian court official and mechanic Wolfgang von Kempelen constructed 'The Turk', a 'chess automation' that became a famous and myth-enshrouded artifact in the Age of Enlightenment in Europe. The automation was comprised of a human-sized mechanical doll in a Turkish costume sitting in front of a chessboard placed on a table-sized cabinet. It conveyed the impression to the audience that it could independently play chess against human opponents. Accompanied by mechanical gear sounds, the Turk, as if by magic, raised its arm, drew the pawn and moved it back onto a cushion. During the opponent's turn it slowly moved its head around, giving the impression of a slightly thrilled engrossment. Touring through Europe, this automation defied various famous opponents (i.a., Napoleon Bonaparte) and raised great interest in the public. Such widespread attention was mainly activated by two initial contemporary discursive traditions and formulations in medieval culture that were set up in the audience by the automation's chess performance: the assumption of a liminal quality of oriental automation, and that of a disciplined and productive body accompanied by a special form of docility attributed to Muslim subjects. These two assumptions configured a particular discourse of Muslim as automation and thus created a favorable buffer between von Kempelen's chess machine performance and its critical observers (Aytes 2013: 83f.). After a change of ownership to the Bavarian Musician Nepomuk Mätzel, a visit in the US and numerous mentions in letters and contemporary literature (i.a., Edgar Allan Poe), the automation was exposed as a well-conceived hoax in the early 1820s: diverted by its pseudo-complex construction, a just-as-human opponent lurked inside the automation and operated the Turk unnoticed by its mesmerized audience (Standage 2002).

Nowadays, von Kempelen's chess automation serves as an eponymous label for Amazon Mechanical Turk (AMT), currently one of the most notable crowdsourcing-based Human Computation labor markets for digital piecework. Publically launched in 2005, it has grown to one of the largest distribution platforms with – according to reported data from AMT – 500,000 registered people situated in 190 countries (Amazon Web Services 2015). Down to the present day, the platform sets standards in Human Computation labor markets by means of popularity and pricing. The analogical comparison to von Kempelen's hoax intends to express that employers ('Requesters') communicate with AMT as a 'machine' that internally consists of 'human intelligence manpower' provided by employees (commonly 'Turkers'). Hence, similar to its reference in the Age of Enlightenment, the contemporary 'Turk automation' conveys inscriptions of both techno-ideological discourses and assumptions. Nowadays, rooted in Computer Sciences, they convey the perception of the Turk's 'inside' as an on-demand accessible, artificial intelligent computer system for digital tasks, which actually consists of a globally diffused pool of human digital workers. Correspondingly, Amazon labels its 'product' "artificial artificial intelligence". This formulation points out that AMT suggests an on-screen interaction with an artificially intelligent computer system, but that in fact this artificial intelligence is 'artificial' itself because it is provided by human workers 'hidden' behind its interface.

A body of critical literature addresses this 'interior liveliness' of the Amazon Turk. It examines Turkers' working conditions (Silberman et al. 2010; Marvit 2014; Martin et al. 2014; Lease et al. 2013), highlights (negative) consequences for Turkers due to the digital mediation of labor and the associated abstractions and discourses (Irani 2013; Irani/Silberman 2013; Lease et al. 2013), and points to general ethical questions and future challenges of this labor form (Bederson/Quinn 2011; Kittur et al. 2013). Much of this literature qualifies AMT as a labor market with high worker competition, substantial power and information asymmetries in favor of Requesters (resp. Amazon), and, in cases of occupational hazards, discouraging working conditions. Although this literature locates these issues more or less directly in AMT's platform design, no systematic approach to critically address its design patterns, and their effects and social construction has been undertaken so far.

Hence, in this article the intention is to portray the technologically seeded power- and information asymmetries in AMT's infrastructure based on Turkers' experiences documented in literature and media, and my own interaction with the system (Star/Ruhleder 2001; Orlikowski/Robey 1991; Majchrazak/Markus 2012). Considering classical Labor Process Theory (Braverman 1974/1998; Taylor 1919/2007), I show how these asymmetries and design patterns serve to interface, control and govern labor processes in digital space and how they culminate in a specific mode of *digital labor division*. I argue that Human Computation-divided labor within AMT's infrastructure links Tay-

loristic principles of labor division with self-governing concepts of labor as well as additional techno-social traits and hierarchies accomplished by the digital labor discourses materialized in AMT's infrastructure. AMT's crowdsourcing-based access to its globally situated, highly fragmented and dispersed workforce additionally enhances the effects of digital labor division (deskilling, pricing, efficiency enhancement) as it supports both labor arbitrage and de-territorialization of labor. Guided by SCOT perspective (Pinch/Bijker 1987/2012) I analyze the capacities of involved actors to enforce and implement their meanings into AMT as a technological artifact. The analysis reveals that hierarchies on AMT are not only depicted and produced in its infrastructure by means of the technological potential to determine power relations and working conditions in labor processes; hierarchies also find expression in different *qualities of influence* on AMT's *infrastructure* and *labor process design*, as these qualities determine the affordances and constraints of the AMT technology for specific actors.

I further describe Turkopticon, a widely used browser extension that encodes pooled information of Turker reviews on Requesters directly on the interface of AMT. Thereby it dissolves the strictly set boundaries in the design processes of the platform and organizes and integrates the meanings and interpretation of Turkers with relevance to AMT directly into the system. That is, Turkopticon mitigates the hierarchies depicted in AMT's infrastructure as it serves to gain power and influence in the design (process) of the infrastructure. By means of the technological quality of its influence, I interpret the tool as an expression and result of social conflicts related to technological design issues. Finally I introduce some approaches and suggestions on how to meet the emerging challenges in digital labor environments on the crowd-level, intermediary-level and (trans)national level.

