

## Entropy as a trope: Yuri Lotman's general theory of communication as a case study in interdisciplinarity

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### GENERAL THEORY OF COMMUNICATION: A META-INTERDISCIPLINARY PERSPECTIVE

The Tartu-Moscow School of Semiotics was founded by Yuri Lotman in Tartu, Estonia as a structuralist school interested in objective ways of analyzing language and other sign systems.\* Although much of the school's work focused on the study of literature, it comes as no wonder, then, that its members should turn to issues concerning the relationship between the humanities and science (the notorious matter of “measuring harmony with algebra”, to cite Pushkin's Salieri). However, the extent of the school connections with the contemporary scientific scene is still unusual. Today, in an era of digital humanities that have brought the descendants of structuralism and early cybernetics together in a still-uneasy dialogue, it is especially fruitful to go back to these tentative beginnings. Apart from historical interest, they offer a hope for a pre-existing shared theoretical basis between literary studies and quantitative explorations of literary texts, and an illustrative case study in some of the terminological complexities of interdisciplinarity, whereby a technical term in one field is liable to find a new use, imperceptibly, as a metaphorical concept in another.

Many projects associated with Lotman were only possible under the augurs of cybernetics, a new science emerging in the 1950s in the wake of Norbert Wiener's *Cybernetics* (1948; see Conant 1981), and newly blessed by the Soviet regime's favor in the beginning of the 1960s (Salupere 2015, 63–66 for an overview of recent scholarship; Semenenko 2012, 10–14; Venclova 1965; Ivanov 1983; Egorov 2004). Even if the overlap between semiotics and cybernetics had been a politically induced accident, cybernetics and information theory may be expected to have had a considerable influence on the Russian semiotic tradition; but the dialogue between these disciplines was genuine. Semiotic symposia and seminars regularly numbered among their participants such people as the prominent mathematicians Andrey Kolmogorov and Vladimir A. Uspensky (brother of the philologist and linguist Boris A. Uspensky, the other co-founder of the school).<sup>1</sup>

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Cybernetics, not unlike semiotics itself, was not only a discipline, but also a meta-discipline. Their dialogue must thus be regarded as an exploration of interdisciplinarity itself that may have lasting relevance for the present. The two disciplines were seen by the participants of this exploration not as distinct branches of knowledge but as two nascent ways of looking at *information* and, therefore, as complementary. Lotman's own view on the matter appears clear enough:

Without the acquisition, storage and transfer of information human life is impossible [...]. It is evident, therefore, that semiotics, a comparatively new discipline devoted to the study of communication systems, has a rightful place in the scientific family and that this place will, it seems, come to be of considerable importance (2000, 8).<sup>2</sup>

Lotman's prediction did not quite come true: although highly developed and relevant for both literary theory and anthropology, semiotics has never become a full member of the "scientific family". Reasons for this may have included, alongside fundamental methodological differences, the recent cult of specialization in academia and the consequent breach between the so-called hard sciences and the humanities. Yet had the status quo of the 1960s in the USSR persisted, statistical and computational methods may have been less marginalized in literary studies, and the advent of digital humanities more organic.

What concerns us here, however, is the place semiotics initially sought to occupy within the scientific hierarchy. Kolmogorov's half-jocular "epistles to a philosopher, a cybernetician and a literary theorist" (1997, 216), divide the progress of human history into four stages in semiotic terms: during the prehistoric period human beings used sign systems they inherited from their ancestors, then they learnt to gradually create new systems and languages, and were eventually able to create them from scratch (hence the creation of artificial languages, science, programming etc.). Semiotics is accorded an unexpectedly prominent place in the history of humanity according to this logic, as the fourth and final stage of its development:

But the fourth stage starts with the construction of a general theory of all imaginable sign systems – of semiotics [...] in the USSR, the December 1962 SYMPOSIUM will forever mark the date when it began. It was only at this symposium that the true majesty of the coming era has been proclaimed! (223)

There is serious intent behind the lighthearted spirit of this proclamation that chimes with Lotman, who similarly goes on to proclaim a general theory of communication systems linking together semiotics, information theory and cybernetics:

This is how a general theory of communication systems came to be. An important contribution to it was made by information theory. [...] The principal concepts of information theory – "communication channel", "code", "message" – turned out to be highly convenient for the interpretation of a number of semiotic problems. [...] The issue of storage and transfer of information also became, concurrently, a central concern of cybernetics, where "information" was taken more generally to stand for any structured organisation (2000, 8).

