The 2026 Gatherings in Biosemiotics

Sheffield, 27th - 31st July 2026

Sheffield School of Architecture and landscape,
Faculty of Social Sciences. The University of Sheffield.

Book of Abstracts





University of
Sheffield

Welcome to the 26th Gatherings in Biosemiotics Studies

And Welcome to Sheffield

On behalf of the organising committee, the Sheffield School of Architecture and Landscape, University of Sheffield, and the International Society for Biosemiotic Studies, it is our great pleasure to welcome you to the 26th Annual Gathering in Biosemiotics.

This year's Gathering brings together world scholars to explore the myriad forms of communication and sign processes found in and between living systems; from molecular signalling and cellular communication, through plant and animal behaviour, to the embedded sign processes of human cognition and semiosis. Since 2001, these annual meetings have provided a unique and vital forum for the biosemiotics community to share ideas, forge collaborations, and advance this rich and growing field.

Sheffield provides a wonderful backdrop for this year's Gathering. Known affectionately as the Outdoor City, Sheffield is a place of remarkable contrasts: a proud industrial heritage and a thriving creative culture, set within one of the greenest urban landscapes in Europe. With five rivers running through the city, over 250 parks and green spaces, and a third of its area sitting within the Peak District National Park, nature is never far away; so we hope you get an opportunity to enjoy some walking, cycling, and hiking for those with time to explore during your stay. The city's identity has been shaped by centuries of making, from its world-renowned steel and cutlery industries to its current position as a centre for advanced manufacturing, research and innovation. Today that spirit of making and collaboration runs through its cultural life too. Sheffield is home to a thriving theatre scene, a vibrant independent music scene (you might have heard of Pulp, Human League, Def Leppard, the Arctic Monkeys to name a few), the Millennium Gallery, and the regenerated Kelham Island quarter: a former industrial district now home to independent cafes, breweries, and creative spaces. Sheffiled has two universities. The University of Sheffield, our host institution, ranked among the top 100 universities in the world, with a long tradition of interdisciplinary research that makes it a particularly fitting home for this years Gathering. We hope you find time to experience something of the city during your stay, and that Sheffield's particular combination of intellectual energy, natural beauty, and Northern warmth leaves a lasting impression.

This booklet contains the abstracts of presentations taking place across the five days of the conference, from 27th to 31st July 2026, together with the programme and practical information to help you make the most of your time here.

We wish you a stimulating, enjoyable, and memorable Gathering.

Tim Ireland and Paul Cobley.

Conference Venues

This year's Gatherings is held across two University of Sheffield venues, both within easy walking distance of each other on the University's western campus.

The Wave, at 2 Whitham Road, Sheffield, S10 2AH is the main venue for the Gatherings. We will be based here on Monday 27th, Tuesday 28th, Thursday 30th and Friday 31st.

On Wednesday 29th July we will be based at The Arts Tower, Western Bank, Sheffield, S10 2TN for our specially themed "Biosemiotics and the built environment" day. The Arts Tower is one of Sheffield's most distinctive buildings, and is the home of the School of Architecture and Landscape. It was the tallest building in the UK outside London when it was completed in 1966.

Getting to the Venues

By train: Sheffield railway station is approximately 25 minutes on foot from both venues, or a short taxi or tram ride. The Sheffield Supertram runs from the station to stops near the university campus.

By tram: Take the Yellow or Purple line from Sheffield station towards Malin Bridge or Middlewood and alight at University of Sheffield stop.

By bus: Several bus services run along Glossop Road and Western Bank, close to both venues. Services 51, 52, and 120 all stop nearby.

(Trams and buses accept contactless card payments)

By taxi: Both venues are well known to local taxi drivers. Simply ask for The Wave or Arts Tower at the University of Sheffield.

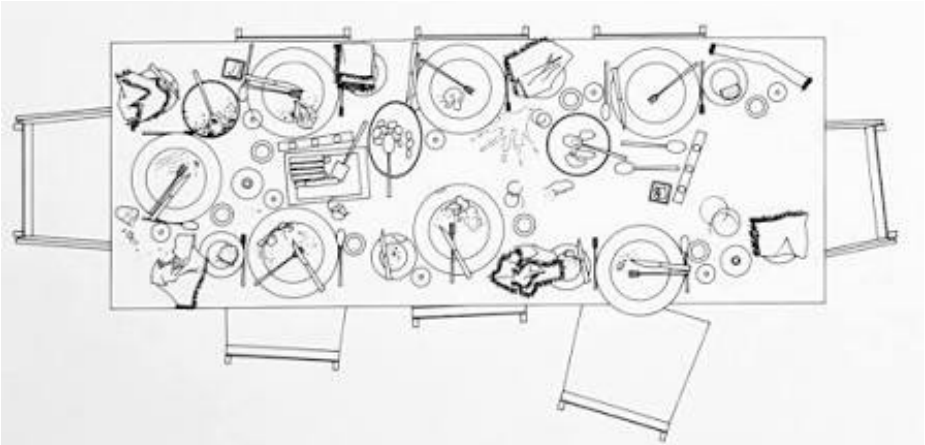
By foot from the city centre: Both buildings are approximately a 20–25 minute walk from the city centre along Glossop Road, passing through the vibrant Broomhill neighbourhood.