2. AMT's Infrastructure and the Digital Division of Labor

2.1. Amazon Mechanical Turk

AMT is a crowdsourcing-based (Howe 2006) online accessible distribution system for Human Computation microwork (von Ahn 2005), conducted by Amazon.com Inc. It constitutes a system "of computers and large numbers of humans that work together in order to solve problems that could not be solved by either computers or humans alone." (Quinn/Bederson 2009: 1) Corporations or private persons can define, edit and post tasks (called 'Human Intelligence Tasks' or 'HITs') within this infrastructure, which commonly include activities such as audio transcriptions, photo tagging, conduction of reviews or evaluations, or checking links for certain information. The platform distributes these HITs to a large number of globally diffused, undefined, and self-selective online workers ('Providers', or commonly, 'Turkers'), who choose and work on these HITs in exchange for a Requester-defined monetary compensation. In economic terms, AMT represents an online spot labor market featuring buyer/seller agreements to trade at agreed prices for certain durations of time (Horton 2010: 516). Accordingly, AMT portrays itself as a "marketplace for work that requires human intelligence" and intends to offer Requesters systematic access to an "on-demand workforce." It further "aims to make accessing human intelligence simple, scalable, and cost-effective." (Amazon Web Services 2015a) For the supply or mediation of its 'product' AMT invoices 20 to 25 % of the compensation sum paid to the Turkers 'employed' by an individual Requester.

The platform is part of Amazon Web Services (AWS). It was originally invented as an in-house service to identify duplicate product webpages in the Amazon online store with the support of independent contractors. With the discovery of its potential, the platform went public in November 2005 (Bergvall-Kåreborn/Howcroft 2013: 4). In 2007, according to information from Amazon, around 100,000 workers originating from 100 countries were registered on the platform. In 2015 Amazon reports 500,000 registered workers from 190 countries (Amazon Web Services 2015). Such large expansion in the number of workers is a result of the launch of a cash-pay system in 2007 for Indian workers[1] who were at that time, alongside the cash-paid US-Turkers, already a big share of the ever-present workforce. Geographically the workforce is concentrated in the USA (ca. 75 %) and India (ca. 18 %)[2]. Estimations on the number of active Turkers range from between 15,059 and 42,912 (Fort et al. 2011).

1 Turkers from other countries are paid in gift cards for the Amazon online store (Amazon Mechanical Turk 2015: online).

2 http://demographics.mturk-tracker.com/#/countries/all

2.2. Infrastructure-based Information and Power Asymmetries

In the following I describe selected design patterns and features of AMT's *infrastructure* based on related literature and my own interaction with the AMT system. Thereby I show how these patterns determine reciprocal courses of actions and scope in the system, how they link to classical Labor Process Theory, and how they yield in a specific mode of digital labor division. Commonly, an infrastructure is 'sunk' into or inside of other structures, social arrangements and technologies, and remains extensively invisible. It persists in spatial and time-related dimensions, is task-supporting, standard-providing and built on an installed base to which its developments rely on. It further links with conventions of practice and both shapes and is shaped by the conventions of a community of practice (Star/Ruhleder 2001: 308f.). In case of AMT, these general qualities are represented in interacting elements of web technology-based interface design, interaction design as well as related rules and practices in related policies ('Participation Agreement').

HIT Design and Rejections: HIT design on AMT is fully controlled by Requesters. This can result in improperly designed HITs with inadequate, incomplete descriptions or too short periods of working time.[3] For inquiries (e.g., uncertainty on exact elaboration of HITs after contractual acceptation), Turkers depend on the communication willingness of their Requesters. In some cases Requesters employ hundreds of Turkers simultaneously, making a reply improbable due to economic considerations, as interviews with large-scale Requesters show: "The time you spend looking at the mails costs more than what you pay them." (Irani/Silberman 2013: 614) In combination with the HIT-rejection system, this default setting leads to another substantial asymmetry: due to the Participation Agreement on AMT, HITs can be *rejected* based on only poor or even no justification with just a few clicks. In cases of a claim in large-scale crowd collaborations, dispute resolutions do not scale: "a thousand to one worker-to-requester ratio makes responding cost prohibitive." (ibid.) Occasionally, Requesters contact large number of workers and reject them with automatically generated messages (Silberman et al. 2010: 41). As a consequence of this rejection-system, there is no guarantee of payment for conducted work. This pay loss-option can be legally interpreted as systematically enabled wage theft (cf. Irani/Silberman 2013: 613).

Reputation: Because of *rejections*, Turkers not only lose payment but also reputation in the AMT system. Reputation represents the number of, resp., the proportion of accepted and rejected HITs saved in a Turker's profile. This reputation is essential to gain access to (well-paid) jobs, as Requesters can pre-set a HIT-acceptance rate as a quality request for their posted HITs, which employees must meet to be able to accept. Some Requesters use 'majority vote' to decide the 'true' answer (called the 'gold standard') for testing and ranking workers' aptitude and thus determine Turkers' job access (Irani 2013: 6). Because 'wrong' answers are potentially rejected, these practices can also affect reputation negatively. Harmed reputation can only be restored by additional HITs carried out by Turkers.

Master Qualification: A very non-transparent issue with job-access is AMT's *Master Qualification*, a qualification level to acquire well-paid HITs awarded by AMT itself. The criteria for obtaining are not disclosed.[4] The Master Qualification-system (potentially) has two positive effects for AMT: Firstly, AMT takes higher commission fees for the mediation of Master-Qualified Turkers (25 % instead of 20 %). Secondly, the nondisclosure of the obtaining criteria might be an indirect incentive for (highly wage-dependent) Turkers to accept HITs at a low price level in order to obtain Master Qualification and gain better paid Master-level-HITs. This can be interpreted as a mechanism to keep the average HIT-price on AMT at an intended level by controlling simultaneously the number of Turkers with access to high-paid HITs, and the number of Turkers trying to achieve the qualification level by working on low-paid HITs.

Payment System: Apart from this nuanced mechanism of Master Qualification, HIT-pricing highly

3 Due to impropriate HIT designs and the high spam-rate (e.g., HITs install malware on Turkers' PC) on AMT, Turkers' choice and opportunity are, next to other factors, largely determined by their experience and skills. Hence, Turking often demands (long and unpaid) self-training periods (Martin et al. 2014: 232f.; Silberman et al. 2010: 41).

4 The only information from AMT on Master Qualification is the following: "Masters are elite groups of Workers who have demonstrated accuracy on specific types of HITs on the Mechanical Turk marketplace. Workers achieve a Master's distinction by consistently completing HITs of a certain type with a high degree of accuracy across a variety of Requesters. Masters must continue to pass our statistical monitoring to remain Mechanical Turk Masters." (Amazon Mechanical Turk 2015: online)

depends on AMT's pay system: Only providing a cash pay system for USA and India (resp., persons with a bank account in the US) crucially affects the geographical proportion of Turkers on the platform and triggers a competition between an invisible workforce of an industrial and an (advanced) 'developing country', characterized by big differences in pay standards and socio-economic framework conditions.