Whether or not Lotman's holistic view of the science of communication can be traced back to Wiener's path breaking monograph, Wiener shares his readiness to admit the existence of common basic principles between hitherto incompatible fields of study:

We have decided to call the entire field of control and communication theory, whether in the machine or in the animal by the name *Cybernetics*, which we form from the Greek *kubernetes* or *steersman*. [...] From 1942 or thereabouts, the development of the subject went ahead on several fronts (19; cf. Lotman 1983).<sup>3</sup>

Wiener's argument admits the interdisciplinary basis of the new science by claiming that "the ultra-rapid computing machine, depending as it does on consecutive switching devices, must represent almost an ideal model of the problems arising in the nervous system" (22). Lotman takes this logic one step further in his conclusion to *The Structure of the Artistic Text*:

The comparison between art and life is not a new one. But we are only beginning to realize how much truth is contained in this once striking metaphor. We can declare with certainty that more than anything else created by man, the artistic text most clearly manifests those properties which draw the cybernetician's attention to the structure of living tissue (1977, 300).

Overall, we have before us a coherent worldview encompassing living tissue, statistical modeling of information and literary text, studied by early cybernetics, information theory and semiotics, respectively. Of the three, the first dealt primarily with the transfer of information within either a living organism, or a machine modeled after such an organism. The second was concerned with the abstract mathematical foundations of communication, while semiotics focused on communication in the social realm, namely sign systems. Lotman's pioneering monograph *The Structure of the Artistic Text*, published in 1970, is written in dialogue with both information theory and cybernetics.<sup>4</sup> In it, literature, as an example of an artistic text in the more general sense Lotman ascribes to the term, is analyzed in terms of both these disciplines at once, as seen in the following passage:

an artistic text [...] transmits different information to different readers in proportion to each one's comprehension; it provides the reader with a language in which each successive portion of information may be assimilated with repeated reading. It behaves as a kind of living organism which has a feedback channel to the reader and thereby instructs him (1977, 23).

Today, when cybernetics has been largely supplanted by the applications of information theory in computing, and semiotics has lost its touch with the hard sciences, the implications of this momentous connection around the 1960s – the time when all these three disciplines had barely been born and sought to define their limits and their respective discourse – may not be self-evident.

One such implication was that, within a general theory of communication systems, the objects of one discipline had to be modeled in terms of another. For example, Lotman attributed the highest importance to Kolmogorov's methods of applying information theory to the analysis of versification (1977, 26).<sup>5</sup> This process of termi-

nology appropriation, he claims, works both ways: if sign systems can be described in terms of information theory and cybernetics, they can also be used for the furtherance of science. In defining art as “the most economical, compact method for storing and transmitting information,” Lotman was providing, in his turn, a theoretical basis for an informational model that was beyond the reach of contemporary mathematics, arguing that “the disclosure of art’s nature as a communication system can effect a revolution in methods of storage and transmission of information” (1977, 23).

### INFORMATION IN A LITERARY TEXT

Lotman defines any text as something both concrete and immaterial. It is concrete since any textual communication must be clearly *defined*, *separated* and *structured* (the three qualities of a text for Lotman; 1977, 51–53). It is, however, immaterial because “it is not ‘things’ themselves, but the relations of things, which are the material substance in sign systems” (53); ultimately, in other words, form becomes a carrier of content. This explains, for example, the importance of parallelism and of what Lotman calls “the minus-device” (“минус-прием”), i.e. the fact that silence or the omission of an element may be heavily charged semantically. Further, in addition to meaning understood as the common denominator of decoding and re-encoding operations, literature contains another level of meaning quite unique to it that comes to light in the process of re-negotiation of the code itself. In a system where code *is* information, repetition and parallelism enable such re-negotiation, and both its main interest and pleasure lie in the process of mutual code adjustment between the text and the reader (Lotman 2000, 172–174).

Since text is structured as a complex multidimensional system, its every variable belongs to more than one plane and can carry different information depending on how we approach it. If we compare this to mathematical representations of space, this notion becomes clearer: within a multidimensional space, each variable belongs to more than one Cartesian system, so that its value can be arrived at through more than one equation (i.e. through its relation to different combinations of other variables) and each equation may have more than one solution. Something similar is also true of literary text in Lotman’s interpretation. The interpretive possibilities of each element are extensive: what is predictable when accessed by one code becomes non-systemic when another code is applied to it, and vice versa. Hence the extreme complexity of the literary text as a self-organizing sign system engaged in a constant re-negotiation of the relations between the signs (cf. Lotman 2000, 163–177).

