

Automation and Affect: A Study of Algorithmic Trading¹

Robert Seyfert

Introduction

In this article, I apply an analysis of affects to results from my fieldwork of companies working in Algorithmic Trading and High-Frequency Trading (HFT), also known as “automated trading”.² In order to delineate the affective specificity and singularity of the socio-technical ecology (*affectif*) in algorithmic finance, I use affect analysis to capture the multidimensional nature of human-machine relations. A historical comparison with previous affective relations in financial markets, such as *attraction* to the stock market ticker and *syntheses* with screens in manual trading, renders visible multiplied and intensified complex multi-frequential bonds – material, electrical, visual, acoustic, cognitive and bodily – between humans and machines. This is somewhat counterintuitive, because it means that automation in fact *intensifies* complex human-machine relations. Moreover, it is the *intensity* of these affective relations that underpins the *coherence* of HFT socio-technical systems. In order to account for the distinctiveness of affective relations in algorithmic finance I suggest the concept of *affective symbiosis*.

In the following section, I will give a short introduction to automated trading. This introduction will be of a rather general nature and focus selectively on those aspects that are relevant for the topic of this book chapter.³

Automation of Trading

As the name suggests, Algorithmic High Frequency Trading is very often but not exclusively defined as automated trading, where automation refers to the data collection, decision making and execution of transactions by computational machines. Further characteristics are low latency transmission and high rates of submitted orders and quotes (CFTC 2012). Another term for automated trading is systematic trading, where “systematic is defined as a disciplined, methodical, and automated approach” (Narang 2013, p.xiv). Human actors are involved in this process in various ways, from the selection of general trading strategies, market places and

trading platforms, the design, maintenance and upgrading of trading software, to the monitoring and supervision of, and intervention in, the live trading process.

It is a type of distributed trading, distributed among various actants, human and non-human alike. Together with the non-human elements such as co-located computer servers, fiber cables, algorithms, etc., human experts, including quantitative researchers, analysts and traders, form the socio-technical assemblage of ‘automated trading systems’. All human and nonhuman elements are simultaneously and equally involved in the construction, operation and maintenance of algorithmic trading platforms. Thus, companies that engage in algorithmic trading are “sociotechnical ensembles” (MacKenzie, Beunza, Millo & Pardo-Guerra 2012, p.280).

Even though cases exist where computers trade without or only with minimal human surveillance, those cases are very rare. They tend to deal with very simple trading strategies or, as in the single case I observed, slow markets. In general, their low profit margins make them less interesting to traders.⁴ By contrast, automated trading systems, like semi-automatic or semi-discretionary trading, require continuous supervision, permanent participation, and regular interventions by highly trained personnel who incessantly sit in front of multiple monitors. Those who monitor the trading system need to understand the functioning of the trading algorithm; they have to know for which market environment and market situation it is made; they need to understand when the situation has altered, and consequently to decide whether to adapt it to the new conditions, or whether to disable certain trading strategies, because the market behaves differently from the model.

Thus, the human trader not only needs to have a logical understanding of the functions of the trading algorithm, but also an understanding of the ways it interacts with its environment. In cases where the trader perceives a change in the market situation, and that the system is no longer synchronized with the market, he⁵ needs to intervene and readjust the corresponding parameters:

if there is something really strange in the stock or if there is takeover bid or rumors in the stock you have to be very careful. Your spreads are going to be wider. You are looking around for more information and in [the] last case you can also ... we are not quoting [orders] anymore. (Anonymous High Frequency Trader ‘A’)

Such interventions require precise knowledge, not only of the trading strategy, but also of the minutiae of market movements, on the part of those who observe the trading systems. In market

situations that are deemed unusual the trader will have to check if the order was indeed correct. He will check the headlines at his monitors (e.g. Bloomberg News) in order to see if some external event has occurred that might interfere or be in conflict with the strategies implemented in trading strategy. In cases of conflict with the algorithm the trader might alter the particular parameters on which this algorithm trades or in extreme cases, he will ‘land’ the algorithm or a particular module of it. If the market situation changes he also has options and limits he can override: for instance, he might be able to change the limits in the amount of orders, if he figures it would be profitable. But he might not be allowed to override certain protection functions, functions that are sometimes even monitored by stock market exchanges. Changes can range from external shocks of a non-economic nature such as natural disasters or political uprisings to unforeseen market events, such as market crashes or unexpected movements during market openings, which in turn might be related to announcements by central banks or to the release of labor data etc. For instance, in March 6 2015, the market opening was critical because the Bureau of Labor Statistics in the United States released its jobs data about 62 seconds late. Such a scenario might cause serious problems for an automated trading system because it might start trading under wrong assumptions (Ehrenfreund 2015). Consequently, a trader needs to delay the initiation or change its parameters accordingly. Such frequent interventions show the degree of human interference and involvement.