2.3. Reinvented Taylorism

The technically seeded power and information asymmetries in AMT's design patterns link to a central strand of the industrial sociology's labor process debate: the *transformation problem of labor*, initially discussed by Marx (1872/2009) and Braverman (1974/1998). According to the transformation problem, companies buy the working potential of people for capitalist production over wages. However, the act of purchase alone does not transfer this potential into a measurable performance with exploitable results. It requires additional organizational and technical measures to transform the purchased labor potential into a suitable form by governing and controlling the production process and thus drawing it in a rentable direction (Braverman 1974/1998; Marrs 2010; Voß/Pongratz 1998: 138f.; Deutschmann 2002: 104). Braverman analyzed technological change as a way to appropriate and displace workforce skills, enhance control of capital over production and establish technology-driven power relations: "It is in the age of the scientific-technical revolution that management sets itself the problem of grasping the process as a whole and controlling every element of it, without exception." (Braverman 1974/1998: 118)

One technical method to govern and control the production process is the *division of labor*, which has its historical origins in the decline of traditional crafts and the transition into the industrial age in the late 19th and early 20th centuries. At this time, fundamental elements in systems of human work and corresponding organization changed. The adaption of production processes to the then modern production technologies expedited a homogenization of labor in industrial contexts as well as a systematic elimination of distinct technical craft skills in production that simultaneously assured company control over the pace and quality of production. All in all, companies created new systems of work in which production no longer depended on the knowledge and cooperation of skilled work. With the ambition to optimize these systems, the question of work organization arrived in science – more precisely, in the circles of 'industrial engineers' – mainly stressing the advancement of mechanical improvement, the work flow design and routinization of tasks (Stone 2004: 27ff.; Marrs 2010: 336f.).

Frederick W. Taylor devoted himself to being one of these 'industrial engineers' of scientific analysis of workflows. Interested in a comprehensive, scientific approach to optimized management, he started to develop a reward system that combined a meticulous analysis of activity with time studies to afflict a scientifically optimal workload for each activity. Taylor considered it as necessary to develop a holistic method to organize, supervise and implement work. An elementary step to this method was to relocate the place of knowledge about production processes in industrial relations from the exclusive possession of the workers in the "Work Bureau" (also 'planning-' or 'laying-out department'; Taylor 1919/2007: 24). As a result, alongside the decomposition of holistic work into standardized steps, Taylor established a decomposition of holistic craftsmen work in manual and mental labor. A significant consequence of these restructured production processes was the *deskilling* of activities by dividing and modulating holistic activity into simple, standardized steps.

2.4. The Digital Division of Labor

Human Computation microwork combined with AMT's infrastructure represents a system to modulate labor into small and standardized, crowdsourceable low-skill tasks, and a system to interface related labor process. It thereby reactivates Taylorian principles of labor division by means of task division, division in manual and mental labor and remuneration systems as well as by their effects in term of deskilling, pricing and efficiency. Distinctly in comparison to industrial times, direct surveillance and control over labor process is externalized on Turkers over securitization and a pre-set timeframe. This refers to newer concepts of *self*-governing of labor processes by means of output-driven and market-oriented goals that gradually replace direct forms of governing in labor regimes (Voß/Pongratz 1998).

Labor Division on AMT conveys a techno-social idiosyncrasy as its infrastructure is shaped by contemporary discourses on digital labor division. The different qualities of interaction with its features accomplish social roles that portray Requesters as 'innovators' who

can (on-demand) access Turkers who in turn do menial labor. This both rhetorical and organizational- and infrastructural-made distinction conveys a discursive devaluation of Turkers by opening a 'Taylorian' continuum of innovation/creation vs. routine/service grounded in various metaphors and discursive formations in prevailed (human) computation discourses in research, journalism and marketing (cf. Irani 2013: 6ff.). These discourses further perpetuate the invisibility of a global workforce through a combination of abstraction and service orientation that suggests a particular kind of social relationship in which the workforce is depicted as an arrangement of technology allowing access to a range of computer services remotely and instantly (Irani/Silberman 2013: 612f.; Irani 2013: 17; Lease et al. 2013: 12). As workers are abstracted to 'non-persons', their work can be devalued or rendered 'invisible' more easily due to the distance, anonymity, minimal communication, and electronic exchange in digital employment relations (Martin et al. 2014: 233). These discursive categories, materialized in the AMT infrastructure, shape practice both in ecologies of AMT and by means of cultural work (Irani 2013).[5] Hence, the principles of early industrial labor division on AMT and their techno-social idiosyncrasy yield a distinct mode of *digital labor division*.

A further cultural aspect regarding digital divided labor is the discursive disguising of the produced hierarchies and power relations by embedding crowdsourcing labor in a "[suggested] non-hierarchical space of peer production" (Irani 2013: 17). At this point, Wexler (2011) notices a purposive notion: In contemporary crowdsourcing discourses he identifies that 'new elites' (organizations and individuals using crowdsourcing) 'chum up' with the crowd (e.g., firms labeling themselves as open source-organization; Bauer/Gegenhuber 2015: 22) in order to create a cooperative façade for exploiting the crowd's resources and extracting benefits and privileges (Wexler 2011: 14f.).

2.5. Resolution of Space, Time and Institution: Labor Arbitrage and De-territorialization of Labor

Digital labor division further draws on mechanisms of spatial, temporal and institutional resolution. Predominantly two factors support these mechanisms: Firstly, the *distinct fragmentation* of the crowd itself. This fragmentation results from a) the dispersed geographical diffusion of Turkers, declining the probability for a widespread overlap in social realities or shared interests/values alongside the corresponding multi-factorial variation in socio-economic realities and conditions, b) the many-to-many employment relationships on AMT that establish a large number of parallel and mutually invisible employment relations (Felstiner 2011: 185), and c) the minimal expressiveness of workers within the AMT infrastructure, expediting the mutual invisibility and dematerialization among Turkers (Lease et al. 2013: 12; Irani/Silberman 2013; Irani 2013: 17). Secondly, the underlying *crowdsourcing mechanism* allows for broad access to a large international anonymous crowd labor market, significantly boosting the distribution range of modulated digital tasks that a broad range of people can work on. Reaching an internationally situated workforce qualifies AMT as a global activity system that connects and divides labor between 'developed' and 'developing countries' (Asmorov 2014: 11). Thereby, it condenses global disparities in socio-economic circumstances and realities in a market mechanism, triggering a competition between a globally situated, mutually invisible digital workforce. This leverage increases the bargaining power of Requesters by producing a substantial labor surplus through a maximization of the number of internationally situated contributors (Bauer/Gegenhuber 2015: 12).