Such conception of meaning, including new meaning, i.e. information, is closely related to the definition of information through the probability of a particular choice, as introduced by Claude Shannon. In terms of information theory, the amount of information that we receive depends on its estimated probability (i.e. on the other available options within the given context). Vladimir Uspensky translates this into the framework of sign systems as follows: “If we see an actress wearing a black dress on a color screen, we get a lot of information: we learn that this dress is indeed black rather than green, red etc. A black dress on a black-and-white screen gives much less information: the dress may in fact be dark red, or dark green” (1997, 153). The lesser

the probability of a particular element within a series, the more information it carries. Within Lotman's model of literature, however, every element belongs to multiple potential series and therefore, however high its probability within one, this does not exhaust the information content: "The capacity of a textual element to enter into several contextual structures and to take on different meaning in each context is one of the most profound properties of the artistic text" (Lotman 1977, 59–60). This is why Uspensky goes on to agree that one intuitive way of defining the unique nature of literature is that in it the entire text is the information it contains (cf. Lotman 1977, 11).

### ENTROPY AS AN ELEMENT OF ENTROPY

Entropy is the one stumbling block in Lotman's otherwise crystal-clear account of the process of reading offered in his foundational monograph *The Structure of the Artistic Text*. Looking at it more closely sheds light on two aspects of Lotman's theory of literary structure: his view of tensions between systemic and asystemic material, and his metaphorical use of interdisciplinary terminology (cf. Salupere 2015 on the role in Lotman's metalanguage of two further cybernetic terms, "mekhanizm" and "ustroistvo"). Both points of tension are summed up in the following description of sensual (sense-related as well as pleasurable) assimilation of a text which ends in the striking conclusion of a theoretical unity between intellectual and sensual pleasure from the perspective of what Lotman calls the antinomy information vs. entropy:

[A]ny process of sense perception can also be viewed as the reception of information. Roughly speaking we can define sensuous pleasure as the reception of information from non-systemic material (as opposed to intellectual pleasure – the reception of information from systemic material). [...] All of the above implies not only a distinction between intellectual and sensual pleasure, but also their theoretical unity from the perspective of the antinomy: information vs. entropy (1977, 58–59).

It is unclear how this theoretical unity relates to Lotman's earlier assertion that the very nature of a literary text is such that the interpretative potential of any given element cannot be exhausted by a single code. As soon as a non-systemic element becomes accessible by a different code and therefore enters an interpretative system, the nature of this "sensual" pleasure must change and become intellectual. Lotman's view on pleasure in reading deserves a separate discussion. What matters for us here, however, is the paradoxes inherent in Lotman's "antinomy: information vs. entropy." Both kinds of pleasure in reading, he claims, are due to the processing of information and therefore ultimately similar. Yet why should such processing of information be seen as opposed to entropy?

The concept of entropy had developed independently of literary study in different areas of science, but especially in information theory and the theory of thermodynamics. Etymologically, it comes from the Greek: the prefix "en" means "in" or "into" and "trópos" – "a turn" or "a transformation". In scientific terms, it indicates the amount of information needed to specify the state of a given system. By the time the term reached semiotics, two contradictory interpretations associated with ther-

modynamics and information theory, respectively, had developed (with the former being an application of the more general principle used in the latter, but with diverging metaphorical connotations). To use the classic example of ice melting in a glass used by Rudolf Clausius in 1862, as the molecules come apart, we need more and more information to describe their location (as there are more possible states for the system). Used in the context of the second law of thermodynamics, this model is concerned with the *dissolution* of a given system. This explains why in popular understanding entropy came to mean disintegration and, ultimately, chaos (after all, the ice ceases to be a well-defined block, turning instead into an anarchic body of molecules).

Insofar as information theory is concerned, on the other hand, entropy is linked, starting with Claude Shannon, to the information content of the *new* element of a series. It is therefore widely used in statistics, especially in the study of Markov chains, to determine the probability of a given development in a system given its preceding states. Understandably, in terms of information theory, the entropy of melting ice will indeed increase as the system disintegrates, but the system does not need to be chaotic to have high entropy. Rather, entropy in information theory is linked to its *unpredictability* and *complexity*; if the entropy of a system is small, it carries very little information (an actress wearing a black dress on a black-and-white screen). A chessboard in the beginning of a match will have small entropy since only a limited number of moves are allowed, and the probabilities of most are comparable. On the contrary, in the middle of the game the entropy of each move will be much higher, especially with skillful players.