Wifi Access

Free wifi is available throughout both venues via the Eduroam network, which attendees from participating institutions can access using their home institution login credentials. If your institution is not part of the Eduroam network you can use WiFiGuest. To Connect to WiFiGuest:

1) select WiFiGuest from the list of available wireless networks
sign in or log in to The Cloud using your web browser (this service is provided by Sky)

2) if you're not automatically directed to the login page, open your device's browser and go to wifi.sky.com



"After Dinner". Final part of a sequence of drawings titled *Increasing Disorder In A Dining Table* by architect Sara Wigglesworth formed the basis for the design of the Straw Bale House (2001)

Lunch Options Near the Venues

On Campus = Quickest Option

The Wave Kitchen is located on the ground floor of The Wave itself, making it the most convenient option.

The Jessop Café on Gell Street is a short walk from the Arts Tower and a good option on the Wednesday. As is Coffee Revolution in the Student Union.

Broomhill is a short walk along Glossop Road or Whitham Road brings you into the heart of Broomhill, which has a collection of independent places:

Vittles Café, 501a Glossop Road: a neighbourhood café serving sandwiches, salads, soup and daily specials in a relaxed setting.

Lokanta, Glossop Road is a Turkish restaurant serving meze dishes and grilled meats.

Med Food Co, Glossop Road offers fast, freshly made Mediterranean food.

Thyme Café, Broomhill and Bon, 486 Glossop Road re neighbourhood cafes.

Gatherings Dinner: Wednesday 29th July, Cutlers' Hall

7-15 Church Street, Sheffield, S1 1HG

The midweek Gatherings Dinner will be held at one of Sheffield's most magnificent and historic buildings, Cutlers' Hall, situated in the heart of the city centre opposite Sheffield Cathedral.

The Company of Cutlers in Hallamshire was incorporated by an Act of Parliament in 1624, and the first hall on this site was built in 1638. The current building (the third Cutlers' Hall on the same site) was constructed in 1832 and designed by architects Samuel Worth and Benjamin Broomhead Taylor in the grand Corinthian style. It is widely regarded as one of the finest livery halls in the north of England.

The connection between Cutlers' Hall and Sheffield's identity could hardly be more fitting for our Gatherings. Cutlery has been manufactured in Sheffield for over 700 years. Geoffrey Chaucer (14th century English poet, widely regarded as the father of English literature and author of *The Canterbury Tales*) mentions a Sheffield knife in the Reeve's Tale, and the Company of Cutlers was instrumental in shaping the city's industrial growth and its global reputation for craftsmanship. In a very real sense, the signs and codes of Sheffield's making culture are embedded in the very walls of this building.

Cutlers' Hall is approximately a 15-20 minute walk from the university campus, or a short walk from the city centre.



Exploring Sheffield: Points of Interest

Sheffield has a lot to offer beyond the Gatheringss programme. Whether you have a free evening, an early morning, or a weekend to extend your stay, here are some highlights worth exploring.

In the City Centre

The Sheffield Winter Garden on Surrey Street is one of the largest temperate glasshouses in the UK and one of the biggest urban glasshouses in Europe: free to enter and just minutes from the train station. Directly adjacent are the Peace Gardens.

Sheffield Cathedral on Church Street (directly opposite your Gatherings Dinner venue at Cutlers' Hall) is well worth a visit. Parts of the building date back over a thousand years, and it is free to enter.

The Millennium Gallery on Arundel Gate houses changing exhibitions of art, craft and design alongside a permanent collection of metalwork celebrating Sheffield's remarkable manufacturing heritage. Free entry.

Kelham Island

A short walk or tram ride from the city centre, Kelham Island is one of Sheffield's most compelling areas. It is a former industrial district that has reinvented itself as a hub for independent bars, restaurants, street food and creative businesses. At its heart is the Kelham Island Museum, free to enter and highly recommended. The centrepiece is the mighty River Don Engine, Europe's most powerful working steam engine, which can typically be seen working Thursday-Sunday. The surrounding streets are excellent for an evening out, with the historic Fat Cat pub and the Cutlery Works food hall among the highlights.

Museums and Galleries.

Weston Park Museum, adjacent to the university campus, houses natural history, archaeology and social history collections and is free to enter.

The National Videogame Museum is a popular and unusual attraction with over 100 playable games. The National Emergency Services Museum on West Bar is a quirky and fascinating collection of over 40 historic vehicles.