Hence, AMT creates a foundation to *arbitrate* labor across spatial and temporal boundaries within the digital space created by its 24/7 online accessible infrastructure. With its Participation Agreement, the infrastructure moreover dissolves national institutional settings by muting the legally founded, traditional link between nationally situated labor and the working person as a citizen. This excludes Turkers from national labor law protections (e.g., minimum wage, overtime rates, sick leave or unemployment benefits) and enables a governing of labor on *de-territorialization* (Aytes 2013: 91f.; Ong 2006; Cherry 2010). Empirically these control and pricing mechanisms are legible on the low average hourly wage on the platform. Estimations range from $ 1–5 (USD), with the highest at the level of $ 4.80 (USD) (Ipeirotis 2010b). Table 1 provides an overview of the mentioned infrastructural design patterns, mechanisms and their effects related to digital labor division.

5 As Asmolov formulates: "[T]he symbolic power of representation and the material power of action are interrelated because of the design of the system." (2014: 4)

Tab. 1.: Infrastructural design patterns of AMT and their effects related to Digital Labor Division

Infrastructure Design Pattern	*Effects related to Digital Labor Division*
HIT design	Potentially inappropriate HIT design
+ rejection system	Potential wage theft
Reputation system	Information asymmetries in favor of Requesters
	Restrictions in job access
Cash-pay system	Price competition
Master qualification (disclosed criteria)	Price competition
	Restrictions in job access (well-paid HITs)
Spatial, temporal and institutional resolution	De-territorialization of labor (crowdsourcing-leverage)
	Labor arbitrage (crowdsourcing-leverage)

Source: own research

3. The Social Construction of Digital Labor Division

As shown, the prerequisites for digital labor division are of a technical nature and found in the infrastructure design patterns of AMT. Therein encoded imbalances set power relations in labor processes by translating techniques of governing labor into an interface form. This reveals that (combined) web-technologies are not neutral entities (Mager 2014: 28; Fuchs 2010: 180), but artifacts "fostered by groups to preserve or alter social relations" (Hård 1993: 409) and streaked with choices, negotiations and conflicts. Thus, analyzing influence capacities of relevant actors on the infrastructure design (process) can provide valuable insights into the origins of the imbalanced configuration of AMT as digital production technologies.

3.1. The Social Construction of Web Infrastructure: SST and Actor-related Capacities

Theoretical approaches, summarized under the concept of 'Social Shaping of Technology' (SST), locate technological development processes embedded in reciprocal, dialectical systems or arenas in which technology and society construct each other (Williams/Edge 1996; Orlikowski 1992). They shed light on socio-economic patterns embedded in the content, innovation and closing processes of technological artifacts (Williams/Edge 1996) and simultaneously depict technology as an artifact portraying societal developments, structures, values and rationalities by reproducing and embodying the complex interplay of professional, technical, economic and political factors (Bijker/Law 1992: 3). The approaches try to open the social, institutional, economic and cultural factored 'black-box' of technology design "to allow the socio-economic patterns embedded in both the content of technologies and the process of innovation to be exposed and analyzed." (Williams/Edge 1996: 866) The central concept is the idea that technology does not develop according to an inner logic or teleological path but according to not necessarily conscious or direct *choices, negotiations* and *conflicts*. According to these assumption, SST raises questions on a) the negotiability of technology and its outcome by highlighting the scope for particular groups and forces that shape technologies to their end in different, 'multidirectional' ways, and b) the irreversibility of technology, meaning the extent and manner in which particular choices may be foreclosed or path dependent by means of social factors (Williams/Edge 1996: 867; Hård 1993: 418).

In the case of AMT, I focus on the Social Construction of Technology (SCOT)[6] (Pinch/Bijker 1987/2012) approach that emphasizes the meanings and interpretations of technological artifacts of different social groups and individual actors. Theoretically grounded in the thoughts of the social construction of scientific knowledge and actor-network theories, they emphasize complex social negotiation- and interpretation processes of individual and collective actors and their capacities to enforce and implement their *meanings and interpretations* in different design processes related to technologies. As the analytical framework in which technology and its design are created, they adduce four dimensions: 1) the interpretative flexibility of technological outcomes and the way in which they are related with their social development environment, 2) the

6 SCOT represents one variation of SST-approaches (cf. Williams/Edge 1996). Differences between these approaches are generally found in different social agency, material agency and political economy emphases.

design influence of relevant social groups, 3) the closure and stabilization processes in the negotiation and interpretation processes, aiming to 'complete' or 'end up' the design process of a technological artifact, and 4) the wider socio-cultural and political context in which a technology is embedded (Pinch/Bijker 1987/2012: 33ff.). Similar to Kuhnian Paradigms (Kuhn 1970), this framework can contain goals, core problems, contemporary common theories, thumb rules and artifacts that structure the problem solving, strategy formation and design activities of actors in an implicit or explicit manner (Klein/Kleinman 2002: 31).

In criticizing Pinch/Bijker for underemphasizing structural and political economic considerations, Klein/Kleinman (2002) complement the strongly agency-centered approach with considerations of political economy in order to contextualize technology development within dominant *social and economic* structures. In the tradition of institutional political economy they define structures as

> *"specific formal and informal, explicit and implicit 'rules of play', which establish distinctive resource distributions, capacities and incapacities and define specific constraints and opportunities for actors depending on their structural location. Power and its operation are then understood within this structural context. The rules of play that define structures give certain actors advantages over others by endowing them with valued resources or indeed by serving as resources themselves" (Klein/Kleinman 2002: 35).*

Hence, influence capacities of social groups also depend on their structural characteristics and positions, determining the extent of a certain group to enforce and implement their meanings and interpretations in the construction of a technological artifact in development and closure processes.