In terms of literary analysis, then, a highly clichéd poem will have small entropy, making it easy to guess the next element. Pushkin or Shakespeare, on the other hand, will have a much higher entropy value, and nonsense poetry potentially even more so (complete lack of apparent sense is mathematically more unpredictable than complexity). It is entropy that Pushkin plays with deliberately for literary effect in *Eugene Onegin*: “И вот уже трещат морозы / И серебрятся средь полей... / (Читатель ждет уж рифмы розы; / На, вот возьми её скорей!)”<sup>6</sup> (Pushkin 1950, 93; cf. Cretu 2008, 53). The predictability of the rhyme is contrasted with the unpredictability of the poet’s turning the tables on the very convention he is exploiting.

However, it would be a misinterpretation to associate high entropy with a lack of organization; on the contrary, up to a certain point, high entropy is indicative of a higher and more efficient organization than low entropy. Before both Shannon and Lotman, Victor Shklovsky intuited this idea in his programmatic essay “Art as Device”. Shklovsky argues that while rhythm is often seen as an automatizing feature in literary language, this is only true of what he calls prosaic rhythm (whether it occurs in poetry or in prose). Poetic rhythm, in contrast, relies on breaks in the rhythm for information. While attempts have been made to systematize such breaks, they are presumably doomed, Shklovsky claims, because “we are talking not of complicating but of disrupting the rhythm, of disrupting it unpredictably; if such a disruption is canonized, it will lose its power as a device of deceleration” (2015, 173; 1929, 23). In other words, skillful, measured, rupture of a pattern increases entropy, making an additional step towards *ostranenie*.

Richard Bailey, who noted the importance of the concept of entropy in contemporary interdisciplinary dialogue as early as 1976, claims that “Lotman is quite literal in his adoption of the vocabulary and analytical method of information theory” (1976, 297). This is accurate, but only to an extent. Critics have noticed important discrepancies in Lotman’s use of scientific terminology (Cretu 2008, 38–49; Vroon 1977, ix–xi; Shukman 1977, 119–133). Patricia Galloway claims specifically of his use of the concept of entropy that “Lotman’s work is certainly capable of standing without it. It is not a crucial notion; he depends upon it only when he needs a ‘scientific’ justification, and when he does so he often finds himself trapped in contradiction” (1981, 59). Cretu’s Ph.D. dissertation offers the first detailed critique of such “limitations of cybernetic and information-theoretic notions in semiotic discourse” (2008, 5) that devotes several pages specifically to Lotman’s use of the notion of entropy. According to Cretu, “Lotman’s use of the concepts is incongruent with the premises of communication theory, as developed by Claude Shannon” (9); ultimately, he argues, “Lotman’s approach to the structure of the literary text appears characterized both by an excessive confidence in the abilities of the cybernetic framework and an insufficient understanding of its premises and especially, its limitations” (49). While Cretu frames the study as a call for “other researchers to continue Lotman’s pioneering efforts toward multidisciplinary” (39), his proposition is essentially to put Lotman’s terminology right by showing how information theory can be used, “taken non-metaphorically” in literary criticism, notably through enriching standard literary criticism, without mathematical support, with such notions as statistical distribution (to highlight unusual use of figurative language in Georgii Ivanov’s poetry); shared elements of structure (to demonstrate intertextuality in a potential ante-text of Bulgakov’s *Master and Margarita*); and code (e.g. allusions to folklore in Ivan Bunin).

Cretu’s criticism of Lotman’s use of information theory terminology is, to an extent, well-justified. “Following Wiener,” Cretu sums up, “Lotman opposes information and entropy, and associates entropy not with statistical variability (as in information theory) but rather with the idea of noise and with the equilibrium state in which distinctions appear to dissolve (as in thermodynamics)” (40). Yet when Lotman writes on Kolmogorov’s use of entropy to discuss poetry, “the opposite point of view appears” (41) and entropy comes to be associated with the gain rather than the loss of information. Cretu cites Lotman’s later work where the word is used in ways incompatible with information theory as a marker of automatization and loss of information, e.g. “the entropy of structural automatization” (“энтропи[я] структурного автоматизма”; qtd. in Cretu 2008, 42). He then concludes that “none of Lotman’s contemporary sources on information theory (Wiener included) would have agreed with such a use of the term” (42). It is largely from this premise – the apparent confusion in Lotman’s terminology – that he rejects Lotman’s conception of the multiplicity of codes in the text, outlined above.