Green Spaces

Sheffield Botanical Gardens on Clarkehouse Road is a short walk from the conference venues, covering 19 acres including beautiful Victorian glasshouses, 18 themed garden areas and a wonderful collection of plants from around the world. Free to enter.

Endcliffe Park, a 10min walk from the campus along the Porter Brook valley, is a favourite local green space ideal for an early morning walk.

The Peak District

The Peak District National Park begins on the edge of the city and is easily reachable by bus from the city centre. The villages of Hathersage, Castleton and Bakewell are all within easy reach and make wonderful half-day excursions. Chatsworth House, the palatial ancestral home of the Duke and Duchess of Devonshire set in magnificent gardens, is approximately 45 minutes by car and well worth a visit, if time allows.

Music and Theatre

Sheffield has a deservedly strong reputation for live music. Look for *Exposed Magazine* (listing events) for what's on. Sheffield Theatres on Tudor Square comprises the Crucible, the Lyceum and the Playhouse hosting a varied programme of productions running throughout the year.

And not forgetting the quintessential British Pub!

Celebrated as the "Real Ale Capital of the World," Sheffield boasts around 58 breweries producing roughly 1,800 different beers annually. Its historic pubs, award-winning microbreweries, and dedicated craft beer taprooms provide one of the best beer scenes in the country. A couple you might enjoy include:

The Red Deer, The Bath House, Fagans, The Grapes, The Fat Cat, Kelham Island Tavern, The Mill Owners Arms, The Shakespeare, The Rutland Arms, Triple Point Brewery. And if spending time at the station before your train pop into The Sheffield Tap for one,

Programme at a Glance

Monday 27th July

First day of conference @ The Wave

Tuesday 28th July

Second day of conference @ The Wave

Wednesday 29th July

Third day of conference

Biosemiotics and the (Built) Environment

@ The The Arts Tower

Thursday 30th July

Fourth day of conference @ The Wave

Friday 31st July

Fifth & final day of conference @ The Wave

The 2026 Gatherings in Biosemiotics

27th to 31st July at the University of Sheffield, UK.

	Monday 27th July @ the Wave	Tuesday 28th July @ the Wave	Wednesday: E @ th
9.00	Hello & Welcome		
9.30	*Representation-in-Action: Naturalizing the Sign-Object Relation Through Morris's Behavioral Semiotics* Alice Zaccagnini	*A critical examination of the representations of wolf Umwelten in a Tourist package* Andrew Mark Creighton	Pau
10.00	*Meaning-making at the crossroads of the Theory of Autonomy and Biosemiotics: Biological Regulation through Memory and History* Eléa Pertusati	*The Systrophere: A Minimal Model of Pre-Symbolic Semiosis* Tiiu Kyllönen	*An innate langua*
10.30	*Sentient Technics: Necessary and Sufficient Conditions for Semiogenesis* Josh Bacigalupi	*The Face Behind the Sign: Physiognomic Science, Charles S. Peirce, and the Untold Origins of His Semiotic Project* Devon Schiller	*How is the id through visu regeneration p*
11.00	coffee break	coffee break	
11.30	*Plant behavior, meaning-making, and sign-satisfying conditions* Claudio Julio Rodriguez Higuera	*The Evolutionary Cost of Identity* Yagmur Denizhan and Vefa Karatay	*Back to the hea in anth*
12.00	*Endosphere and Exosphere: A Phytosemiotic Reading of Innenwelt and Umwelt* Federico Comollo	*Ethological Accounts of Evolution of Communication and Major Transitions in Evolution. Semiotic Criticisms Focusing the Role of Sociality* Sigmund Ongstad	*Green Façad Biological*
12.30	*Cats, Chimpanzees and Humans: Three Species and Models of Joint Agency* Filip Jaroš and Emanuel Jas	*Artificial Intelligence, Real Persons and Biosemiotics* John Pickering	*Sentient Te Biosc*
13.00	Lunch		
14.00	*A Foray into Meaning and Moral Relevance* Jonathan Beever	*Binary Analysis Yields a Theory of Evaluative Contrast in Diatonic Music* Devin Greenwood	*(Hu)Man and M*
14.30	*Life in Earth – a new look at the nature of life* Morten Tønnessen	*Objective Reality: Created, not Discovered?* Chris Barnham	*Making meanin*
15.00	*Info-autopoiesis and the Environment* Jaime F Cardenas-Garcia	*Artificial life, synthetic stupidity, death* Myrdene Anderson and Katja Pettinen	Judith va *Architecture o*
15.30	tea break	tea break	
16.00	*Complexifying the functional circle: Relating Von Uexküll and Merleau-Ponty* Kobus Marais	*The Geometry & Ecology of the Syntax* Thorolf vam Walsum	*When Buildings Coordinatio C*
16.30	*Towards a biosemiotic theoretical biology: Sign Processes and Meaning-Making in Living Systems* Kalevi Kull and Don Favareau	*Aesthetic Embodiments: An Expanded Approach to Biosemiotic Literary Criticism* Peter Lang	*Biosemiotics, t re*
17.00		*Biosemiotics and the lexicon of taste* Judith van der Elst, Frouke Wiarda and Guy van Belle	*Nature, A*
17.30			
18.30			