Obviously, the human requirements at the trading desk are not universal. The number of shifts and working hours, the individual skills of the trader and his knowledge depend on various factors, ranging from the location of the trading firm vis-à-vis the location of the markets they are trading, to the asset classes, the complexity of their models, the particular trading strategies and the market times. Most firms I have talked to traded in markets in North America and Europe, which means they would operate the trading desk for thirteen hours, from 7am to 8pm GMT. I have observed complex situations that call for an almost military precision in the organization of the personnel. Different fleets of traders work in three consecutive shifts, and even lunch and toilet breaks require replacement traders. This makes ethnographic observations and expert interviews especially challenging. Not only do firms restrict access to the trading desk, interviews also need to be arranged according to the schedule of the trading firm. In one case, my interview with the head of trade coincided with the lunch break. Since he was also responsible for organizing the smooth transition between shifts, our interview led to increasingly irritated traders who saw their lunch break shortened as our talk went on.

This description of the organizational setting of the typical automated trading firm gives us a general impression of the role of humans in automated processes. Far from being sidelined from actual trading activities, human actors are active elements of the automated system.

Public discourses on algorithmic finance are dominated by the belief that humans are mostly excluded from trading activities, an exclusion that is tightly tied to the exclusion of human emotions and affects. However, results from my fieldwork indicate that, far from sidelining humans and affects, in algorithmic finance, processes of automation paradoxically *intensify* complex human-machine relations. Here, humans are not simply sidelined (and limited to tasks of surveillance and observation); instead, they become an essential part of the trading system, and are integrated along multiple frequencies through affects. I will argue that their inclusion cannot simply be explained on a cognitive (attention), emotional (discipline), symbolic or semantic (signs on screens) level. Rather, such explanation needs to draw on an analysis of affective relations. Affective relations underpin the coherence of socio-technical systems such as automated trading systems.

Role of Humans in Automated Systems

The fact that processes of automation have led to an intensified integration of humans rather than their exclusion will not come as a surprise to those familiar with the study of automated systems. In a seminal paper on *Man's Role in Control Systems* from 1975, Bibby et al point to the paradox that all “automated systems still are man/machine systems” (Bibby et al. 1974, p.4:1). In “Ironies of Automation” from 1981, a study that extensively draws on Bibby et al., Lisanne Bainbridge highlights the paradox that the “automation of industrial processes” in fact increases the necessity of human operators: “the more advanced a control system is, [...] the more crucial may be the contribution of the human operator” (Bainbridge 1981, p.775). Here, Bainbridge touches on a key point of automation that is also crucial in automated trading, namely the feature of “automatic on-line control where a human operator is expected to take-over in abnormal conditions” (p.775). The operator is responsible for catching errors and dysfunctionalities, and has to spot the functional errors overlooked by the designer. To this extent, the system in fact relies heavily on the operator to identify mistakes or bugs accidentally or unintentionally implemented by the system's designers, or to manually perform those tasks that the designers did not manage to automate. This process becomes more challenging the more complex the system becomes.

The more complex a system becomes, the more it depends on human involvement and, consequently, needs to integrate them to a higher degree. In order to intervene, the operator needs to have a very clear understanding of the functions of the system. Note however, that this ‘clear understanding’ is a specific understanding of the functions of the system. Such knowledge about functions is not the same as knowledge about codes and algorithms. Given the division of labor in HFT firms, the trader in front of the screen might have little knowledge about the *text* of the algorithm but he needs to know what *behavior* to expect from it. This needs to be joined to knowledge of the market environment. Instead of making certain processes truly independent of human influences and interventions, automation turns out to be an *intensification of human and machine relations*. As we will see, such relations are not strictly functional, conveying information, messages and commands. Rather, such communication relies on *non-informational communication* that involves human actors with all of his/her bodily senses.

Narratives on Emotions in Automated Trading

In the fieldwork I have undertaken and in popular discourses on HFT trading⁶, I have repeatedly encountered a predominant narrative to justify automation: automated trading can exclude or minimize incorrect decisions that stems from irrational and emotional human actions. Such human fault and inconsistency not only leads to a loss of profits, but also potentially to market crises. With automation, trading is ‘liberated’ from the erratic nature of human behavior and efficiency is improved. This argument is based on the assumption that unlike humans, computers are neither emotional, nor act irrationally. This is a very common opinion amongst algorithmic trading practitioners. For instance, the Kyte Group, a supplier of algorithmic trading systems, advertises its products in the following way: “Algorithmic trading eliminates the emotion that can commonly occur in trading.” Rishi Narang, co-founder of the HFT firm *TradeWorx*, summarizes the same point in his book *Inside the Black Box*: “In essence, decisions driven by emotion, indiscipline, passion, greed, and fear - what many consider the key pratfalls of playing the market - are eliminated from the quant’s investment process.” (Narang 2013, p.xv). One of the German High Frequency Traders I interviewed explicitly states that the attempt to overcome irrational and affective human behavior was his intrinsic motivation for developing an automated trading system. His decision to turn to automated trading dates back to the 1990s, when the irrational “euphoria” over what were then new technologies, the

development of computer networks and the Internet, and the rise of related products and services, led to a stock market bubble⁷:

as somebody with a quantitative-based education this euphoria [over new technologies] seemed to be very questionable to me. I simply thought there have got to be other methods, that it should be possible to come to trading decisions more systematically, based on mathematical models. (Anonymous High Frequency Trader ‘B’, translated from German by the author)