While the inconsistency in Lotman’s use of terminology such as entropy is very real – and, indeed, striking – this analysis carries a risk of a rather facile dismissal of Lotman’s investment in information theory, which is in fact contextually very consistent. In other words, rather than his notion of entropy being contradictory, this invalidating his usage of the term, Lotman develops – whether deliberately or un-

reflectingly – two parallel and mutually contradictory narratives of entropy, each of them meaningful and fledged out. When, for example, Lotman speaks of entropy in the context of textual analysis, he does so competently and with full awareness of the interdisciplinary theoretical context, as in the following two examples:

1) Attempts have recently been made to calculate the entropy of an artistic text, and hence to determine the amount of information. It should be noted that confusion occasionally arises in popularized works between the quantitative concept of the amount of information and the qualitative concept of the value of the information. These, however, are profoundly different phenomena. The question, “Is there a God?” allows for the possibility of two choices. Selecting a dish from the menu of a good restaurant allows for the exhaustion of significantly greater entropy. Does this demonstrate the greater value of the information received in the second procedure? (1977, 25–26).

2) If we define a certain text as a work of Russian poetry, there is an equal probability that anyone of the meters natural to Russian verse will be used. If we narrow the chronological borders of the extra-textual construct we have chosen as our context and categorize the piece as “a work written by a Russian poet of the nineteenth century”, or if we do the same with genre (“the ballad”, say), the probabilities will change. But a text belongs in equal measure to all these categories, and we should bear this in mind when determining its entropy. The fact that a text is associated with a given genre, style, age, author, and so on, changes the entropy value of its isolated elements; this fact not only forces us to view extra-textual connections as something wholly real, but also indicates certain ways for measuring this reality (50–51).

Lotman is also very much up to date on the latest developments in information theory as applied to literary texts.<sup>7</sup> Kolmogorov did much to calculate the entropy of a given text, and Lotman cites, notably, his distinction between its two components (cf. Uspensky 1997, 162–163): “semantic capacity ( $h_1$ ) – the capacity of language to transmit semantic information in a text of a given length; and the flexibility of a language ( $h_2$ ) – the possibility of transmitting the same content by several equivalent means,” which resulted in the following law ( $\beta$  denotes structural limitations imposed by the literary form, which reduce the  $h_1$  of the language): “Poetic creation is possible only so long as the amount of information expended on limitations does not exceed the flexibility of the text ( $\beta < h_2$ ). In a language where  $\beta \geq h_2$ , poetic creation is impossible” (Lotman 1977, 38).

Lotman re-interprets Kolmogorov’s results, adding that in poetry,  $h_2$  is to a certain extent perceived by the reader as  $h_1$  and becomes “entropy of ‘poetic content’”; an additional resource for meaning unavailable in prose. Elsewhere, we can see that his thinking about the structure of the artistic text is tightly aligned with an information theory perspective:

Since the structure of artistic models would appear to stand out in much greater relief [...], predictability must increase with each succeeding element, and consequently, the structure itself must carry even less information than in natural language. But experiments have shown that an artistic text is less predictable than coherent non-artistic texts, a paradox that seems inexplicable at first glance. It is curious – and we will return to this point again – that different indices of predictability generate genuine poetic values and epigonic imitations (71).

The only thing that is missing in this description is the term “entropy” that information theory would use to describe this paradox of the artistic text, that is to say the fact that the introduction of structure decreases predictability and introduces more, rather than less, information.

Given the attention Lotman paid to mathematical applications of entropy to literature, one would expect him to consistently interpret this term mathematically, as a measure of complexity and unpredictability, and an integral aspect of what makes art, according to Lotman, “the most economical, compact method for storing and transmitting information” (1977, 23). This, however, is not the case at all. Outside of the chapter devoted to the term in *The Structure of the Artistic Text*, and especially in Lotman’s later work (Cretu 2008, 42–43), the term becomes, instead, a synonym to chaos and destruction. What is more, Lotman ascribes the same vision to information theory in his definition of noise, a replay of the information vs. entropy motif: “Information theory defines noise as the intrusion of disorder, entropy or disorganization into the sphere of structure and information. Noise drowns out information” (1977, 58).

This interpretation is inconsistent with both Kolmogorov’s analysis, and Lotman’s own vision of the paradox of structure in the artistic text, whereby an increase of organization does not lead to a corresponding increase in predictability. Instead of a source of information, i.e. meaning, entropy is introduced here to Lotman’s readers as an elemental force coming to destroy all systems (58) as he declares that “[o]ne of the basic functions of culture is to resist the onset of entropy” (75).