Semiotic processes in biology — Chair: Tim Ireland

Modelling semiotic processes — Chair: Victoria Alexander

Communication and Identity in the Built Environment — Chair: Paul Cobley

Semiotic approaches to ethology — Chair: Tim Ireland

The evolution and ontogeny of semiotic processes and mechanisms — Chair: Victoria Alexander

Semiotics of Morphology — Chair: Paul Cobley

Ecological biosemiotics — Chair: Sara Cannizzaro

Biosemiotics and cognition — Chair: Paul Cobley

Environmental and Ecological Perception — Chair: Tim Ireland

Biosemiotics of aesthetics — Chair: Paul Cobley

Semiotic Analysis of Built Environment — Chair: Tim Ireland

Please note the schedule is subject to change

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age of community: the civic centres of Alvar Aalto Yun Wu ~ *dentity of a place communicated ual media in large scale urban projects: Kings Cross & Battersea* Ina Manafova ~ *More-than-human Architecture* Ren and Simon Chadwick	*Shades of meaning: semantics of words and proteins in embedding space* Henrik Nielsen, Mariana Vitti-Rodrigues and Claus Emmeche *Autoimmunity: Proof of Concept for Biosemiotics* Victoria Alexander	*Environmental and biosemiotic perception as reflected in the poetic texts of Jaan Kaplinski: From the history and present state of Tartu biosemiotics* Ekaterina Velmezova *Life beyond itself* Barbora Jurková
coffee break	coffee break	coffee break
rt of the forest – structural thinking ropology and cell biology Marcella Faria *des and the Shifting Meaning of Growth in Built Environments* Maria Papanthymou *chnics: From a Cybernetic to a emiotic Mode of Growth* Josh Bacigalupi	Teaching Biosemiotics *Rountable/Short presentations* Don Favareau *Biosemiotics* Journal Editorial Board Meeting	The biosemiotics of health and disease Chair: Kobus Marais *The Gut-Microbiome-Brain Heterarchy: A Biosemiotic Model of Distributed Regulation* Rebeca Méndez-Veras *The fermentation revolution: The holobiont in contemporary microbial discourse* Prisca Augustyn *Artificial Intelligence (AI) in healthcare: exploring the implications of AI for the clinician-patient relationship through a biosemiotics framework* Sara Cannizzaro
ycelium: Ethics and Experience of Co-Creation Britta Bielak *g in measures, a spatial semiotic exploration* n der Elst & Frouke Wiarda *f Behavior Space: An Interactive Interpretant* Ole Møystad	Multi-level semiosis and integrative approaches Chair: Claudio Julio Rodriguez Higuera *Goethe and Grammar: A Batesonian Abduction towards a Theory of Context* Phillip Guddemi *Semiotic stabilization* Kalevi Kull *The Axes of Edibility: Food's Suprasubjective Objecthood* Emanuela Bove	Semiotic processes in biology Chair: Jana Švorcová *The Time of the Genetic Code: How Aminoacyl-tRNA Synthetases Generate a Molecular Specious Present* Praveen Prathapan *From Molecular Assembly to Basal Cognition: Biosemiotics, Codepoiesis, and the Emergence of Coherent Semiotic Fields* Oscar Castro Garcia *Exosome communication as an empirical model of cellular semiosis* Jenny Öhman
tea break	tea break	tea break
s Stop Carrying Forward: Semiotic on Failure in Multi-Stakeholder onstruction Systems Lars Herrmann *rauma and the built environment: searching complexity* Robin Johnson *Architecture & Human Being* Claudio Guerri	Peirce and Biosemiotic Technology Chair: Claudio Julio Rodriguez Higuera *Semiotic Nonagon: Taxonomy, Hyper-relations, and Biosemiotic Inquiry* Claudio Guerri *A Peircean theory of technology* Alin Olteanu *Artificial Symbionts of the Afterlife: Navigating Presence of Absence in the Posthuman Umwelt* Peter Mantello	*Metaphors To Survive By II: Becoming a (Meta)Sign in Biological Mimicry* Róbert Bohát *Living 'Organisms' Manifest Phenomenal Consciousness, Anticipatory Agency and Semiotic Freedom - Fabricated 'Mechanisms' Do Not.* Gary Goldberg Close
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The abstracts in this booklet are published as received from authors. The organising committee has not edited the content and cannot be held responsible for any errors, typos, or inaccuracies. This document is produced for conference reference purposes only and is not for wider publication.

