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Chapter 2

Intelligence behind Movement: Laboratories of Biomechanics and the Making of Movement Utopia

Nicolás Salazar Sutil

> *Movement is reality… because movement is life. But life has as its main element labour; consequently, the main element of reality is labor and the truest sign of reality is activity.*
>
> Nikolai Chernyshevsky, "What is to be Done (1989 [1863], p.181)

How human motion was engineered in the early 20th century through State-sponsored laboratories of industrial work movement is the topic of this essay. In this context, we find the emergence of an industrial modernity defined by how well (i.e. how productively) people move in the workplace, particularly in terms of the ergonomic and physiological means of achieving maximum performance with minimum effort. The subject of this essay is the making of a Soviet economic utopia during the 1920s in the course of which the Bolshevik State championed the engineering of a society of good movement (what I call "movement utopia"), particularly in terms of the normalisation of everyday movement according to factory work training. Is it too much to assume that this history of the modernisation of human movement (which is incidentally paralleled in the United States) should be looked at as a direct antecedent of Soviet (and American) cybernetic research, from where a historical sense of digital movement stems?

The point of this historical investigation, at least in the context of this collection, is to identify how people's intimate lives can be designed and engineered through everyday movement, and how movement constitutes a prime technique for the construction and control of selfhood outside the sphere of discursive ideology. What is true of Soviet Russia is also true of high-tech capitalist forms of production— movement offered Soviet social engineers what it has to offer technology firms or product designers and engineers in a capitalist context: a means of penetrating people's lives at the corporeal or sensory level and constructing identities from within— and not by means of ideology alone (i.e. through an imposed system of ideas and ideals). There is also a kind of "motorology" at work here, an imposed system of gestures, moves and motor functions that define how we interact with other humans and machines, and how our bodily and psychic selves are normalised at an embodied and kinesthetic deep-level. Digital movement, as we will see presently, is yet

another historical guise of a process that has been defining modernity through an alignment of technologized economic production with a reengineered human motor. Over the course of this history, human movement has been persistently transformed to function in co-operation with the machine motor. In a digital capitalist context, the upshot of this motorology is the commoditisation and fetishisation of everyday movement performance. Kinetic identities, and by extension our own psychic selfhoods, can be defined by the moves, gestures, and locomotional habits that are corrected and normalised by our increasingly technologized lives, in the context of which the operability and performativity of digital technology has become entangled with the issuance of prescriptive physical movements. If some movements can be considered to be "good" for machine interaction and device operability, and more broadly, if some movements are deemed good as far as work and productivity are concerned, it is because the value of the moving body resides in its biological capacity to generate an economy *of* movements, and an economy *through* movement— what I call "kineconomy."

Intelligence behind movement

My argument is that whereas behind physical movement lays a motor intelligence, behind intelligence there is an intelligentsia. Put otherwise, human movement is programmed by the central nervous system and brain, which I see as an analogy of the way the central organs of the Bolshevik State could program the everyday movement and rhythms of Soviet life. In the contemporary context, the engineering of a digital kineconomy has been redefined by mobile, network, sensor and haptic systems that rely on a controlling intelligence (as well as corporate intelligentsia) capable of normalising and de-differentiating the way we move through a world of ubiquitous data representation and enactment. One of the reasons why the Soviet experiment is so significant as a historical antecedent, is because it represents the first overt political and cultural attempt to study human movement as a form of intelligence— quite distinct to the automatic and unintelligent actions of reflex system research prevalent in pre-Revolutionary Russia and advanced by Ivan Pavlov's work in involuntary motor activity. The Soviet experiment of the 1920s sought to connect the science and scientific management behind programmed intelligence and voluntary movement to a political programme and a motorology that would help engineer human conduct, habit, identity and political selfhood through corrected movement and socio-politically determined motor control.

Three key issues will make up the overall framework of this investigation. First, I will explore the notion of the laboratory of movement in the Soviet Taylorist context, where the

design and engineering of the utopian man-machine was tested and developed. My case study is the Moscow-based Central Institute of Labour (*Tsentralnyi Institut Truda*, variously abbreviated in English as TsIT or CIT). Second, I will turn my attention to the role played by motion technology in CIT's research agenda. I will argue that the scientific study of movement was grounded on the development of a new motion capture apparatus capable of observing, recording and breaking down motor actions to fine-grained detail. Technology also laid the foundations for mathematical and computational methods for the description of live motion, which provide the basis of a contemporary method for the formal representation and enactment of digital movement. Third, I will argue that the application of scientifically and technologically enhanced movement at CIT was promoted not only for high-performance at the factory workshop, but also for a utopian artistic vision that was staged by the Projectionist Theatre resident at CIT, and which was led by Ukrainian vanguardist Solomon Nikritin. My case study then supports the historical emergence of a new culture of kinesis, defined by the integration of industrial, technological and sci-artistic knowledge to transform everyday movement. Finally, as we learn to move electronically and as we begin to define what it means to move digitally, a look back at the biomechanical history of corporeal movement must provoke a critical intervention and a caveat: the utopia of technologized movement in its contemporary historical context is fraught with many problems and shortcomings. The promise of a new culture of technologized living, and the utopian discourse digital technologies can afford, hinge upon the condition of inherent blindness of those who create new technology, and many of those who use it.