Why does Lotman ignore – or, equally puzzlingly, overlook – how extremely appropriate the notion of entropy as a measure of predictability would have been in his model of literature? This would have been understandable if he simply did not see literature in these terms,<sup>8</sup> but as demonstrated above, this is not the case. One straightforward answer is that the “destructive” connotations of entropy were simply much more widespread. Wiener himself, who was familiar to Lotman, develops the notion of entropy as a force of chaos, opposed to information (in a context where “information” has a different meaning altogether from Shannon’s probabilistic use of the term, a nuance Lotman may have been unaware of, see Cretu 2008, 40; Uspensky 2016, 392). Indeed, Lotman and his colleagues ascribed to this popular understanding of the term as chaos in everyday conversation. For example, in a letter written in 1976, Boris Uspensky asks Lotman about his hopes for a trip to Poland and adds: “I know from my own experience that in such situations one often confuses entropy (the Augustinian devil) with evil will (the Manichean devil). But can it be entropy after all?” (Uspensky 2016, 390). To this, Lotman quips, indicating that he does not think his trip is delayed for reasons of arbitrary chaos alone: “O Mother Entropy! I think the Manichean Mother has had a hand in this too”<sup>10</sup> (393).

There is, however, an alternative explanation, although it may well be related to Wiener’s influence and the popular connotations of the term. Lotman’s notion of unpredictability is in fact highly developed in his later work, quite independently from information theory, under the name of “explosion” (“взрыв”). Around the time of the collapse of the USSR, he writes of “explosion” as the violent disruption of conventionality that

produces new information, the tension created between stability and novelty in culture, and the alternative to evolution in the development of the semiosphere: “the moment of the explosion is the locus of a marked increase in the informativity of the entire system. Its developmental curve takes a completely novel, unpredictable and complex path” (1992, 28). Lotman describes the moment of explosion as a “moment of unpredictability” (190) and devotes a chapter to this concept. He is very clear about linking unpredictability, further, to a high information content (93, 189, 208).

Now, in information theory entropy is essentially doing the same conceptual legwork, yet Lotman chooses to describe this phenomenon by a neologism. Entropy is only mentioned once in Lotman’s explosion book: “the laws of entropy” are evoked to denote chaos (178). Was he unaware of the implications of entropy in mathematics? Perhaps, though his exposure to, and use of, both cybernetics and information theory makes this extremely unlikely; what is more, Lotman cites the second law of thermodynamics in its exact sense elsewhere (1983, 28), which makes it clear that he was familiar with the basic scientific concepts behind both conceptions of entropy. A comparative analysis of entropy and explosion in his thinking suggests another possible explanation. Lotman, a World War II veteran, was fully aware when he defiantly chose to use the term “explosion” in a positive context (1992, 22) that not all explosions were constructive. Alongside the scholarly narrative of art as a system for storing and communicating information, the term “entropy” in Lotman’s work reflects a parallel narrative of the conceptual development in his own thinking that prefigures his notion of the explosion (cf. Salupere 2015, 80). On the metaphorical plane of the semantic drama Lotman was working towards in his writing – the system’s violent transfiguration into a higher, supra-rational version of itself thanks to the chaos introduced by the “explosion” – there was a niche for the fallen archangel, so to speak, the other, destructive side of such an explosion that undermines the system instead of thrusting it forward. Entropy appears to have filled this niche.

*The Structure of the Artistic Text* prefigures this opposition in the way it identifies entropy with noise. While “noise” is defined as “the onset of entropy in a structure” (1977, 76), Lotman believes that art has the power to “transform noise into information” (1977, 75). In his later work, Lotman develops his idea of noise in the context of what he calls autocommunication (2000, 165–167). He considers this way of communication to be central to literature (which relies on autocommunication alongside regular communication as defined by Roman Jakobson). It involves and in a sense transforms the reader directly since the new information transmitted consists not so much in the message itself as in the code. New input adjusts the code applied henceforth to new information by the receiver. In this communicational setting, external stimuli, which would normally be considered as noise (the sounds of a tempest described by Fyodor Tyutchev; a book one is trying to read while entranced by other thoughts; the patterns of the fire or of bricks arranged in a Japanese garden), then act not as interference but as a catalyst for autocommunication that helps generate new information (cf. Segers 1976, 72–75). Insofar as noise and creativity are connected for Lotman, this may explain the complexities of his notions of entropy and explosion as forces that can lead, depending on context, to both outcomes.