Monday
27th July
@ the Wave

9.00 Hello & Welcome

Semiotic processes in biology
Chair: Tim Ireland

9.30 *Representation-in-Action: Naturalizing the Sign-Object Relation Through Morris's Behavioral Semiotics*
Alice Zaccagnini

10.00 *Meaning-making at the crossroads of the Theory of Autonomy and Biosemiotics: Biological Regulation through Memory and History*
Eléa Pertusati

10.30 *Sentient Technics: Necessary and Sufficient Conditions for Semiogenesis*
Josh Bacigalupi

11.00 coffee break

Semiotic approaches to ethology
Chair: Tim Ireland

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12.00 *Endosphere and Exosphere: A Phytosemiotic Reading of Innenwelt and Umwelt*
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12.30 *Cats, Chimpanzees and Humans: Three Species and Models of Joint Agency*
Filip Jaroš and Emanuel Jas

13.00 Lunch

Ecological biosemiotics
Chair: Sara Cannizzaro

14.00 *A Foray into Meaning and Moral Relevance*
Jonathan Beever

14.30 *Life in Earth – a new look at the nature of life*
Morten Tønnessen

15.00 *Info-autopoiesis and the Environment*
Jaime F Cardenas-Garcia

15.30 tea break

16.00 *Complexifying the functional circle: Relating Von Uexküll and Merleau-Ponty*
Kobus Marais

16.30 *Towards a biosemiotic theoretical biology: Sign Processes and Meaning-Making in Living Systems*
Kalevi Kull and Don Favareau

Day 1: Monday 27th July 2026

Abstracts

Semiotic processes in biology

Representation-in-Action: Naturalizing the Sign-Object Relation Through Morris's Behavioral Semiotics

Alice Zaccagnini

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The problem of sign-object representation runs through contemporary biosemiotics creating an apparently irresolvable tension. How can organisms interpret environmental objects without collapsing into either mentalism or mechanistic reductionism? This contribution argues that returning to American Pragmatism's roots, specifically the methodological behaviourism of G.H. Mead and C.W. Morris, provides a framework for understanding representation as simultaneously naturalized and meaningful. Although Morris was central to Thomas Sebeok's intellectual formation, his approach remains underexplored in contemporary biosemiotic discussions. The aim is to recover Charles Morris's behaviourist and biologically inspired semiotic methodology and to show how this approach can help reframe what we mean by "representation of the object."

Trained under Mead and influenced by Peirce, Charles Morris rearticulates Peircean triadic semiotics within a behaviourist framework (Morris, 1946). However, as he himself points out repeatedly, his behaviourism is far from a stimulus-response mechanistic view. On the contrary, Morris, like his teacher G. H.Mead (Mead, 1934), uses behaviourism as a methodological tool of investigation that recognizes the role of context and social interaction as fundamental. Although Morris avoids the term "representation" for fear of mentalist drifts, his analysis of Peirce's representamen (Peirce, 1931–1958) as the engine of a disposition-to-respond provides an important starting point for a theory of representation that occurs in action. In doing so, he combines the concept of interpretant with that of interpreter (Morris, 1946), extending the semiotic-interpretative process to non-human forms. It is precisely in the way mediation takes place that the distinction between symbol and signal - both classified as signs - is played out, and thus the boundaries between living forms, human and non-human, within this continuum.

Representation-interpretation, in this Morrisian sense, does not necessarily consist in "having an idea of an object," but may be the biological capacity to use a sign as a functional analogue of the object, enabling the organism to behave as if the object were present. Representation therefore takes place through the interpretant, not "within" an interpreter. In this sense, representation is neither a mirror image of the world nor a mental idea, but a teleological-dispositional mapping. The Morrisian disposition is not merely a response to what the environment offers, but the construction of a Peircean habit that organizes response sequences into behavioural families. Consequently, the "as if" dimension introduces the temporality of interpretation and the possibility of biological error - elements absent from Gibsonian realism (Gibson, 1979). Indeed, Morris's notion of the sign, in its various forms and modifications, retains the fundamental element of temporality: it is possible to draw a parallel between the behaviourist terminology in which the sign is defined and the reflections on present experience by William James (James, 1890) and G.H. Mead (Mead, 1938), which incorporate reference to both past and future.

The interpretant is therefore observable in behaviour as a response pattern, yet irreducible to mechanical causality because it is selected for its functional meaning in a particular context. A living system does not necessarily need to represent the world in a mentalist sense, yet it behaves as if it were representing - not by containing a

representation within itself, but by acting representationally. This apparent circularity is intentional: representation, on this account, is not a substrate but a functional description of a pattern of behaviour oriented toward an absent or anticipated object. In this way, as he himself wrote, the question of when to speak of signs or not relates to the empirical problem of the study of perception (Morris, 1946). Representation thus emerges as a strategy of mediation: a "representation-in-action" that allows the organism to free itself from immediate causality and enter the temporality of interpretation. When this process involves images or memory, it constitutes part of the symbolic capacity that makes the mind a function (Morris, 1925).