Soviet visions of future movement

In his book *The Human Motor*: *Energy, Fatigue and the Origins of Modernity*, Anson Rabinbach (1990) wrote that a unique vision of modernity emerged in industrial Europe that saw the working body as an exemplar of a universal process by means of which energy is converted into mechanical work. The shift from universal mechanics to the language of *Kraft* or mechanical labor required the elimination of the spiritual understanding of labor preserved in agrarian society, in lieu of a work ethic determined by abstract and quantitative relations. The argument tags along Georg Simmel's (1902) famous critique of the quantitative logic of industrial capitalism, which interrogates the function of numeration and quantification as sociological phenomena, particularly in terms of the growth of the technologized metropolis and the collateral effect of metropolitanism on the mental life. If we consider a strictly

Simmelian view here, and inasmuch as group integration is hindered in large cities by the unavoidable differentiation of persons within it, a very large number of people can constitute a unity only with decisive division of labor, and not merely on the obvious grounds of economic technique suggested by Marx. Simmel argued that work had to be divided also at a more practical level. Thus one could argue, drawing on Simmel, that division of labor also involves the breakdown of *physical work* into component units, for instance through the identification of key actions and motions that make up an optimal way of achieving mechanical work, and which can be formally prescribed through training and physical indoctrination to improve kineconomic performance.

The Soviet utopia of the 1920s is a good example of how the quantitative rationality described by Simmel could be developed into a political program of social engineering that would affect not only the mental life, but also the physical life of the new machine man. Having rejected Taylorism as an example of capitalist exploitation, Lenin was finally swayed by scientific management when he understood that the ultimate success of his Soviet Republic rested on the modernisation of Russian agrarian society— a radical transformation that would involve electrification, industrialisation, and the social re-engineering of Russian peasantry. Lenin understood that the problem was not so much the Americanisation of socialism, but the sudden and massive juxtaposition of two cultural frames—the village and the city. Richard Stites (1989) writes that the very language of peasants' gesture—"particularly the broad sweep of the arm (suggesting and no doubt derived from the wielding of the scythe)—seemed to reject the angular world of the industrial city" (163). Faced with the problem of an untrained and sluggish agrarian workforce, Lenin (1919) wrote that the Taylor System provided a number of most valuable scientific attainments in the analysis of mechanical motions during work, particularly in terms of "dismissing superfluous and useless motions, whilst determining the most correct methods of work, [and] the best systems of accounting and control" (25). It is clear that the ambition to engineer a modern eukinesis— i.e. a correct way of moving and gesturing— came from the very top of the Bolshevik intelligentsia, and not only from the Premier of the Soviet Republic. Leon Trotsky wrote:

> Man at last will begin to harmonize himself... He will make it his business to achieve beauty by giving the movement of his own limbs the utmost precision, purposefulness, and economy of his work, his walk, and his play. He will try to master first the semiconscious and then the conscious processes in his own organism, such as breathing, the circulation of the blood, digestion, reproduction… and he will

> try to subordinate them to the control of reason and will. The human species, the coagulated *Homo sapiens*, will once more enter into a state of radical transformation, and, in his own hands, will become an object of artificial selection […] Communist man will become immeasurably stronger, wiser and subtler; his body will become more harmonized, his movements more rhythmic… (2005, p.206)

The language employed by Lenin and Trotsky is strikingly visionary and utopian. These political leaders were not just talking about movement, control and transformation in a purely ideological way. These are terms they wanted to apply to bodily training and somatic practices in order to conduct a sweeping reform of the Russian economy and Russian society at the deepest political and motorogical level: i.e. at the level of how the new Soviet citizen ought to move, and how that movement ought to be harmonised and trained at a household level so as to achieve maximum productivity through human-machine integration. One who fully embraced these exhortations was the well-known Proletcult poet and critic Alexei Kapitonovich Gastev. In 1919, Gastev published a manifesto entitled *Tendencies of Proletarian Culture*, where he spelled out an industrialist and scientific vision in which machines were seen as extensions of the human body. Gastev would gain his reputation as the "Russian Taylor," also becoming one of the biggest national sponsors of the state science (and art) of biomechanics. Integration of biomechanics and Soviet Taylorism would lead, according to Gastev, to the transformation of Soviet society "in all the everyday and public life of people, regulating consumption and rationing family economy, even the movement of pedestrians on the streets" (1921, unpaginated).

NOT at work

Back in the late 1910s and early 1920s, the most significant system for the industrialisation of workers' movement was scientific management, as proposed by Frederick W. Taylor, Henry Ford and Frank B. Gilbreth (in his time-motion studies). Although these methods had developed in an overtly capitalist context, Taylorism was adopted and rebranded in Soviet Russia, where it became known as Scientific Organisation of Labour (*Nauchnaya Organizatsiya Truda*, or NOT). In its Russian variation, scientific management evolved into a state-sponsored program for the training of factory workers following a method that would eliminate superfluous and disorganised movement at the factory workshop and assembly line.