In this context, we can see Lotman's "terminological polysemy" (Cretu 2008, 150) and his insistence on the "antinomy: information vs. entropy" in his early work (Lotman 1977, 59) as the result of a metaphorical substitution. The duality already inherent in the term "entropy" made it a good candidate for this role. Placing Lotman's use of a term from a different discipline within the evolution of his own thinking explains why, alongside the technical use of the term derived from information theory, we find a seemingly contradictory storyline based on far less relevant, albeit much more popularized, connotations of chaos originally associated with the notion of entropy in thermodynamics.

Lotman himself argues that any text may be reduced to two fundamental principles – of equivalence and of metaphor (1977, 103). In the way he himself uses borrowed terminology, its meaning is assumed to have the status of equivalence, whereas in fact it tends to oscillate between equivalence and metaphor. Accordingly, while Lotman's view of the text is deeply informed by the mathematical understanding of entropy as a measure of unpredictability, whenever the word is used outside of a technical context, it turns into a monstrous threat to information, i.e. the very thing that it defines elsewhere both in mathematics and in Lotman's own work.

Lotman's insistence on the "antinomy: information vs. entropy" in *The Structure of the Artistic Text* is imprecise from the point of view of information theory and visibly inconsistent with his own technical analysis in the same work, which is based on a genuine engagement with Kolmogorov's ideas. However, it is both informative and telling as a case study in metaphorical substitution in interdisciplinary work. The real place entropy occupies in Lotman's metaphorical framework is not as much that of anti-information, as that of an anti-explosion (which explains the emotional investment that we see in Lotman's use of the term). Hence his unwillingness, whether deliberate or unconscious, to see "the brighter side" of entropy, which would have been much more consistent with his concurrent use of information theory, including the term "entropy", in his work.

## CONCLUSION

Claude Shannon claims that he took John von Neumann's advice when he decided to borrow a term from thermodynamics to describe information: "Von Neumann told me, 'You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one knows what entropy really is, so in a debate you will always have the advantage'" (Tribus – McIrvine 1971, 180). Much the same may, ironically, be said of Lotman's integration of the term into his own thinking about literature and culture. Considered by some as a flaw in his thinking, his engagement with information theory can be seen, instead, as a dual contribution to interdisciplinary research in literary studies, both aspects of which are still relevant today.

On the one hand, "Lotman's commitment to scientism – to a humanistic scholarship dedicated to the ideal of objectivity" (Alexandrov 2000, 341; cf. Salupere 2015, 68–69) has gained a new relevance in the era of digital humanities. In 1967, Lotman

wrote an article on “Exact Methods in Russian Literary Science” for the Italian journal *Strumenti critici* where he proposed that “the opposition of exact sciences and humanistic sciences must be eliminated” (qtd. in Eco 1990, x). The inconsistencies in Lotman’s terminology ought not to stand in the way of our appreciation of the genuinely visionary nature of his commitment to crossing – indeed, doing away with – interdisciplinary boundaries (Gherlone 2013). Ibrus and Torop argue for his work’s “‘explosive’ potential and its contemporary momentum – its applicability and unique analytic affordances for interpreting the most modern phenomena of global digital cultures” (2015, 3; cf. Bruni 2014).

Lotman’s engagement with information theory, in particular, can offer an important perspective on the uses of stylometry in digital humanities today. Indeed, a Lotmanian analysis of digital humanities in the vein of Ilya Kliger’s (2010) reevaluation of world literature is well overdue. It is one proof of the foresight of these ideas that the notion of applying mathematical calculation of entropy to inform literary analysis has reemerged in recent years. For example, Teahan and Harper (2003; cf. Kelbert – Teahan 2011) use entropy as a measure of structure (as reflected in the computer’s ability to compress a text: the more patterns the text exhibits, the more predictable it is and the easier it is to compress) and ultimately of the complexity of the literary text. Newest developments in information theory further indicate that Cretu’s assertion that “[i]nformation theory has nothing to say (at least in the current stage of its development) about the relationship between the artistic qualities of a message and its informational capacity” (2008, 47) may not hold for much longer: context-dependent entropy now allows the option of mathematically distinguishing between desired and undesired probabilities (e.g. Mozgunov – Jaki 2020), opening possibilities for future research on literary analysis.

On the other hand, Lotman’s own firm stance on interdisciplinarity makes it especially telling to consider his performance of it. It is hardly news that the meaning of terms borrowed by literary theory from other disciplines can often be border on metaphorical (cf. Sokal – Bricmont 2003).<sup>11</sup> Russian semiotics is a special case in this respect since its place within the would-be general theory of communication gave it a claim to a literal, not metaphorical, transfer of such terminology. The ambiguous nature of interdisciplinary terminology in Lotman’s work reveals something about a historical moment when transdisciplinarity was briefly seen as a tangible possibility by leading representatives of several academic disciplines across the sciences and the humanities in a way that has not yet been regained in the 21st century. It also exemplifies some of the pitfalls, complexities and promise of interdisciplinary work.