This contribution therefore aims to philosophically reconstruct those elements of American Pragmatism that resonate with current debates in biosemiotics. To do this, it will be necessary to clarify certain terminological issues and philosophical principles that underpin the thinking of the early pragmatists. The aim is to exhibit the structure of representation understood in this way - open, triadic, dispositional, sensorimotor, and temporal-habitual - through a comparative table set against the schemes of mechanism and mentalism; and, on the basis of this reconstruction, to show how a conception of representation as "representation-in-action" allows us to establish a critical proximity to post-cognitivist and enactive cognitive sciences, without adopting their representational eliminativism and while foregrounding the philosophical and epistemological difficulties of such an affiliation.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.

James, W. (1890). *The principles of psychology* (2 vols.). Henry Holt.

Mead, G. H. (1934). *Mind, self, and society from the standpoint of a social behaviorist* (C. W. Morris, Ed.). University of Chicago Press.

Mead, G. H. (1938). *The philosophy of the act* (C. W. Morris, J. M. Brewster, A. M. Dunham, & D. L. Miller, Eds.). University of Chicago Press.

Morris, C. W. (1925). *Symbolism and reality: A study in the nature of mind* [Doctoral dissertation, University of Chicago]. (Reprinted by John Benjamins, 1993.)

Morris, C. W. (1932). *Six theories of mind*. University of Chicago Press.

Morris, C. W. (1938). Foundations of the theory of signs. In O. Neurath, R. Carnap, & C. W. Morris (Eds.), *International encyclopedia of unified science* (Vol. 1, No. 2, pp. 1–59). University of Chicago Press.

Morris, C. W. (1946). *Signs, language and behavior*. Prentice-Hall.

Peirce, C. S. (1931–1958). *Collected papers of Charles Sanders Peirce* (Vols. 1–6, C. Hartshorne & P. Weiss, Eds.; Vols. 7–8, A. W. Burks, Ed.). Harvard University Press.

Meaning-making at the crossroads of the Autonomy Approach and Biosemiotics: Biological Regulation through Memory and History

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This contribution presents the working hypotheses of my PhD project, which focus on biological autonomy and semiosis through the integration of two approaches: the Autonomy Approach (Montévil, Mossio, Moreno, El-Hani, et al.) and Biosemiotics (Kull, Emmeche, Hoffmeyer, et al.).

An account of the semiotic triadic structure can contribute to the understanding of living system's stability, more precisely regulation through behavior. If the concept of "sense-making" in the context of biological autonomy has been studied by the enactivist tradition in cognitive sciences for many years without reference to semiotics (Varela, Thompson, Di Paolo, et al.), I propose that a distinction between unmediated and mediated organism-environment (sign structure) relationship reveals the potential of the semiotics framework in understanding biological autonomy. Yet, explaining the emergence of a sign structure through a naturalized biological theory remains challenging, especially regarding the long-lasting debate on representation. If sign structures are a necessary dimension of life, how to understand their causal efficacy without having to resort to exogenous entities?

I will argue that biological memory can provide the appropriate approach for this issue. Although biological memory is present in biosemiotic, notably through the notion of *habit* and the study of *epigenetics* (Švorcová, 2024), a focus on biological memory as foundation of sign structures requires further elaboration. Insofar as memory is a very general notion that designates the ability to "store information", the concept mostly belongs to neurosciences, informatics and, to some extent, applies to current Large Language Models. A reflection on biological memory proper is needed. I will argue that the organism-environment relationship can be understood as *mediated*, in a semiotic way, by the organism's own *history*, in the sense of Montévil (2020) and Hoffmeyer (2010).

Hoffmeyer, J. (2010). Semiotic Freedom: An emerging force. In P. Davies & H. Gregersen (Eds) *Information and the Nature of Reality*. Cambridge University Press, 2010.

Montévil, M. (2020). Historicity at the heart of biology. *Theory in Biosciences*, 141 (2): 165-173.

Švorcová, J. (2024) Plastic Ontogenesis: Memory, Closure, and Habitual Teleology in Development. In. J. Švorcová (Ed.), *Organismal Agency: Biological Concepts and their Biological Foundations*, Springer.