Such statements express the common belief that in order to trade successfully, correctly, and thus, efficiently, not only feelings of euphoria, but in fact all kinds of affective phenomena must be suppressed. Thus, the attempts to neutralize affects are directly linked to the idea of the maximization of profits, and to the minimization of stock market panics and other similar crisis phenomena.

In this narrative, it is quite clear that the eradication of affects in automated trading requires the exclusion of human agents, since emotions clearly stem from these human agents. It is based on a strong belief that links emotions strictly to humans and sees in machines an absence of affects. It presupposes an ontological difference—an unbridgeable gap—between emotional humans and affect-neutral machines.

In such an approach, we would expect to see the role of humans on screens to diminish with fully automated trading. The machine as automata, the algorithmic code as its operating instructions: the trading system left to its own devices, with minimal intervention from human traders. Humans—and their unreliable emotions and affective drives—are ‘eased off’ the system.

My initial descriptions above suggest that in fact ‘affective easing-off’ does not happen. Traders in fact look at even *more* screens and windows, and the requirement for their presence has in fact intensified in different ways, as the following sections will make clear

Affect Analysis: “*Getting a feel for your system*”

In her analysis, Bainbridge also gives us an initial, if vague, hint about the relation of humans and their machines: “Manual operators may come into the control room quarter to half an hour before they are due to take over control, so they *can get this feel* for what the process is doing” (Bainbridge 1981, p.776 [italics mine]). What is important in this process of ‘getting a feel’ for the system is that it exceeds traditional notions of how humans and machines interact e.g. by

cognition and symbolic communication (through keyboards, touch-screens, etc.). ‘Getting a feel’ is not simply the cognitive and intellectual process of assessing the state of the system, its condition, performance and possible issues. Rather, ‘getting a feel’ is a liminal process that marks the transition from the form of subjectivity with which the person enters the room to the immersion (and dissolution) of the subject within the socio-technical ensemble. ‘Getting a feel’ is the transgression of the subject that is necessary to immerse oneself within this ensemble. What Bainbridge describes here, perhaps unknowingly, is a process of mutual attunement of humans and their machines, a process that is inherently based on affective relations. In this context, affective relations refers to social relations that are not reducible to symbolic or semantic forms of communication (Massumi 1995, p.87). They might include all types of sensory transmissions (sound, smell, electric circuitry); they are multi-frequential. That also means that affective relations do not solely function as channels for the transmission of information. *Getting a feel* for something is a non-informational relation. In fact, affects sometimes simply designate the way bodies are attracted to each other, or repulsed by each other. Thus, before communication takes place, affective relationships might have to be established.

As I have mentioned above, I will apply an affect analysis, to account for such affective processes. For this reason, it will be necessary to deploy an abstract conception of affect, one that does not reduce affectivity either to the decontextualized drives or to human emotions, one that emphasizes the relational context of affect.

Recently, attempts have been made to analyze the affective relations of humans and non-human actors, including machines (e.g. Latour 2004, 2005; Despret 2004; Seyfert 2012). Recently, we have developed an “affect analysis” to “elucidate the myriad ways in which nonhuman others participate in the creation and maintenance of human sociability” (Kwek, Seyfert, forthcoming). Affect analysis is essentially a neo-Spinozist attempt to conceptualize interactions as *generalized encounters of bodies* and the mutual effects they instill into each other (Deleuze, Guattari 2005). Many of its authors are inspired by the Spinozist questions: Who is affecting whom, and how does that change them? What are the types of attraction and repulsion? What relations and interactions are present? (Kwek 2015). It is important to note that, even though they do include passions, emotions and desires, affects are not identical to them (Bohrer 1984). On the most abstract level, affects designate relations between (human and non-human) bodies and the way these heterogeneous elements are held together. An affect theory assumes that “dynamic relations are taken to be ontologically prior to the entities related” (Slaby, 2016, p.4). This also means that the coherence within this assemblage is prior to the

coherence of the individual. This does not aim at introducing a structural element within affect theories but it does “[suggest] that fluctuations in affect towards select ideas, objects, or acts remain within a specific spectrum” (von Scheve 2017, p.17). In contrast to affects as abstract relations, emotions and feelings are sub-forms of affects. They require a somewhat-stable form of the self, a body with a normative classification in which affects have fixed meanings. Emotions are part of subjectivity, they are the defining characteristics of subjectivity. In that sense, emotions are normative and they receive their normativity from the classificatory system of the subject. For instance, for common subjectivity pain is something negative, while joy is something positive. Thus, emotions and feelings are extensive affects (Seyfert 2015) or, to use Foucauldian terminology they are *affects of the self*.