Physical movements would have had to be corrected at the factory in order to be time-effective, following a one-best method approach.

"Mechanisation" wrote Gastev in 1919, "will impart to proletarian psychology a striking anonymity, favoring the classification of an individual proletarian unit as A, B, or C, or 325, 0.075, 0, and so on" (in Bailes 1977, p. 378). The idea that numeration and quantification had become determining factors in the construction of a modern social lifeworld, going back to Simmel, is hereby fulfilled at an embodied level. Taylor himself had commented that when scientific management was being tested at the Bethlehem Steel Factory in Pennsylvania, it was necessary to bring to a halt the random handling of individuals in lieu of a detailed system that involved the numeration of workers (2005, p. 63). In his classic study of Soviet Taylorism, Kendall Bailes (1977) pointed out that the technical process of growing uniformity through quantitative and metrological tools would permeate every aspect of the worker's existence: "even his intimate life, including his aesthetic, intellectual and sexual values" (378). Consequently, the new Soviet man would no longer move according to personal qualities or subjective kinetic identity, but according to a mechanized collectivism, in whose domain movement is "devoid of expression, of a soul, of lyricism, of emotion, and is measured not by a shout or a smile but by a pressure gauge or a speed gauge" (379). What drove this depersonalization of the individual, or rather, the "dividual"—to borrow the term from Deleuze (1992)— was the need to raise productivity through a technologization of the means of production and labour. This in turn led to the re-engineering of the human body so that mechanical labour could be aligned to and coordinated with machinic production, which is why the European science of biomechanics proved so useful. "The cog in the wheel" is a commonly used metaphor for the new Soviet man which, according to Slava Gerovitch (2007), testifies to the fact that the passive individual was subsumed under the collective. This expression implied the machinelike operation of the party and state apparatus controlling social life (137). The image sums up my idea of an intelligentsia behind an intelligence, and a system of political control behind the issuance of motor control.

Chronization

It is worth pointing out that in order to change the way people move, Gastev first had to change the organisation of a social sense of rhythm and time. Drawing directly on Taylor's time study methods and Gilbreth's time motion studies, Gastev claimed that it was necessary to develop a stopwatch-clicking mentality in Russia to understand rhythm and the physical

life as having outward manifestations in rationalised movement. Thus, the goal of the Soviet utopian enterprise according to Gastev ought to be the creation of a "plastic culture" that would harmonise the rhythm of the anatomical body and the machine. Where formerly workforce production was carried out in relation to an agrarian sense of temporality (seasonal time), or a religious sense of time (Church calendar), the Taylorist revolution in Russia also relied (like in the United States) on the objectification of time, or the "chronization" of social life. Thus, a time-ineffective labourer might yield one unit of production over a prescribed length of time. Synchronisation of work would lead to the production of three units in the same amount of time.[1] This principle of time organisation would be extended to everyday life, so that the body of the new Soviet man would now be forced to internalise the temporality of the city and the factory at a somatic level. Gastev wrote in his essay *Time* (1923), that subjective notions of time-keeping and time-motion would be eliminated, and that new methods for objective time-setting would be introduced instead.[2]

Gastev's vision was not free of controversy. Indeed, the émigré novelist and literary critic Yegveny Zamyatin put forward a scathing parody of Gastev's project in his science fiction classic *We* (1999 [1921]). The novel's narrator— referred to as D-503— depicts a future society governed by a totalitarian state that forces its citizens to walk in even ranks and in metrical step to the beat of a State march. Zamyatin imagined Gastev's dystopia as a total chronization of life, such that people would have to plan their daily activities on so-called "Table of Hours." Sleeping times, work times, sex hours, and even the number of bites performed during eating hours (fifty)— were all prescribed in Zamyatin's One State. Zamyatin wrote: "Like one body with a million hands, at one and the same second according to the Table, we lift the spoon to our lips. At one and the same second we leave for a stroll and go to the hall to do the Taylor exercises, and then to bed" (1993, p.13). Zamyatin added: "I watched the [workers] how they would bend over, straighten up, turn around, all in accordance with Taylor, smoothly and quickly, keeping in time, like the levers of a single immense machine… It was the sublimest, the most moving beauty, harmony, music…" (81). It is clear that Zamyatin was foreseeing how Trotsky's utopian vision might turn into a dystopian nightmare.