Sentient Technics: Necessary and Sufficient Conditions for Semiogenesis

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This presentation will be the second of two, whereby the first presentation argues for a transition from an extractive mode of growth – what I call Cybernetic Technics – to a mode of growth that intrinsically self-regulates its own adaptive semiosis at both the local and global scales – what I call Sentient Technics. Intrinsic to Sentient Technics is a veritable process of *semiogenesis*. This presentation will summarize the necessary and sufficient conditions for this semiogenesis: the individuation of ever-novel, increasingly complex and radically emergent sympathies that embody both the present and absential attributes of vital semiosis. To justify this claim, a novel technology, which is both buildable and empirically testable, will be proposed to emulate semiogenesis. Both the dynamics intrinsic to this technology and the theory to test it are triadic, in the Peircean sense.

The three distinct, interdependent and irreducible dynamics are Virtuality, Affinity and Affectuality, which correspond to Peirce's Firstness, Secondness and Thirdness, respectively. The theory will empirically test for semiogenesis (Š) by measuring three dynamical attributes of the proposed technology: Complexity (Č), Adaptive Work (∑W) and Self-regulation (Ř).

In summary, this technology and its emulation of semiosis includes a finite population of diversely sympathetic, or *resonant*, nodes immersed in a common continuous medium. This medium among nodes has the intrinsic capacity to embody a *transfinite* number of patterns – i.e., *infinite* in a *finite* bounded space, a concept discussed by Peirce and G. Cantor. These relatively ephemeral patterns are the superposed result of diverse nodal responses to both each other and the common medium's dynamical activity (Virtuality/Firstness). These nodes re-*form* themselves to in-*form* themselves by connecting along the sparse asymmetric order in the common medium's interference pattern; this is called *armoniataxis* (Affinity/Secondness). There is a productive tension between Virtuality and Affinity that is analogous to Lotman's concepts of *tension* and the *creative function*. However, a living semiosic system can veer too far into either abyssal Virtuality or an Affinity of fatal fixation. To maintain a productive balance between these two pernicious states requires a continual self-regulatory aesthetic drive (Affectuality/Thirdness). This will be shown to be the technical heart of a Sentient Technics.

Abstracts

Semiotic approaches in ethology

Plant behavior, meaning-making, and sign-satisfying conditions

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How do we ascribe sign usage to organisms? Generally, we look at their behavior and we speculate whether the kinds of signs the organism is using are describable within the framework of what I call the Sebeokian synthesis of biosemiotics, that is, through a simplified rendering of Peircean signs. This paradigm has been fairly successful at giving cognitive accounts of interpretation in organisms that may arguably also possess a complex phenomenal life. However, when it comes to organisms that defy our commonsense notions of sentience, sign usage becomes hampered by problems such as the icon-index divide and the lack of access to reportability from the side of the organism.

This paper will try to argue for a different starting point for talking about signs. Taking from Millikan (2017), albeit critically, I will try to show that, regardless of interpretive forms, we can account for signs as satisfying certain inherited truth conditions that are relevant to the organism. In order to make this argument I will be informed by recent accounts of plant cognition and sentience. The limits of phytosemiotics, I argue, can be unbound from sign types provided we reformulate the way signs come into place in biosemiotic theories. The upshot will be a potential avenue for thinking about non-representational models of cognition in organisms that do not lend themselves to cognitive analyses that more readily apply to non-sessile organisms.

Millikan, R. G. (2017). *Beyond concepts: unicepts, language, and natural information*. Oxford: Oxford university press.

Endosphere and Exosphere: A Phytosemiotic Reading of *Innenwelt* and *Umwelt*

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In the biosemiotic framework, plants are an under-researched (for now) yet consistent presence in discussions of *Umwelt* theory. Indeed, vegetal organisms are included in the general debate about semiotic meaning-making processes in other-than-human life. Building on von Uexküll's opening to plant semiosis (von Uexküll, 1909), later reinforced by the pivotal works of Krampen (1981) and Kull (2000), the existence of semiosis in plants has been partly recognised by the biosemiotics community. While botanical species are described as non-mechanistic beings capable of acting through their interpretative ability, phytosemiotic theory has some shortcomings: on the one hand, phytosemiosis is considered explainable through the *Umwelt* theory; on the other, a clear discussion of the functional circle of plants, and therefore the coordination of internal and external semiosis, is lacking from the debate. Indeed, the modularity of plants appears to be an obstacle to discussing them in classical biosemiotic terms: vegetal organisms are described as non-unitary and plural; furthermore, the absence of brains and centralised nervous systems makes it challenging to demonstrate the existence of a vegetal *Innenwelt*, which is necessary for a functional circle. Indeed, the concept of the "internal world" has been considered applicable only to unified organisms with specific cognitive characteristics. Apparently, the idea of collective semiotic agency seems to fit better with vegetal life, which should be considered an endosymbiotic union of different parts (and, therefore, different *Umwelten*).