In turn, “intensive affects” are moments of transgression that always threaten such fixed meanings, where pain can become enjoyable, pleasure affixed to melancholy, etc. Intensive affects are transitive insofar as they make it possible to move from one type of subjectivity to another. In fact, affects can counter emotions, in which case the subjectivity of an individual starts to dissolve. Very often, affects are also forces that threaten the integrity of subject. Thus, intensive affects are de-subjectifying. In other words, such affective forces within such an “affect regime” are stronger than the emotional configuration of the individual subject. In that context, Massumi argues that children sometimes perceive something frightening as positive, while their parents associate the same fright only with something negative. For Massumi, the positivity lies in the *intensity* of the fright (Massumi 1995, pp.87-88). While fright itself might be negatively connoted, the intensity it produces can be in itself attractive and fascinating. A fully integrated subject (a heuristic construct) might perceive intensive fright as a purely negative affect precisely because it threatens the very existence of its subjectivity. However, the disintegration of its subjectivity can be pleasant for the individual. The attraction to such intensity has nothing to do with Freud’s death drive. It is not the joy about a disintegrating subjectivity but the joy about the new relations that emerge after this disintegration. While affects can be de-subjectifying, they also always indicate the creation of novel social relations into which the individual enters.

In other words, in moments of intensity the social relations to other bodies are more attractive than subjective relations to the body itself. De-subjectification and transgressions are the necessary requirements to get attracted to other bodies.

The entirety of affective relations within a specific assemblage, between humans and non-humans, is what I have called an *affectif* (Seyfert 2012). In socio-technical systems, this affectif

not only includes relations among humans but also among humans and non-human actors such as algorithms, and it also includes a wider variety of relations, e.g. visual, acoustical, bodily, electronic relations etc. Thus, an affect analysis needs to disentangle the affective relations and elements within a given *affective arrangement* (Slaby, Mühlhoff & Wüschner 2016; Mühlhoff, Slaby, this volume).

The following section will apply affect analysis to automated trading systems. I will demonstrate the specificity of such systems by briefly comparing them with previous forms of market technologies and their characteristic affectifs. In other words, I argue that there is a historical genealogy, not only of technological forms or systems, but also of the affective relations specific to each technology. The first is related to the invention of the stock market ticker and the dominating affective relation of *attraction* created between human and machine. Next, I will focus on screen-based manual trading, which is constituted by a *synthetic relationship* between the technological object of the screen and the human trader. Finally, I will return to focus on the field of automated trading, and suggest that the dominating affective relations are *symbiotic* ones.

Such a historical genealogy also shows that automation was never a question of excluding humans, but of involving or immersing them in a different way, through different configurations of affect.

1867 – The attractions of market devices

An illustration of how devices and humans integrate on an affective level can be found with the invention of the stock market ticker in 1867.

Urs Stäheli shows how this medium of transmission itself becomes the center of attraction: “The individual developed a strong attraction to the ticker, to the extent that escaping this medium was no longer possible” (Stäheli 2013, p. 217). The attractiveness to this ‘tool’ was so high that its functional value took a back seat. It was related to a variety of affective relations, e.g. to its “endless clattering”, the “endless strips of tape” and its “staging” of the ticker under a glass case (pp.214-217). Traders new to this technology developed an almost pathological fascination with this device. They could not take their eyes off the new technology and became increasingly distracted from their actual tasks, that is, to use the incoming information to trade. The individual trader felt an irrational urge, was drawn to the object. They developed a “fever of the ticker” – a phenomenon that described the tendency of people to get lost in the ticker. Thus, this behavior was seen as a pathological phenomenon. It produced “*hypnotic effects*” that

dissolved the boundaries of subject: “The noise of the ticker only came to an end when the ticker suddenly paused. At this point, the market came to a standstill and the subject emerged from the hypnosis induced by the ticker” (p.218).

The force or pull of the device, its ‘attraction’, is clearly a moment of intensity. The subject immerses itself, and thus dissolves within human-ticker-affectif. It re-emerges once the ticker stops. What Stäheli’s analysis shows us is that this immersion takes place on an affective level and involves processes of de-subjectification and transgression. In feverish activities, we are not quite ourselves anymore simply because we have become immersed within an assemblage previously external to our ‘self’. This process of immersion is a process of de-subjectification that exceeds the level of the subject and of the emotional self.