3.2. Capacities in the Construction of Digital Labor Division on AMT

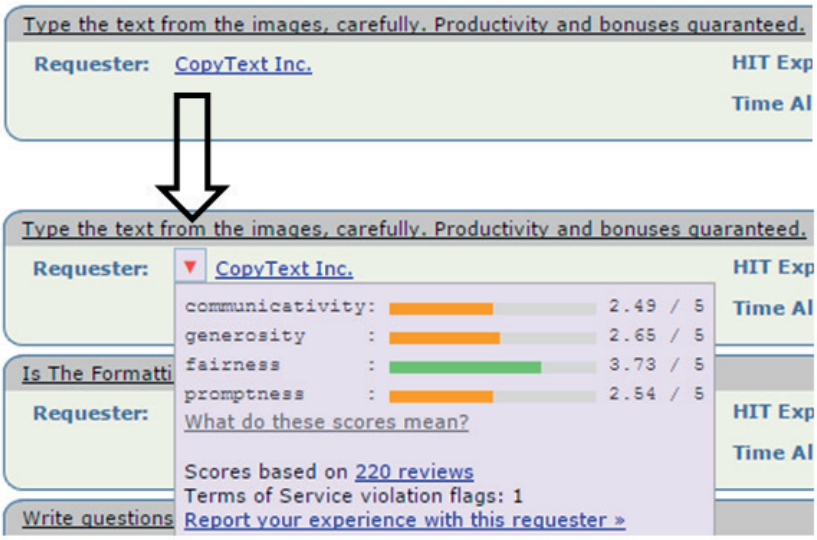
Guided by the SCOT-approach, I intend to identify different capacities of actors interacting with AMT to enforce and implement their meanings and interpretations in its construction process. Considerations of capacities reveal infrastructural-made hierarchies that are not only depicted and produced in the infrastructure by means of digital labor division and its effects; hierarchies also find expression in the *quality of an actor's influence on infrastructure* (addressing general interface and interaction design patterns) and *labor process design* issues. In other words: the extent of how certain actors can enforce and implement their meanings and interpretations in the design and closing processes of the technological artifact determines the affordances and constraints available to certain actors in its use (cf. Majchrazak/Markus 2012). This sheds light on the social construction of technological prerequisites that enable digital labor division by means of influence capacities.

With regard to infrastructure design, Amazon.com Inc., resp., Amazon Web Services, appears as the central organizational actor occupying major impact on AMT's infrastructural composition in multiple design processes. Hermetically sealed, it fully determines the problem definition, interpretative flexibility of the technological outcomes of the platform and the way in which they are related with their social development environment as well as the related design, closure and stabilization process.[7] Turkers lack capacities in design influence and are not integrated into interpretation and design processes nor in closure and stabilization processes regarding the technological affordances and constraints of the digital infrastructure they work in. Requesters as individual employers also lack influence in infrastructural design issues. Large-scale Requesters, however, might have a higher influence on infrastructural design issues in respect to, e.g., changes in the 'Participation Agreement' or new HIT-templates, etc.

However, Requesters are endowed with full control and influence at the labor process-level by means of HIT design, job access (different qualification levels, country), time setting, payment and rejections. Although Turkers' immediate working conditions highly depend on these factors, they usually have no direct influence. Because of their exchangeability, arising from the circumstance that the required skills for HITs are usually found widely distributed in the population, Requesters are not forced to 'negotiate' HIT design issues with their Turkers. The only constraint here is that Turkers have to accept HITs after testing one example. This concession in design influence in labor processes may arise from AMT's intended purpose to interface labor processes for Requesters, and the strong dependence of this business model on shares from Requesters' paid compensations to Turkers.

7 A remarkable detail in this respect is that the AMT logo indicates that the platform still remains in beta status since its public launch.

Figure 1: Example for a Requester review encoded by the Turkopticon browser extension in the AMT interface



Source: Own research

In the case of AMT, the differences in influence capacities mainly arise from the structural positions of the involved actors. AMT is one of numerous products of its parent company Amazon.com Inc., an organization holding concentrated market power emanating from its broad popularity and its material/virtual infrastructures in different branches. Backed by this powerful corporation, AMT itself is moreover the current major intermediary in the Human Computation oligopoly market. These capacities impart extensive market power towards its fragmented customers and stakeholders and allow AMT to dictate preferred business conditions through its infrastructural design. In contrast, Turkers lack such structural power capacities by means of their distinct fragmentation, causing them to face severe difficulties in organizing their collective meanings and interpretations with relevance to infrastructural design issues in the space of AMT. Again, their exchangeability weakens their influence in design issues. Individual Requesters remain (although their central role in AMT's business model) in a similar position, although large-scale Requesters might have a more influential position. Regarding design issues at the labor process-level, Turkers again – induced by the deskilling effects of digital labor division and their fragmented appearance – have few capacities to build up pressure towards AMT or Requesters. On the contrary, Requesters as the essential element of AMT's business model, hold structural power capacities at the labor process-level by means of HIT design, job access, rejections and a low-cost crowdsourcing-based access to a digital labor surplus.

3.3. Turkopticon: Challenging Hierarchies in the AMT Infrastructure

In general, these sketched imbalances in influence capacities have notable consequences on technological outcomes. As Klein/Kleinman state: "Where labor is poorly organized (highly fragmented and dispersed) capital is likely to be able to dictate the character of the technology." (Klein/Kleinman 2002: 42) To mitigate the dictation of AMT in the technological configuration of the platform and to compensate related ethical issues, Lilly Irani und Six Silberman developed Turkopticon back in 2008. Turkopticon is a database-driven requester rating system combined with a browser extension, intended to render Turkers visible on AMT and help them to avoid unfair employers: "Turkopticon helps the people in the 'crowd' of crowdsourcing watch out for each other – because nobody else seems to be. (...) Turkopticon lets you REPORT and AVOID shady employers." (Turkopticon 2014: online) It is named after the Panopticon, a prison surveillance design most famously analyzed by Foucault. The prison, initially planned by Jeremy Bentham, is composed of a circle of prison cells with glass walls on the front and back and nontransparent walls between the single cells. With a guard tower placed in the center that does not reveal whether it has a guard inside or not, this constellation triggers an effect of self-disciplining among the prisoners as the sheer possibility of surveillance forces them to control their behavior on their own (Foucault 1975/1994: 258).