The dynamic of the two parallel uses of a single borrowed term in Lotman’s work is an especially telling example of the nature of the membranes between different disciplines (especially ones between sciences and the humanities), and of their mutual permeability. In Lotman’s case, the unusual coexistence of the technical and the metaphorical in his use of the term “entropy”, each playing a distinct part in the development of his thinking, would be inconceivable without a genuinely symbiotic relationship between semiotics, information theory and cybernetics in the Soviet

noosphere. Looking back to the close contacts between these disciplines in the 1960s restores a perfect environment for more comprehensive study of models of interdisciplinarity that remains relevant today. This includes, notably, the study of the translation of concepts from one scientific discourse into another, and their liability to fill in a metaphorical niche in a discipline's conceptual framework.

## NOTES

- <sup>1</sup> Cf. Salupere 2015, 69–71. Cf. V.A. Uspensky's account of his own correspondence with Kolmogorov, and their work on a bibliography of Western research on cybernetics.
- <sup>2</sup> Here and elsewhere, except *The Structure of the Artistic Text*, translations from the Russian are mine.
- <sup>3</sup> Cf. the development of this idea in the discipline of biosemiotics (Alexandrov 2000, 342).
- <sup>4</sup> It is worth noting that Lotman's monograph came out before Akiva Iaglom and Isaak Iaglom's fundamental study of information theory, which discusses the entropy of literary texts (1973, 258–273, and especially 269–272). Lotman's own impressive insight into cutting-edge approaches to literary study from a mathematical perspective can be credited to contacts with cybernetics and the air du temps, as well as mathematicians' participation in the early seminar series and symposia on semiotics.
- <sup>5</sup> The term “information” should be used carefully here; Kolmogorov in his “epistles” mentions that we do not even know exactly what information is and Vladimir Uspensky warns that “the mathematical theory that usurped the title of ‘information theory’ offers as a quantitative measure of information contained in a particular possibility a number, namely the base-2 logarithm of the probability of that possibility. [...] in the context of the analysis of artistic texts this measure should be used *cum grano salis*: here the so-called information theory probably plays an even more secondary role than statistics” (1997, 154–155).
- <sup>6</sup> “And now the frosts already crackle / and silver ‘mid the fields / (the reader now expects the rhyme ‘froze-rose’ / — here, take it quick!)” (Pushkin 1991, 202; the Russian rhyme is *morozы – rozy*)
- <sup>7</sup> In addition to Kolmogorov, Lotman also cites, for example, Fonagy's *Informationsgehalt von Wort und Laut in der Dichtung* (Lotman 1977, 71) as well as Taranovski (1953).
- <sup>8</sup> Cf. Segers 1976, 74–75, whose notion of entropy bears a trace of the same opposition between entropy and information.
- <sup>9</sup> “По себе знаю, что в такой ситуации очень часто путаешь энтропию (августинианского дьявола) со злонамеренной волей (манихейским дьяволом). А может быть, все-таки энтропия?”
- <sup>10</sup> “О, Мать-энтропия! Думаю, что и Манихейская Мать тут приложила свою руку.”
- <sup>11</sup> Translation theory is one case in point, cf. Guldin 2016; Saint-Andre 2010. Apter 2006, Walkowitz 2015 are recent prominent examples of work that uses translation to describe wider phenomena in literary theory.

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## Entropy as a trope: Yuri Lotman's general theory of communication as a case study in interdisciplinarity

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Semiotics. Cybernetics. Interdisciplinarity. Yuri Lotman. Information theory. Entropy.

This study considers the dialogue in the USSR between semiotics, cybernetics, and information theory, as a case study of the complexities of conceptual transfer between disciplines. Yuri Lotman's use of the concept of entropy in literary criticism is especially telling. Information theory defines entropy in terms of a system's complexity and predictability, while its metaphoric use outside that discipline connotes chaos and destruction. Lotman's use of the term oscillates between these contradictory meanings and exemplifies both his development as a thinker leading towards his concept of the explosion, and his position as an intermediary figure (a mediator, to use his own term) between scientific and literary discourse. The tensions and the promise of a transient point of interdisciplinary encounter in 1960s Russia foreshadow current forays at dialogue between the sciences and the humanities, and illuminate, more generally, the gray area between literal and metaphorical uses of one discipline's terminology in another disciplinary context.

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