1969 - Synthetic situations in manual screen based trading

The next step in market technologies was the development of screen-based manual trading, marked by the launch of the first electronic trading platform (Instinet) in 1969. As Karin Knorr Cetina has argued, screen-based traders do not operate with a picture of imagined ‘people behind’ the screens, other human actors for whom the screen merely serves as a medium (as suggested by approaches such as Affective Computing [Picard 2000, 2003]). The slick skin of the screen *is* none other than (the composition of) the market itself (Knorr Cetina, Bruegger 2000, 2002a). Instead of imagining a market behind the visualizations on the screen, the trader immerses her-/himself into the market on the screen; it is an immersion in a visual surface. Knorr Cetina conceptualizes this immersion as a *synthetic situation*. In *synthetic situations*, the use of technologies such as screens increase the depth of information and the responsiveness required of those who use the technology. Synthetic situations show how human actors affect and become affected by their artificial environment. Such situations demand “total immersion”: “On the level of individual traders, response presence also entails more than continuous monitoring: it entails a mode of affectivity that we can circumscribe as intensity” (Knorr Cetina 2009, p.74). The use of technology such as screens intensifies human involvement: “Figuratively speaking, traders strap themselves to their seats in the morning; they bring up their screens, to which their eyes will be glued from then on, their gaze captured even when they talk to or shout at each other” (p.64). This “total immersion” and the emergence of a socio-artificial assemblage from the merging of mesmerized traders in front of the screen with the unfolding of events on the screen are ‘intensive’ processes precisely because they involve transgression and de-subjectification.

However, as we will see below, this “total immersion” is in fact a partial immersion since it is exclusively visual and does not involve sounds, haptic sensations etc.

After these two examples (ticker and screen) from a pre-automated area of trading, I would like to move to the affective relations in automated trading.

1989 - Intensified involvement of human actors in automated trading

As Donald Mackenzie has recently shown, the beginning of automated trading can be traced back to the launch of a company called *Automated Trading Desk* in 1989 (MacKenzie 2017, p. 173.) At first glance, to argue for an affective cohesion in automated trading systems might seem counter-intuitive if not downright wrong, mainly for two reasons. If previous ethnographic studies could still point to the role of emotions on the trading floor (Hassoun 2005; Ho 2009), or the obsessive emotional engagement with the market on the screen (Knorr Cetina, Bruegger 2002b; Zaloom 2006a), then the turn to automated trading not only seems to have eradicated the human interactions on the floor but also their mutual emotional entrainment. Second, the main motive for including artificial agents into trading, the reason to automate trading, was precisely to eradicate (human) emotions and affects in trading.

However, ethnographic observations in various algorithmic trading firms show a different picture. The ethnographer is confronted with a disconnect between certain narratives and practices. While these discourses commonly assume the exclusion of humans, what we are seeing in practice is that even in cases of fully automated trading systems, human actors are very rarely excluded and the limits of automation are often acknowledged.

These limits of automation were in fact confirmed in some of my interviews, and as Bibby et al. and Bainbridge (1975) have noted, cost and complexity were important considerations. For instance, often traders point out that the closer a process approximates full automation, it becomes exponentially complex and expensive and thus perhaps defies the purpose behind automation itself:

models are especially very useful and handy for let's say the 95 % standard stuff.
And for the rest that you cannot model or that is very difficult to model ... are
[you] going to spend 80% of your time to develop the last one percent?
(Anonymous High Frequency Trader, ‘A’)

Another aspect that was frequently mentioned in the interviews refers to the fact that the operator has to intervene when things happen that were not included in the design.

At a certain level I think you need to automatize as much as possible. [...] The problem with having everything automatized is that you're going miss out on the 'black swan'. And that is the one that is going to kill you, if you are not fast enough to adapt to that. [...] But at the same time these are also the times that there are a lot of opportunities. So you want to be actually in the market in these kind of times, because the spreads are different, nobody knows what to do, the volatility is all over the place, people don't know, they panic. So there is a lot of exaggerations in the market, that is when you want to get out there. (Anonymous High Frequency Trader, 'A')

Such interventions do not just refer to the compensation for the unexpected but also for the taking advantage of opportunities.

Occasionally, he [the trader operating at the trading system] might take advantage of opportunities that arise in the market manually because the system does not absorb as much volume as the market provides (Anonymous High Frequency Trader 'C', translated from German by me).

Consequently, the linkage between humans and machines is deepened and *intensified*. The involvement of humans is by no means a process of easing but an intensification of *affective attention* and *affective involvement*.

Emotional labor and management

The intensification of *affective attention* and *affective involvement* has also been understood as emotional management both by practitioners and in scholarly analyses of HFT (Borch, Lange 2016). Algorithmic trading, especially in the case of High-Frequency Trading, requires "constant human supervision" (Aldridge 2013, p.130). Supervising and maintaining an algorithmic trading system costs emotional energy and is psychologically draining. It is far from the common representation of a human calmly observing calculations on the screen. As HFT trader Michael Halls-More has put it: "There is no sipping Martinis really" (Overton 2013).