Gastev's institute for the machinization of man

In 1921 Gastev sought financial support from Lenin to create the Central Institute for the Scientific Organisation of Labour and the Mechanisation of Man (CIT). The principal aim of

this Moscow-based research hub was to train the new factory worker in the understanding of units of industrial motion: i.e. the stroke and the thrust, by developing regular work rhythm aimed at full motor automation. After practice in the tempo and sureness of the hammer and chisel stroke, Gastev wanted his cadets at CIT not only to be ambidextrous, but also to apply their knowledge of biomechanical movement to generate efficiency in all kinds of fitting and machine work. Gastev gave particular attention to the psychophysiological behaviour of workers, which explains why he created a labour clinic at CIT responsible for studying cardiovascular and respiratory rhythms. The clinic was also responsible for overseeing the study of fatigue, energy cost, quantity and quality of work movement performance, as well as reorganization of diet. Likewise, Gastev's institute also focused on how to design optimum housing conditions, clothing, transport and leisure activity to improve industrial movement performance. Indeed, over the coming years, and up until its closure by Stalin in 1938, CIT continued to develop a method known as "system (method) CIT," designed to standardize and streamline skilled workers based on determination of labour units, as well as segmentation and rationalisation of key movements performed by the factory worker. The method could be taught to training instructors, factory administrators, military personnel and labourers working across the major Soviet industries (i.e. textile, construction, engineering, coal mining, metallurgy, auto and transport). Having visited the institute in the early 1920s, Austrian journalist and cultural historian René Fülöp-Miller (1927) wrote that anyone entering the front door as a normal living man would issue from the back door— after passing through countless laboratories— a completely perfected machine. He added:

> On entering the building, you find here a number of investigators engaged in fixing the general maximum output capacity of the human organism, and there, in the psychological-technical laboratory, other people, who are trying to ascertain how much energy is used in every movement, and how this movement can be made in the most economical way. The balance of energy is fixed as exact as possible, and efforts are made carefully to ascertain the optimum periods both of work and rest. The exact psychological working cadence has already been discovered; the effects of various physiological and psychological stimuli are exactly studied, and all micro and macro-motisms are determined with utmost exactness. Precision in the investigation of the energy of the organism here celebrates rousing triumphs. (1927, p. 210)

The main scientific area of research developed at CIT involved the study of biomechanics. Gastev was inspired by the early modern pioneers in the field (especially Giovanni Alfonso Borelli), as well as the landmark laboratory studies carried out in the late 19th century by Étienne-Jules Marey in France and Wilhelm Braune in Germany, both of whom were well known at CIT.[3] The study of industrial biomechanics was coupled with an application of artistic systems for movement analysis such as those proposed by François Delsarte and Émile-Jacques Dalcroze, whose methods served as platforms for the development of an industrial approach to movement analysis at CIT. One example of this is found in the work of theatre critic and practitioner Ippolit Sokolov, who became closely associated with Gastev's institute. In an essay published in 1921, Sokolov spelt out the need to develop a system he called "Industrial Delsarte"[4] at the heart of which was the development of a Delsarte-inspired system known as "industrial gymnastics". But whereas Delsarte (1887) had popularised the idea that the body could produce harmonious movement through a trinitary system underpinned by a belief in the spiritual essence of movement (involving the Good, the True and the Beautiful), Sokolov embraced the notion of good movement in its laicised connotation, and so as to serve the interests of the Soviet intelligentsia. And even though Delsarte's system would gain huge popularity also within a spiritual trend in the European movement arts of the 1920s, for instance with the development of the Delsarte-inspired idea of "eukinetics" put forward by Rudolf Laban, industrial gymnastics evolved into an application of good movement to Taylor's "one best way" philosophy; i.e. maximisation of productivity in the minimum amount of time and with minimum effort. The approach championed by "system (method) CIT" can be described, in hindsight, as a kind of industrial eukinetic, whose effects would be drive kineconomic performance, and lead the utopian transformation of agrarian Russia into a modernised, industrialised and technologized superpower.

Bernstein's lab

The person responsible for leading CIT's Laboratory of Biomechanics was the talented young physiologist Nikolai Aleksandrovich Bernstein. Bernstein would go on to become a leading figure in Soviet physiological cybernetics, as well as a world pioneer in the field of motor control. Bernstein (1983) himself acknowledged that the creation of a modern laboratory of movement was not a novelty. Unlike, say, the model of the *Station Physiologique* established by Marey in 1882, the Laboratory of Biomechanics at CIT was a state-sponsored lab—being thus mandated by political interest. And so while Bernstein was given the responsibility to

carry out specialised work to advance European biomechanical science, his direct instruction would have been to apply knowledge to the Soviet context and according to the party's main agenda.