Turkopticon intends to implement the same effect of self-disciplining on Requesters by making their actions visible. The system enables Turkers to assess Requesters by means of four quality measures (attributes): communicativity ("How responsive has this requester been to communications or concerns you have raised?"), generosity ("How well has this requester paid for the amount of time their HITs take?"), promptness ("How promptly has this requester approved your work and paid?") and fairness which relates to the approval and rejection-rate of HITS ("How fair has this requester been in approving or rejecting your work?") (Turkopticon 2014). The qualities are measured on a value scale between 1 and 5 with "0" indicating that there is no data available. These values can be supplemented with a short description in a text field and only accessed on the Turkopticon website. The browser extension directly encrypts the collected quantitative data on the interface of AMT where it can be inspected in a little pop-up window when hovering the mouse cursor on the little quadrat attached next to the Requester's name (see Figure 1). The extension is available for Chrome and Firefox and has in sum ca. 28,600 downloads (23,800 for Chrome, 4,800 for Firefox).

The concept behind Turkopticon refers to considerations of Donna Haraway, a feminist techno science scholar. She argues for "partial connections–alliances built on common cause rather than common experience or identity–as a way to sustain political and ethical action across people with irreducible differences." (Irani/Silberman 2013: 615) These considerations are in line with the huge differences between socio-economic realities concentrated in the AMT market mechanism as well as with the distinct fragmentation found among Turkers on AMT. From this perspective, Turkopticon unites digital workers not by their affiliation to an ideal type of a 'digital worker' with broadly shared interests and identities, but by the fact that they have the same *potential for inadequate or unfair working conditions* and inappropriate Requester-behavior as well as the *design-caused incapacity* to proceed against it in case of occupational hazards.

The function of Turkopticon elevates Turkers to a more relevant group in the enclosed design process of the platform infrastructure by actively influencing AMT's design patterns by means of client-side scripts, that attach an additional feature on the interface. A SCOT-centered interpretation unveils that the tool (partly) dissolves the strictly set boundaries in the interpretation, design, closure and stabilization processes of AMT at the agency level and organizes and integrates the meanings and interpretation of Turkers with relevance to AMT on the infrastructural level. Thereby, Turkopticon challenges the hierarchies depicted in the quality of design influence of the labor market infrastructure of AMT.

The continuous technical influence of Turkopticon on AMT's interface design expresses social conflicts in design issues of a digital working environment. As Hård (1993) notes, SST-models tend to consider conflicts in technological development only in their genesis and overemphasize harmonious aspects of closed technological artifacts. Thus he suggests treating social conflict as a "cause of innovation, diffusion, transfer, and application—not only as a result of these processes" (Hård 1993: 409) in order to highlight conflictual moments between social groups in the development of technological artifacts and to view this conflict as a permanent process in various arenas. Drawing from this notion, Turkopticon represents a technological artifact resulting from social conflict expressed in its permanent influence on AMT's design patterns. In a broader view, the nature of this influence qualifies web technology as a *dialectical technological nexus* between digital production technologies and the computers/devices of digital workers, allowing the latter direct influence *through* web-technology on the web technology-*based* systems' inbuilt hierarchies and inequalities. Although these quite moderate influence capacities do not equalize the substantial inequalities in digital capitalism, the dynamics between Turkopticon and AMT disclose a dialectical potential of web-technologies with both serving exploitative and emancipative purposes.

4. Meeting the Challenges of Digital Labor

The example of AMT reveals various challenges for workers in digital working environments. Attempts and suggestions to meet the challenges of digital labor occur on various levels. As Turkopticon exemplifies, some of them are found at the crowd-level. Crowd-moderated tools as well as information and discussion websites such as TurkerNation, mTurk Grind, mTurk wiki, TurkAlert or channels on social media platforms (e.g., reddit), reduce information asymmetries in online labor markets, empower crowds to lobby for their needs and interests in digital working environments, and increase consciousness of the position of digital workers in the field of digital economy. By simultaneously showing their potential for (supported)

self-organization and digitalized collective action, they profile crowds as social bodies with political relevance (Bauer/Gegenhuber 2014: 25).

According to my analysis, most of the potential to impact the conditions of digital work can be found at the intermediary level. Addressing design issues, general design guidelines can provide frameworks for managing the highly condensed multitude of interests and socio-economic characteristics in the digital space of intermediary platforms in a balanced manner. A common example is the framework of *Value Sensitive Design* (VSD), a theoretically founded, comprehensive and iterative design approach for ICT systems emphasizing the (different) ethical values of direct and indirect stakeholders as well as the effects of technologies on them (Friedman et al. 2002). Here, a systematic integration of the corresponding crowd in infrastructure or work design issues would be vital. To evaluate and monitor the implementation of such quality criteria, (inter)national organizations (e.g., labor unions) could award 'quality labels'[8] for best-practice intermediaries, signaling appropriate working conditions to digital workers (Benner 2015: 298).

Yet, online labor markets have remained absent from (trans)national labor law regulation. As digital labor is confronted with issues of low-wage work and a lack of social security, the debate of legal regulation oscillates around the inclusion of digital workers in national labor standards such as the Fair Labor Standards Act (FLSA) in the US. Presently, Turkers dwell in a legal grey zone when it comes to the question of whether digital workers are employees (that would apply to FLSA) or independent contractors (Cherry 2009: 1096f.). Further there is a debate on a minimum wage for digital labor. Here, the central issue is that the level of such a minimum wage is highly relative due to differences in individual person-related characteristics (employment-intensity, motivation, marital status, etc.) as well as in the disparities in surrounding national economic and cultural circumstances. That is, a 'fair' payment in crowdsourcing is generally difficult to define or even to operationalize. In this direction, the concept of reservation wage (the lowest wage a worker will take for a given task) is useful but also not definitive (Silberman et al. 2010: 43). These debates uncover crucial challenges of (trans)national legal regulation and point to limitations of current institutional arrangements to affect labor issues in digital space towards the internationality of crowd labor and the related transcontextual use of intermediary infrastructure.

5. Summarizing Remarks

AMT, an online labor market for Human Computation tasks, is a popular example of digital production technology. Central design patterns and features of its infrastructure determine substantial power and information asymmetries in favor of Requesters in prevailing employment relations. Considering classical Labor Process Theory, AMT's infrastructure, shaped by contemporary discourses on digital labor, portrays a specific mode of digital labor division. Its effects are enhanced by AMT's crowdsourcing-based access to highly fragmented Turkers, enabling a global-scale labor arbitrage and a governing of labor on deterritorialization.