The psychological drainage occurs on various sites of the trading system. Traders need to trust the trading system, which might also mean to watch and accept losses during longer periods. For instance, the trading strategy can be set to bet on larger profit margins during rare market

events, while accumulating small losses in normal times. The bigger profits are meant to easily offset the accumulated losses. In that case, the human actor is mostly looking at a losing strategy:

“Trading is extremely stressful even if it's the machine itself that's doing the trading. In fact [...] losing trade is twice as psychologically draining as the equivalent winning trade is psychologically reinforcing, which basically means that you're generally going to be operating at a psychological deficit at the end of every work day” (Roberts 2010).

Psychological drainage is not limited to watching actual trading processes but also to the development of code. Even though a quantitative researcher or financial engineer might not directly watch the trading process, he will still measure and worry about the performance (e.g., in post trade analysis). He will still be affectively attached to the trading system.

“You are always worried about what you don't know you have included in your model. Anyone who trusts their model implicitly is properly not really thinking from a fully quantitative mindset in that regard because by definition we call it model, it is not reality. So there is gonna be things that it missed, obviously, it is only a proxy. There is always things you don't know you don't know [...] you are constantly researching your models and you are very aware of their performance all the time, continuously measuring their performance. You understand that there are drawdown periods, you live through them ... it's never fun [...]”. (Halls-Moore, in Overton 2013, italics mine).

In cases of psychological drainage, the shape the affective attachment takes is constant worry and anxiety, and these are seen as emotional behaviors that need to be kept under control. Thus Borch and Lange (2016) mainly look at affective relations from the perspective of emotional management, as (the emotion of) anxiety and the need to control such behavior. The other side of this anxiety is the production of trust and the resistance to the urge of intervention: the “ideal trading subjectivity that emerges here is concerned with retaining the detachment to markets produced by algorithms.” (Borch,Lange 2016, p.14-15).

But emotional management is not the only affective phenomena associated with algorithmic trading. In addition to the managed emotion of the high frequency trading subject, there are however other types of affective relations within the ecology of an HFT, affective relations that have to do with the attachment to the markets produced by algorithms. In this context, the affective relations refer to the integration of a socio-technical assemblage, which requires de-subjectifications from previous contexts. In HFT, the trader needs to leave the narrative of the

detached individual and immerse himself into this assemblage. Such detachment is very often not a conscious decision. It also does not exist in the discourse of HFT, the ‘how to’ books and manuals. In fact, such detachment even contradicts the discourse on the emotional management of the trader subject. There is a clear disconnect between the discourse on automated trading and its actual practices. I will use the terms affective attention and affective involvement in order to describe the way human actors immerse themselves with the trading systems.

Intensified relations

The work of Karin Knorr Cetina and Ur Bruegger on foreign exchange markets in the early 21st century is also a study of a historical transformation of social relations. In what Knorr Cetina has called post-social relations face-to-face interactions are increasingly replaced by face-to-screen relations (Knorr Cetina 2009, p.64). It is safe to say that the amount of face-to-screen interactions – also called “scopic” relations (Knorr Cetina, Preda 2007, p.126) – have only increased ever since.

However, and this is a central argument of this paper, other forms of face-to-*non*-face interactions, forms beyond the visual, have been added to such scopic relations. Such relations exceed the realm of the visual, while engaging the body through multi-frequential bonds. Consequentially such all-encompassing engagement is different from the *attraction to* the ticker and the *synthesis of* humans and screens. Rather, these multi-frequential bonds define intensive relations between humans and machines. In order to designate this degree of intensity I am differentiating the synthetic situation in manual trading from the *symbiotic relations* in automated trading.

There are fundamental transformations in the transition from manual and screen-based to automated trading. On the one hand, the appresentation on the screen that Knorr Cetina and Bruegger identified as *the market* are now based on operations of algorithms. These operations still appear on screens but they are accessed and visualized through algorithms in electronic stock market exchanges that use *order matching engines* to algorithmically match buy and sell orders. The algorithmization of the market involves several different *techniques*, and takes place across different *sites*. For an individual trader the operation of a matching engine, visualized on his screens, *is* the market. In the firm, the algorithmic construction of the market takes place in the way traders access the markets. Algorithms articulate the bids and offers provided through the data feeds of electronic exchanges are channeled through algorithms; this algorithmic construction is known as an *order book*. Thus, market access is constructed as an

algorithm, in the order book. For a trader, the most crucial aspects are not related to the intentions of other, competing, traders, but to what happens in the order book.