Bernstein took the laboratory in a direction that opposed the dominant physiological school, which at the time followed Ivan Pavlov's doctrine of conditional reflexes. Clearly, Bernstein was not interested in involuntary and conditioned movement. He wanted to study a dimension of movement Pavlov had utterly failed to recognise in his work: namely, programmed human motor activity. On the other hand, Bernstein's intention was to understand how the brain controls bodily movement, and *not* how to develop effective means of social and political control. The laws of industrial work movement could be formulated, according to Gastev, in terms of two determinations: an up, and a down. By identifying the shortest movement curve between the point of highest elevation of a hammer, and its place of landing, Gastev believed CIT scientists could yield the most rational trajectory of a hammering motion, and thus help identify the most economical (the most cost effective way of moving). Not only would automation of these good movements lead to an avoidance of fatigue and improved motor performance; the political ambition of Gastev's industrial movement training was to improve productivity of factory work in general, in order to improve Soviet economy (or its kineconomy). As Bernstein's work showed, this seemed like a crude simplification of a much more complex neurophysical process involving the neurophysical programming of motor actions. Bernstein's experiments showed that the same labor task was performed differently—with varying tensions of different muscles—at various times. Muscular movements were constructed, so to speak, each time the task was performed. Bernstein concluded that reflex theory could not adequately explain muscular movements. Bernstein understood movement in terms of a mathematical distinction between human locomotor mobility, which has no boundaries and is characterised by total freedom of movement, and what Bernstein (1999) called "deformational mobility," which refers to how anatomically bound parts of the body can move with respect to each other in a way that is limited by degrees of connectivity. Thus, the scientific knowledge that was being generated within CIT was not necessarily contained either within reflex theory, nor was it dumbed down by oversimplifications imposed by political agenda. Human movement was being discovered and re-invented in terms of a complex program that the brain carries out programmatically and which the body must perform according to mathematically describable operations involving kinematic chains.

Kymoyclography and the mathematisation of motion

Wilhelm Fischer and Otto Braune were the first to apply mathematical and computational mechanics to the study of live anatomical human movement in the 1890s. Insofar as their method focused on a mathematical description of live movement (this is of course before the invention of the electronic computer), and insofar as their samples were obtained using the very first modern optical motion capture system, their work can be credited as a monumental achievement in the history of movement science and technology. Bernstein's ambition was to lead the next generation of physiological studies through an improved mathematical approach, and an enhanced technological medium used to support this framework. Indeed, Bernstein's position in the history of movement science is equally significant, not least because he drove the Soviet laboratory away from the biomechanical paradigms of the 1920s, onto the cybernetic paradigm of the 1950s and 60s, and thus saw the transition from combustion machine to computer machine, from biomechanical to robotic and cyborg human movement. At the heart of this drive for a new science of movement was the language of "technologized mathematics" (Rotman 2008), which is where the language of digital movement would inevitably emerge from.

[INSERT FIGURE 2.1 NEAR HERE]

Figure 2.1 Chronocyclographic method of controlling progress in learning the rationalised use of the hammer. The light points give a picture of optimum performance. First published in Fülöp-Miller (1927)

Before the hammering action of the cadet could be described as "movement geometry" (Bernstein 1999/1929), however, Bernstein had to develop the technological means of capturing live movement, and representing the motion in a graphic way. To this effect, Fischer and Braune's chronocyclograph was used as the basis to develop a new optical motion capture system at CIT's Laboratory of Photocinematography (led by Nikolai Tikhonov). This in turn led to the developed in 1927 of a novel motion capture apparatus devised for the more exact investigation of normal and pathological motions. Tikhonov and Bernstein captured CIT cadets using photographic sequences of images of selected lines or points on the body, similar to Marey's famous method of chronophotographic geometry. The drawback, in Marey's case, was that chronophotographic shots were perfectly readable only for locomotor movements where the object moved continuously along the visual field of the camera over the course of a single trajectory. Bernstein wrote: "For small, complex, and

repetitive movements whose trajectories always come back to the starting point, these methods cannot be used" (1999, p. 127). Since these were precisely the kind of movements Gastev wanted to investigate, Bernstein and Tikhonov had to find the means of recording the curving trajectories produced by moving limbs over repeatable cycles of localized movement (i.e. chiselling, hammering, rifle handling). To achieve a tridimensional representation of these movement forms, Bernstein also suggested the method of mirror-recording, which led to a tridimensional capture and stereoscopic vision of movement without the need for multi-camera calibration.

Unlike the Geissler tubes used by Braune and Fischer, CIT cadets were dressed in black suits connected to electrical light bulbs attached to the joints of the organ under investigation. CIT's motion capture set-up further combined the advantages of the cyclographic apparatus with suitable recording techniques (time-lapse), which enabled the registration of live movement in terms of motion curves. One advantage of seeing motion represented thus is that it could be mathematically analysed in terms of sine waves. The extraction of these curves of movement from the photographic print and their formal representation as sinusoids became known as kymocyclography (literally, the writing of wave cycles).[5] What Bernstein's kymocyclograms showed, in effect, was that the variation between movement trajectories and their complexity decreases significantly, even in richly innervated systems, under the action of human movement automation. As such, motion capture technology was intended to produce a kind of writing—what Peter Weibel (1996) calls a writing over the seeing, or "opseography", in the sense that one could read (mathematically) the curves that stereoscopic time-lapse photography yielded when capturing reflective body markers in studio conditions. The opseographic inscription, and subsequent mathematical representation, generated a kind of "multidimensional graphism" (Salazar Sutil and Melo 2014), which in its formalised representation also generated numerical, tabulated and computational data that would provide quantifiable validation of Gastev's policy of full bodily automation. In other words, in order to produce the best trajectory for the hammering motion in the assembly line, the worker had to follow quantified and exactly measured movement curves in the most automatic and mechanised means possible.