A SCOT approach to AMT highlights the relevance of actor-related power and influence capacities in technology design issues, both of which vastly determine the characteristics and purposes of a technological artifact. It shows that hierarchies are not only depicted and produced in the infrastructure (by means of digital labor division) but that hierarchies also find expression in different qualities of influence on infrastructure and labor process design issues. The different capacities fully exclude Turkers in the design and closing processes of AMT. Moreover, they set the prerequisites for Amazon and Requesters to instrumentalize AMT's digital infrastructure to govern digital labor. Turkopticon mitigates these configured hierarchies in the AMT-system. By encoding pooled information of Turker reviews on Requesters actions directly into AMT's interface, Turkopticon challenges inbuilt power and information asymmetries and organizes Turkers' capacities to gain influence on the design (process) of the digital infrastructure they work in. By that, Turkopticon puts Turkers in a more visible and capable position.

Turkopticon is one of numerous examples of web-based shared tools and spaces addressing the power and information asymmetries on AMT. The need for these diverse forms of technology-supported influence highlights the repressive potential of web technologies and its inbuilt dynamics of emancipative and repressive elements in the contexts of digital economy. In respect thereof, web technology represents a *dialectical technological nexus* between digital production technologies and digital workers' computers/devices by allowing a

8 See the website http://faircrowdwork.org/ operated by the German labor union IG Metall. [20.05.2015]

direct influence through web-technology on web technology-based systems' inbuilt hierarchies, arising from unequally distributed capacities in the design of software. This reveals their dialectical potential in both serving exploiting and emancipating purposes. In respect thereof, the example of AMT points to the necessity for improvements and institutional regulations regarding digital labor on multiple levels. Such regulation remains challenging due to the internationality and transcontextual use of infrastructure on intermediary platforms. Hence, the web-technological nexus exemplified by Turkopticon could play an elemental role in meeting (some of) these challenges of multi-faceted inequalities in the digital economy.

References

Altmann, N./Deiß, M./Döhl, V./Sauer, D. (1986): Ein 'Neuer Rationalisierungstyp.' Neue Anforderungen an die Industriesoziologie. *Soziale Welt*, 37 (2/3), 191-207.

Amazon Mechanical Turk (2015): *Worker Web Site FAQs.* Online: https://www.mturk.com/mturk/help?helpPage=worker [13.02.2015]

Amazon Web Services (2015a): *Overview of Mechanical Turk.* Amazon Web Services Documentation. Online: http://docs.aws.amazon.com/AWSMechTurk/latest/RequesterUI/OverviewofMturk.html, [12.02.2015]

Asmolov, G. (2014): *Crowdsourcing as an Activity System: Online Platforms as Mediating Artifacts.* Paper presented at Crowd Intelligence: Foundations, Methods and Practices. Barcelona, 8-9 January 2014.

Aytes, A. (2013): Return of the Crowds. Mechanical Turk and Neoliberal Stats of Exception. In: Scholtz, T. (Ed.): *Digital Labor. The Internet as Playground and Factory.* New York/London: Routledge, 79-97.

Bauer, R./Gegenhuber, T. (2014): Crowd-based Sourcing – Global Search and Twisted Roles of Consumers and Producers. *Working Paper.* JKU Linz.

Bauer, R./Gegenhuber, T. (2015): Crowd-based Sourcing – Global Search and Twisted Roles of Consumers and Producers. Paper forthcoming in: *Organization* – Special Issue: Organizations and their Consumers.

Bederson, B. B./Quinn, A. (2011): *Web workers unite! Addressing challenges of online laborers.* Paper presented at CHI EA '11 Extended Abstracts on Human Factors in Computing Systems.

Benner, C. (2015): Amazonisierung oder Humanisierung der Arbeit durch Crowdsourcing? Gewerkschaftliche Perspektiven in einer digitalen Arbeitswelt. In: Benner, C. (Ed.): *Crowdwork – zurück in die Zukunft? Perspektiven digitaler Arbeit.* Frankfurt/M.: Bund Verlag, 289-302.

Bergvall-Kåreborn B./Howcraft D. (2013): *Crowdsourcing and Open Innovation: Amazon and Apple's digital platforms.* Paper presented at The 6th ISPIM Innovation Symposium – Innovation in the Asian Century, in Melbourne, Australia on 8-11 December 2013. Online: http://goo.gl/r5MLUY [19.02.2015]

Bijker, W./Law J. (1992): General Introduction. In: Bijker W./Law L. (Eds.): *Shaping Technology/Building Society: Studies in Sociotechnical Change.* Cambridge: MIT Press, 1-16.

Braverman, H. (1974/1998): *Labor and Monopoly Capital.* New York: Monthly Review Press.

Cherry, M. (2009): Working for (virtually) minimum wage: Applying the Fair Labor Standards Act in Cyberspace. *Alabama Law Review,* 60 (5), 1077-1110.

Cherry, M. (2010): A Taxonomy of Virtual Work. *Georgia Law Review,* 951. Online: http://ssrn.com/abstract=1649055

Deutschmann, C. (2002): *Postindustrielle Industriesoziologie. Theoretische Grundlagen, Arbeitsverhältnisse und soziale Identitäten.* Weinheim/München: Juventa.

Felstiner, A. (2011): Working the Crowd. Employment and Labor Law in the Crowdsourcing Industry. *Barkley Journal of Employment & Labor Law*, 32 (1), 143-203.

Fort, K./Adda, G. (2011): Amazon Mechanical Turk: Gold Mine or Coal Mine? *Computational Linguistics,* 37 (2), 413-420.

Foucault, M. (1975/1994): *Überwachen und Strafen. Die Geburt des Gefängnisses.* Frankfurt/M.: Suhrkamp.

Friedman, B./Kahn, P. H./Borning, A. (2002): Value Sensitive Design: Theory and Methods. *UW CSE Technical Report,* 02-12-01.

Fuchs, C. (2010): Labor in Informational Capitalism and on the Internet. *The Information Society,* 26 (3), 179-196.

Gere, C. (2008): *Digital Culture.* London: Reaktion Books.

Hård, M. (1993): Beyond Harmony and Consensus: A Social Conflict Approach to Technology. *Science, Technology and Human Values,* 18 (4), 408-432.