However, this algorithmization of the market is not simply a process of mediation. Even though algorithms mediate between traders, exchanges and other trading algorithms, they are more than that. They are structural *and* agential elements of an algorithmic trading firm. This is why it is a *symbiotic* relation, not merely an instrumental one. Algorithms are more than mediators because they contribute to the agency of the trading system. This becomes particularly obvious in negative cases, when traders lose control over their algorithmic symbionts, e.g. in algorithmic crashes. One of the most famous example is the demise of Knight Capital, an algorithmic trading firm that assumed severe losses because its technicians accidentally put untested algorithms into operation (SEC 2013). Algorithms and actors are bound to one another, and affective relations constitute their bond. These bonds become all the more intensive. In my fieldwork, I have identified a variety of affective frequency that exceeds the classic symbolic, semantic and cognitive realm. In the following, I will focus on how automated trading adds qualitatively different affective relations (visual and acoustical)

Affective Relations on the visual level

The cover of Karin Knorr Cetina's and Alex Preda's *Handbook in The Sociology of Financial Markets* (2005) provides a particularly expressive illustration of the transformations involved in the move from manual to automated trading. This volume is illustrated by a manual trader looking at six screens arranged on a single vertical plane. By contrast, automated trading settings very often require far more complex arrangements. In addition to the simple quantitative increase in number of windows and screens, the intensified connectivity is sometimes accomplished architecturally, by curving these monitors around the human body. The architectural configurations of the technical devices in the HFT firms I studied are proprietary; for that reason, I cannot discuss them in detail. Nonetheless this prohibition itself is enough to demonstrate that what may be seen as an apparently marginal and merely 'decorative' or aesthetic factor in the arrangement of technical equipment is in fact crucial to the basic functioning of HFT. These screens and their windows contain different sorts of information, ranging from market movements, information about trades, profits and losses, internal emails, dialog computer logs containing information about network connectivity, to news tickers, RSS feeds, Twitter comments, news on Bloomberg etc. The sheer number of screens and the fact that each screen can contain multiple windows requires a certain *regime of*

visual attention. This regime guarantees that the trader's eyes follow a certain movement while going over his various monitors and windows. Such visual regime of attention creates a channels of attention, an affective relation, through which human traders are integrated into the system.

Affective relations as acoustic entanglements

In addition to the visual – ‘scopic’ – connection, many automated traders also operate with acoustic entanglement. In certain companies, there exists a whole array of coded soundscapes⁸.

Different historical market eras have different soundscapes. Aside from the ticker, the most important soundscape used to be the trading floor. As the term *open outcry pit trading* vividly describes, acoustic transmission was the central method of communication on the trading floor. However, the acoustic atmosphere was by no means simply the result of an intense transmission of information. Its significance is clear in what happened in the transition from the crowded floor to the lonely screen. The transition from the floor to the screen has been defined by the nostalgia, or perhaps the habits, of former floor traders, who have moved on to electronic trading but who miss the noises from the trading floor. In the early days of automated trading, traders would try to simulate the acoustic atmosphere of the actual trading pit. Software applications such as MarketSounds, Patsystems or VirtualPit “generated a realistic mix of background noises” including “sounds of people shuffling around, talking and, occasionally, yelling in the background” (Lucchetti 2006). Instead of transmitting actual information, the acoustics help the trader to immerse him- or herself in the market, in order to amplify his/her affective involvement: they might help a former floor trader adjust to the activities of the markets, to create an atmosphere where they can thrive and be inspired.

Such affective attachment through noise is different from the sophisticated *aural regime*, occasionally applied in HFT. The soundscapes and signal noises used by algorithmic trading firms have an instrumental purpose. Applications such Trading Technologies are not so much about creating the atmosphere of the pit but rather about adding another layer of depth to market information and by helping the trader to establish a more intense relationship to the automated trading system. In addition, they provide a certain amount of information because the level of intensity also contains hints about the movement of prices – the up and down of the acoustic volume corresponds with the development of prices.

These sounds are a general way of keeping the trader informed about what is going on, the trades, profits and losses, and what strategies the computer pulls. Most automated trading

systems consist of hundreds of trading algorithms. They are programmed to use different strategies in various market situations, and the trader is informed about each of these strategies by a combination of an assigned sound and by the information on the screen. In addition, these sounds contain error warnings. Sounds also help direct the attention of the trader to important events. Thus, the soundscape is connected to visual attention management. While a trader might follow the visual regime described above – consecutively checking a series of windows on screens – these sounds redirect his glance in case something important happens on another screen, something that calls for more immediate attention. Thus, signals might interrupt the visual order of attention, redirecting it if something important happens on a screen that the glance has just passed. These soundscapes are thus cognitive and affective complications on an acoustic level. They provide one frequency of the affective bonds that keep the trader engaged in the market.

In one case, when I entered the trading room, I was hit by a cacophony of completely unrelated noises such as steam boats, bull horns, car horns, etc. For instance, the sound of a door bell might indicate a small trade whereas a large trade is signaled by the sound of a steam engine, and a bold siren signals a submitted order that was immediately canceled and so on. The assignation of meaning to individual sounds is unique to each trading company, though the sounds are mostly assembled from commonly available software applications. In one case the head of trade told me they used to have different sounds that included mostly animal voices but his traders complained they felt like they were in a zoo. Therefore, the firm decided to change the composition of tones to a more industrial setting.