[INSERT FIGURE 2.2 NEAR HERE]

Figure 2.2 Kymocyclograph produced by Bernstein c. 1927 showing the action of sawing a board with a handsaw. The kymocyclogram demonstrates a high degree of automation

No doubt the terminology Bernstein was beginning to develop at CIT would have chimed in with Gastev's political agenda. "Control," "central system," "motor program"—these terms could be readily interpreted as the conceptual building blocks of a political discourse. However, the two projects began diverging as the political climate in Soviet Russia changed with the rise of Stalinism. Indeed, the destiny of these two projects— and these two men— were to run very different courses. Whilst Gastev was killed during the Great Purge and CIT was completely disbanded, Bernstein went on to win the Stalin Prize for science in 1948. The tension between scientific intelligence and political intelligentsia is of course a much broader question, and one that deserves more than a passing reference. What this relationship showcases, however, also bears directly on my underlying thesis. Where science objectified and instrumentalised the body and its physical intelligence, the political establishment in turn instrumentalised scientific knowledge for its own self-serving purposes. Hence, behind movement lies a motor intelligence, and behind this intelligence lies an intelligentsia.

It will be evident from this that a corollary statement is in order. Bernstein's capacity to see (think) the neurological process behind movement hinges on the optical power of his motion capture system. Whereas Fischer and Braune had described their motion capture technology as a "new microscopy of movement" (1987, p.116), the technological instrument and accompanying method developed at the Laboratory of Biomechanics was both a microscope, an X-ray, and a proto-computer, in the sense that the apparatus could not only look into the fine grained details of a micro-movement, but also reveal movement in its formalized manner as a mathematical wave or curve, or indeed as computable data. In other words, the technology allowed for a translation of the language of physicalized kinematics to its abstract mathematical description.

As scientists pushed toward a cybernetic era characterised by greater levels of information processing and mathematical and computational knowledge, and as new technology began to yield vast levels of movement data, so it became apparent that the challenge lay not only in refining physical intelligence, but also the mental intelligence and the technological means of processing vast data crops. Lev Manovich (1995) points out that there is a passage from Taylorism to cognitive science and cybernetics, which can be read "as one of the most important signs of the shift from industrial to post-industrial society," adding: "The point is not whether corporeal labour was indeed universally displaced by mental labor.

What is important is that the obsession with the rationalization of corporeal work (Taylorism, European science of work, psychotechnics) disappeared, displaced by a new obsession with the rationalization of the mind" (1995, unpaginated). It is important to stress that there is a historical confluence from one history to the other, in the sense that the degree of technologization and the mathematical/ computational determination of live movement, which stemmed from research institutes like CIT, fed the need for new technologies of information processing and for a computer-aided science of movement. And it is here, with the emergence of a computer machine, that the history of a biomechanical utopia ends, and a contemporary eukinetic utopia— the utopia of the digital— begins.

Postcript: Nikritin's cartograms of utopia

In 1923, and partly in response to the unwelcome hijacking of the term "biomechanics" by Vsevolod Meyerhold and Nikolai Foregger,[6] Gastev awarded an artistic residency to the Projection Theatre at CIT headquarters in Moscow. Evidently, Gastev's intention was to promote further sci-artistic integration within his institute. More specifically, Gastev wanted the work of his resident artists to focus on "organizing a performance of work methods on stage," and on "creating an objective theater of normalized labour" (in Pchelkina 2013, p. 158). Gastev was granted the title of honorary member of the Projection Theatre, and members of the Projection Theatre were in turn allowed to work in close collaboration with CIT scientists, including Bernstein and Tikhonov.

Led by Ukrainian avant-garde artist Solomon Nikritin,[7] Projectionism was an avant-garde movement whose principal intention was to "reflect the urge to rush ahead into the future" (Smirnov, 2013, p.13). Projectionism was thus committed to the conceptualisation of utopian futures through sci-artistic integration, particular through a cross-traffic between human actors and technological agents. Nikritin's principal idea was that the essence of the work of art resides in its method, not its material output. He wrote that the achievement of projectionism was "the intellectual work of the masses concentrated in one discipline—in projectionist expression of organizational classification and methodology." Nikritin added: "The art of projectionism is… the algebra of organizational science" (15).