Horton, J. J. (2010): Online Labor Markets. In: Saberi, A. (Ed.): *Lecture Notes in Computer Science vol. 6484*, Berlin/Heidelberg: Springer, 515-522.

Howe, J. (2006), The Rise of Crowdsourcing. *WIRED Magazine,* Issue 14.06, June 2006. Online: http://www.wired.com/wired/archive/14.06/crowds.html [06.02.2013]

Ipeirotis, P. G. (2010a): Demographics of Mechanical Turk. *Working Paper.* Online: http://www.ipeirotis.com/wp-content/uploads/2012/02/CeDER-10-01.pdf [12.09.2014]

Ipeirotis, P. G. (2010b): Analyzing the Amazon Mechanical Turk Marketplace. *XRDS* 17(2), 16-21.

Ipeirotis, P./Foster, P./Jing, W. (2010): Quality Management on Amazon Mechanical Turk. *Proceedings of the Second Human Computation Workshop (HCOMP) 2010*, 64-67.

Irani, L. (2013): The cultural work of microwork. *new media & society* 21. Online first http://nms.sagepub.com/content/early/2013/11/19/1461444813511926.abstract

Irani, L./Silberman, M. S. (2013): Turkopticon: Interrupting Worker Invisibility in Amazon Mechanical Turk. Paper presented at *CHI 2013 Changing Perspectives*, 611-620.

Kittur A./Nickerson, J. V./ Bernstein, M. (2013): *The Future of Crowd Work.* Paper presented at CSCW '13 February 23–27, 2013, San Antonio, Texas, USA.

Klein H. K./Kleinman L. (2002): The Social Construction of Technology: Structural Considerations. *Science, Technology, & Human Values,* 27 (1), 28-52.

Kuhn, T. (1970): *The structure of scientific revolutions.* Chicago: University Press

Lease, M./Hullman, J./Bigham, J./Bernstein, M./Kim, J./Lasecki, W. S./Bakhshi, S./Mitra, T./ Miller, R. C. (2013): *Mechanical Turk is Not Anonymous.* Online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2228728 [19.02.2015]

Mager, A. (2014): Defining Algorithmic Ideology: Using Ideology Critique to Scrutinize Corporate Search Engines. *tripleC: Communication, Capitalism & Critique*, 12 (1), 28-39.

Majchrzak, A./Markus, M. L. (2013): Technology Affordances and Constraints in Management Information Systems. In: Kessler, E. (Ed.): *Encyclopedia of Management Theory.* London: Sage Publications. Online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2192196 [17.05.2015]

Marrs, K. (2010): Herrschaft und Kontrolle in der Arbeit. In: Böhle, F./Voß G. G./Wachtler, G. (Eds.): *Handbuch Arbeitssoziologie.* Wiesbaden: VS Verlag, 331-358.

Martin, D./Hanrahan B. V./O'Neill J. (2014): B*eing a Turker.* Paper presented at CSCW 2014: Performing Crowd Work February 15-19, 2014, Baltimore, MD, USA.

Marvit, M. Z. (2014): The Wages of Crowdwork. How Amazon created the most exploited workforce you've ever seen. *The Nation,* February 24, 2014, 18-25.

Marx, K. (1872/2009): *Das Kapital.* Köln: Anaconda.

Ong A. (2006): *Neoliberalism as Exception: Mutations in Citizenship and Sovereignty.* New York: Duke UP.

Orlikowski, W./Robey, D. (1991): Information Technology and the Structuring of Organizations. I*nformation Systems Research,* 2 (2), 143-169.

Orlikowski, W. J. (1992): The Duality of Technology: Rethinking the Concept of Technology in Organizations. *Organization Science,* 3 (3), 398-427.

Papsdorf, C. (2009): *Wie surfen zur Arbeit wird: Crowdsourcing im Web 2.0.* Frankfurt/M.: Campus Verlag.

Pinch, T./Bijker W. (1987/2012): The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other. In: Bijker W./Hughes T./Pinch T. (Eds.): *The social construction of technological systems: New directions in the sociology and history of technology,* Cambridge, MA: MIT Press, 11-44.

Quinn, A./Bederson, B. B. (2009): *A taxonomy of distributed human computation.* Technical Report HCIL-2009-23, University of Maryland. Online: http://hcil2.cs.umd.edu/trs/2009-23/2009-23.pdf [19.02.2015]

Ross, J./Irani, L./Silberman, M.S./Zaldivar, A./Tomlinson, B. (2010): *Who are the Crowdworkers? Shifting Demographics in Mechanical Turk.* Paper presented at CHI 2010, April 10-15, Atlanta, USA.

Scholz, T. (2013): Introduction: Why Does Digital Labor Matter Now? Scholz, T. (Ed.): *Digital Labor. The Internet as Playground and Factory.* New York/London: Routledge.

Silberman, M. S./Irani, L./Ross, J. (2010): Ethics and Tactics of Professional Crowdwork. *XRDS* 17(2), 39-43.

Standage, T. (2002): *The Turk. The Life and Times of the Famous Eighteenth-Century Chess-Playing Machine.* New York/Ontario: Walker Publishing.

Star, S. L./Ruhleder, K. (2001): Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. In: Yates, J. A./VanMaanen, J. (Eds.): *Information Technology and Organizational Transformation. History, rhetoric and practice,* 305-346.

Stone, K. V. W. (2004): *From Widgets to Digits. Employment Regulation for the changing workplace.* Cambridge: University Press.

Taylor, F. W. (1919/2007): *Die Betriebsleitung insbesondere der Werkstätten.* Heidelberg: Springer.

Turkopticon (2014): Homepage. Online: http://turkopticon.ucsd.edu [15.02.2015]

von Ahn, L. (2005): *Human Computation.* Doctoral Thesis, School of Computer Science, Carnegie Mellon University.

Voß, G./Pongratz, H. J. (1998): Der Arbeitskraftunternehmer. Eine neue Grundform der Ware Arbeitskraft? *Kölner Zeitschrift für Soziologie und Sozialpsychologie,* 50 (1), 131-158.

Wexler, M. N. (2011): Reconfiguring the Sociology of the Crowd: Exploring Crowdsourcing. *International Journal of Sociology and Social Policy,* 31 (1/2), 6-20.

Williams, R/Edge, D. (1996): The social shaping of technology. *Research Policy,* 25, 865-899.