Sounds are not merely alerts. Sounds also function as an integrational mechanism on the organizational level to include those who are part of the firm but not directly connected to the screen, for instance superiors such as the head of trade. They transmit to everybody on the trading desk the general status of the firm's activities, just as previous soundscapes did for the trading floor. They allow all human actors and actants to 'get a feel' for their affectif. In algorithmic trading, sounds might alert colleagues and superiors to different events in the market, but they also inform others about the size of an order or the initiation of a particular trading strategy. They give everybody on the trading desk a general idea of the market and the firm's current market activities. In one firm, the head of trade was not directly immersed in the markets *via* screens but was connected to the market activities of the firm mainly through the soundscape of the companies trading systems that he could hear in his office, which was adjacent to the trading desk. The first day of our interview happened to be a slow market day and he pointed this out to me by referring to the low acoustic signals in the background. During

a later interview, an algorithm sold about 1500 lots and signaled this activity through its designated sound. The head of trade, informed through the sound, jumped up and immediately left his office and entered the trading desk in order to double check the trading activities with the person sitting in front of the screen.

Such soundscapes do not merely intensify the visual connections to the markets through screens. They do not create a synthetic situation, because sounds function as affective connectors for all elements – human and non-human– of an automated trading system.

As the ethnographic description has shown, automated (HFT) trading depends on human-machine relations that exceed the operation of scopic media and the management of emotions. It relies and depends on multi-frequential affective bonds that relate human actors to their algorithmic systems. In our case, this involved visual and aural regimes).⁹ In fact, the linkage of humans and non-humans becomes so intense that their relation becomes *symbiotic*. As compared to the synthetic situation of screen-based manual trading, automated trading radically increases what Dorothy H.B. Kwek has called the affective *receptivity* (Kwek 2015, p.8) of *both* humans and machines. There is an increase of mutual training and a gymnastics of attention (Weil 2002, p.120) and affectability (Guyau 1884, p.10).

Conclusion

In this article, I have analyzed automated trading systems. Usually, they are understood to apply systematic trading techniques that exclude humans from the allocation of information, decision-making and execution of trades. In this notion, trading algorithms are autonomous purification techniques that clear financial markets of irrational and affective elements. I have shown that this is far from being the case. Instead of an exclusion of humans and affects, such systems intensify human and non-human relations. In order to produce the internal cohesion of an automated trading system, intensive relations between humans and non-humans are necessary. These relations are not limited to semantic and symbolic communication (of information). They require a complex arrangement of intensive affective relations (affectif) that exceed the management of emotions. While management of emotions depends on the disciplining of the subject, automated trading requires de-subjectifying affects of transgression. Automated trading also includes new affective relations on the visual and acoustic level. In a heuristic comparison with previous affective relations, such as *attraction* (to the ticker) and *syntheses* (with scopic media), the affective relations within automated trading systems are best described as *symbiosis*.

Finally, the findings of this study are by no means limited to Finance or automated trading. Rather, they might be a characteristic of algorithmic cultures in general (Amoore, Volha 2015; Roberge, Seyfert 2016).

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² For a more detailed description of my fieldwork, see also Seyfert 2016.

³ For more detailed studies, I recommend MacKenzie 2011, 2014, 2015; MacKenzie, Beunza, Millo & Pardo-Guerra 2012; Borch, Hansen & Lange 2015; Arnoldi 2016; Borch, Lange 2016; Lange 2016; Lange, Lenglet & Seyfert 2016; Seyfert 2016.

⁴ My fieldwork did not start before 2012. It is possible that more fully automated trading systems were successful prior 2009, after which the benefits of early innovation seemed to ebb off and after which automated trading practices required more sophisticated and complex systems.

⁵ I am using male pronouns because all traders I have talked to were in fact male.

⁶ The empirical fieldwork took place from 2014-2016, during which I have visited 25 companies and talked to about 50 people in Europe, North America and Asia. Most interviewees were working in Algorithmic High-Frequency Trading firms. These firms usually employ between five to a hundred people. These midsize-companies are characterized by a particular culture, which is characterized by proprietary trading, meaning they are trading their own money. Within such firms, I have interviewed various types of employees, ranging from quantitative researchers, financial engineers, traders that operate the trading desk and experts from IT departments. For further details and a more technical analysis of the operations in High-Frequency Trading, see also Seyfert 2016.

⁷ The *New Market* was a trading segment of the Deutsche Börse from 1997 until 2004 that was created, similarly to NASDAQ, for the trading of so called new technologies.

⁸ For an analysis of soundscapes on the trading floor, see Zaloom 2006b.

⁹ For an affect analysis of corporeal-pharmacopic regimes in algorithmic finance, see Seyfert forthcoming.