It is also worth pointing out that around this time Nikritin entered into direct correspondence with higher members of the Soviet intelligentsia, including Trotsky himself. Trotsky (2005) had written some years earlier that through social construction "all the arts—literature, drama, painting, music, and architecture will lend to a process of beautiful form,"

adding: “The shell in which the cultural construction of communist man will be enclosed, will develop all the vital elements of contemporary art to the highest point, so Man will become immeasurably stronger… and his body will become more harmonized, his movements more rhythmic” (207). In order to materialise this vision, Nikritin’s contribution at CIT involved much more than devising propaganda theatre in workers’ clubs and businesses, as Gastev had originally intended. Nikritin also constructed CIT’s so called “perspective boxes,” which helped calculate the local coordinates of moving subjects— similar to the lattice backgrounds used by Étienne Jules Marey and Eadweard Muybridge in their chronophotographic studies. The Projection Theatre also experimented in the use of analytical scores that would serve as graphic records for the formal representation and composition of sound, rhythm, movement and emotional excitement. More ambitiously, Nikritin developed an educational program for actors in terms of a system of self-growth, based on a practical training method known as “harmonious biomechanics.” Liubov Pchelkina (2013) has explained that Nikritin’s actor training system involved technical and expressive resources of the bodily organism, so that the performer could master their bodily movements, vocal apparatus and emotions, and so that this complete performer could in turn adapt to scenic and acoustic space. Like Meyerhold’s laboratory, Nikritin’s training method was grounded on an application of Gastev’s biomechanics, and it included work on analytical gymnastics, breathing technique and physiological organisation, as well bodily positioning (158).

[INSERT FIGURE 2.3 NEAR HERE]

Figure 2.3 Solomon Nikritin. Draft manuscript. Explanation of the biomechanical octave. Image reprinted courtesy of Liubov Pchelkina

In his desire to model the movement of workers, dancers and pilots— the three great archetypes of the Soviet eukinetic utopia— Nikritin imagined a synthesis of the mathematico-scientific knowledge produced by Bernstein, the technologies of movement observation developed by Tikhorov, and the industry enterprise led by Gastev, in order to see where this synthesis might land in the near future. To this effect, and whilst still resident at Gastev’s Central Institute of Labour, Nikritin produced three graphic representations he called the “cartograms of the program” (1924). Nikritin’s triptych shows the stages through which society should pass— including periods of preparation, revolution and organisation— before it congeals into a better future. In Cartogram 2, the artist specifies the stages of progress of

development of this new society, and he indicates the main initial conditions related to the point of beginning. Among them are: "clear distinctness of responsibility, personal interest, general planned work."[8] Thus, a utopian sense of human creativity could be projected from a present techno-scientific and artistic creative context, unto its yet unimagined future.

[INSERT FIGURE 2.4 HERE]

Figure 2.4 Solomon Nikritin's Cartogram of the Program No2. Courtesy of State Tretyakov Gallery

What Nikritin envisaged was not the State mathematics parodied by Zamyatin, nor the dystopia that was to grip the Soviet Union during the Stalinist purge. Nikritin saw creativity branching into ever more complex networks made up of multitudinous nodes and distributive links, where the overall structure is devoid of any centralised control. According to Pchelkina (2013), the cartogram of the program can be interpreted as an algorithm. A clear foresight into our own digital era is found in these pseudo-algorithms, which predict the emergence of a class-less and authority-less society made up of evolved citizens. It is also a society whose movement is not prescriptive and disciplined, but distributed, self-disciplined and self-organising. In this society we find the growth of consciousness issued forth organically, so as to make up a living organism of distributed intelligence (much like the Internet), performed by new citizens (or, if you prefer, netizens).

Conclusions

If this essay has not convincingly traced the emergence of our own contemporary understanding of technologized motion back to the Soviet biomechanical project (let us not forget parallel efforts were made in the United States), then I do not know what other history digital movement might be traced back to. What I do know, however, is that the failure of technological utopias in the Soviet case is a word of warning. Underlying today's digital kineconomy are questionable promises of free online mobility, or promises of technologies that can be transported and carried everywhere to boost productivity and communicability, or promises of motion capture systems that can map live movement onto digital characters to achieve total believability of animated movement for subsequent user consumption. All these promises that underpin the future development of contemporary digital movement cannot be

studied without a critical perspective, and without knowledge of the corporate intelligentsia behind this new intelligence.

In the same way that movement typically starts with an *invisible* mark made by the corporeal body, so the political forces that drive intelligent movement and cash on it are not visible to the average technology consumer. But whilst new digital technologies can develop the capacity to see movement with the greatest clarity, they can also efface the apparatuses of political control that lay behind them, enabling a blinded technologization of human movement. If I say that the vision behind new technology is blind, it is not only because we do not see the future that technology will fashion for us. Nikritin could not foresee that the movement utopia imagined by Gastev would end in Stalin's massacres. The point I would like to end this essay with is this, however: technologized movement withdraws us from our own inner vision of movement. The promises offered by technologized movement can alienate us from our own connection with the neurophysical and intellectual source of movement, allowing the machine to think the movement and to control it for us. This withdrawal from movement, or from the intelligence of movement, means that we are turning our backs on the internalised processes behind movement. Intelligence is being effaced, considering that not too many people know how computers think and how they program good movement, nor do we necessarily know how our mobile gadgets move with us, nor how we are moved by them. We are bound to become less intelligent or at least more superficial in our understanding of physical intelligence if we let ourselves be driven by a world where everything moves automatically for us. Intelligence is outsourced— thought becomes the responsibility of the machine, not the user. The digital movement utopia with all its promises of free accessibility and mobility, with its promises of total motion recognition and motile interactivity, can lead to a dependence on total machine automation and the emergence of a society which is not, as Deleuze (1992) predicted, a society of control, but a future society out-of-our control.

Notes

[1] In 1931, a public bricklaying competition was staged in Moscow as part of Gastev's "labour championships". Three different approaches were tested: that of an unskilled and untrained worker, that of a worker versed in Gilbreth technique (developed by Frank B. Gilbreth using time motion and motion study), and the "system (method) CIT". The untrained bricklayer laid 327 bricks in an hour; while Gilbreth technique yielded 452 bricks in the same time. Using "system (method) CIT" the winning bricklayer laid 907 bricks. See Albert Kravchenko "Taylor and Gastev" in Expert 18.703 (May, 2010).

[2] Examples of this included the use of personnel sheets, personal report cards, record maintenance work orders for trains, trams and all vehicles, production schedules, chronometric cards, time control devices and time clocks in factories, alarm clocks, chronometers, metronomes and horns. See A. K. Gastev How to Work: Selected writings by A.K Gastev (online).

[3] Gastev's idea to develop a State science was inspired by the European science of biomechanics, in particular the book The Movement of Animals, by Italian mathematician Giovanni Alfonso Borelli. Gastev was also inspired by French scientist Julien La Mettrie, whose book Man-Machine (1747), was timely translated to Russian in 1911. Marey's work was also well-known, as was the classic work on the biomechanics of the gait produced in Germany by Braune and Fischer in 1895 (On the Human Gait). Bernstein (1983) quotes the Weber brothers, Marey, Muybridge and Fischer and Braune as pioneers in the field.

[4] Sokolov was briefly associated with CIT, and with Gastev's project for the creation of a Taylorist theatre during the 1920s, before moving on to become a relatively well-known film critic. Whilst at CIT, Sokolov produced a number of essays on the subject of industrial movement including his essay Industrialisation of Gesture (1921), where he spelled out his ideas for the taylorisation of gesture and the creation of a stage reflexology, or what this author called "scenic-technical reflexology". Also in 1921 he published Industrial and rhythmic gymnastics, where he proposed a fusion of Delsarte technique and industrial movement to create a "gymnastics of labor". The work was intended to offer a rejection of the laboratory theatres of Meyerhold and Foregger, which Sokolov deemed a mere aestheticization of Gastev's scientific developments. On the subject of Industrial Delsarte, see John E. Bowlt (1996) "Ippolit Sokolov and the Gymnastics of Labor," 411-22.

[5] Bernstein described his motion capture system thus: "The frequency of exposure can be raised to 600 per sec., time being measured by means of the author's Sirenen-Nonius devise with an accuracy of [plus or minus]4.10-5 sec. The method has already been applied to the study of bodily work, piano-playing, adiadocho-kinesis, tremors, arm-tonus reaction". See Bernstein (1927) "Kymozyklographion, ein neuer Apparat für Bewegungsstudium," 782-792.

[6] It is well known that Meyerhold and Foregger developed experimental laboratory theatre models based on CIT, and on the scientific narratives of biomechanics and reflexology. Gastev dismissed Meyerhold's utilization of CIT's methods, however, and the application of biomechanics to Meyerhold's laboratory theatres (RSFSR). Crossovers between CIT and Meyerhold's theatre laboratories were frequent, particularly between the Studio for Movement Registration at CIT, where Meyerhold's student Ilia Shlepianov was employed. Similar to Meyerhold's program for an alphabet of stage movements as part of his method for stage biomechanics, the Studio for Movement Registration at CIT developed techniques for the graphic and photographic recording of live movement, and its transcription into a language of movement and a "semantic cadence". See Nicoletta Misler (1991) "Designing Gestures in the Laboratory of Dance", 157-173.

[7] Gastev was impressed by Nikritin's avant-garde stage design, particularly the plotless "rhythmo-dynamic" compositions exemplified in stage productions like *The Tragedy of AOU* (1922) and *Pressing and Impact* (1923). These works featured a mixed media design that included a noise orchestra, a gymnastics apparatus, and mobile scenery. Special projectors were also included as well as large screens to depict "virtual characters, which could be extracted from the film projection, and which appeared to interact with actors on the stage" (Pchelkina 2013, p.158). Gastev himself was no stranger to the multimedia studio—indeed, some of the laboratories at CIT would feature a number of interactive technologies, particularly within the Sensorics and Psychotechnics labs, which were furnished with simulation apparatuses for the training of car drivers and plane pilots (Smirnov 2013).

[8] In the margin notes of *Cartogram 2*, Nikritin also writes: "simplification of realisation of the historically predefined events is possible by means of sciences, philosophies of arts and the political organisation and realisation of new consciousness." This translation of Nikritin's Cartogram is by Liubov Pchelkina and Andrey Smirnov. I am grateful for their help in helping me access some of Nikritin's material, and for permission to reprint Nikritin's sketch.