In this paper, I return to von Uexküll's first intuition, but argue that a zoocentric bias prevents us from extending the discussion of plant semiosis further. Indeed, what has been seen as a lack of complexity, i.e., the non-unitary and modular nature of plants, on the contrary, enables them to operate both as a whole and at levels above and below individuality and unification, thereby exceeding our classical understanding of *Umwelt* and *Innenwelt*. Consequently, complex endosemiotic processes are required to coordinate plant actions across systemic, local, and more-than-individual layers of semiosis, necessitating the theorisation of vegetal internal semiosis. Starting from the question "What are the characteristics of a vegetal functional circle?", I claim that to understand and assess phytosemosis, we must engage with a phylogenetic idea of biosemiotics (Lineweaver, 2025), namely that through semiotic freedom, life kingdoms and even species evolved different forms of biosemiosis, bringing as a consequence the emergence of different *Umwelten* and *Innenwelten* that cannot be reduced to the same model. Therefore, after Thure von Uexküll's discussion on endosemiosis (von Uexküll et al., 1993), I propose adopting the concepts of "endosphere" and "exosphere" in phytosemiotics as vegetal alternatives to *Innenwelt* and *Umwelt*. In this way, we can focus on plant endosemiosis and exosemiosis, their differences, and the circumstances under which their boundaries fade. This approach enables a better understanding of essential plant traits without dismissing the *Umwelt* theory entirely; instead, it broadens it to encompass vegetal life more precisely.

Krampen, M. (1981). Phytosemiotics. *Semiotica*, *36*(3/4), 187–209.

Kull, K. (2000). An Introduction to Phytosemiotics: Semiotic Botany and Vegetative Sign Systems. *Sign Systems Studies*, *28*, 326–350.

Lineweaver, C. H. (2025). Phylogeny as the Basis for the Sub-fields of Biosemiotics. *Semiotica*, *264*, 171–194. https://doi.org/10.1515/sem-2023-0175.

Von Uexküll, J. (1909). *Umwelt und Innenwelt der Tiere* (1st ed.). Julius Springer.

Von Uexküll, T., *et al.* (1993). Endosemiosis. *Semiotica*, *96* (1-2), 5–52. https://doi.org/10.1515/semi.1993.96.1-2.5.

Cats, Chimpanzees and Humans: Three Species and Models of Joint Agency

Filip Jaroš, Emanuel Jas

According to Thomas A. Sebeok, every form of life is able to emit and comprehend signs. There are several cases of animal symbolic communication that lead to coordinated intentional actions (waggle dance of bees, play bow of canids). In general, joint agency is usually perceived as a ubiquitous biosocial phenomenon in recent biosemiotics (Rodríguez Higuera and Coca 2025; cf. Sharov and Tønnessen 2021, 118; Švorcová et al. 2024). Organisms as different as bees, canids, fish, and humans are interpreted as cooperative agents who can communicate with their conspecifics with respect to an object of their interest and coordinate their actions accordingly.

Such a view of (non-human) sociality is far from granted. Several disciplines both from philosophy (enactivism, philosophical anthropology) and science (comparative psychology) are highly sceptical about the ability of non-humans organism to share minds. De Jesus (2018) shows that enactive approaches cannot scale social cognitive capacities of different species due to their aversion towards representationalism. In comparative psychology, Carpenter and Call (2013) question whether apes truly share their attention during playful interactions and other interactive engagements.

In our presentation, we will argue that scepticism towards joint agency in non-human organisms has to do with anthropocentric leanings in philosophical accounts of joint cooperative activities (e.g. Bratman 1992). We will show a path towards a biosemiotic interpretation of the evolution of sociality by providing theoretical models of joint agency in cats, chimpanzees, and humans. While using some conceptual inputs from Tomasello (2022), we will restrain from perceiving cat cognition as a case of individually-intentional agency and chimpanzee cognition as a case of proto-human ("rational") agency. To decide whether a particular species is capable of *which* joint agency, we need to create operationalized concepts that are suitable not only for laboratory tests, but also for interactions of free-ranging animals.

Bratman, M. E. (1992). Shared Cooperative Activity. *Philosophical Review*, 101(2), 327–341.

Carpenter, M., & Call, J. (2013). How joint is the joint attention of apes and human infants? In J. Metcalfe, & H. S. Terrace (Eds.), *Agency and joint attention* (pp. 49-61). New York: Oxford University Press.

De Jesus, P. (2018). Thinking through enactive agency: sense-making, bio-semiosis and the ontologies of organismic worlds. *Phenom Cogn Sci,* 17, 861–887.

Rodríguez Higuera, C.J., & Coca, J.R. (2025). Joint Agency as a Semiotic and Biosocial Phenomenon. *Found Sci* https://doi.org/10.1007/s10699-025-10012-5

Sharov, A. A., & Tønnessen, M. (2021). *Semiotic agency. Science beyond mechanism*. Springer.

Švorcová, J. (Ed.), 2024. *Organismal Agency. Biological Concepts and Their Philosophical Foundations*. Springer.

Tomasello, M. (2022). *The Evolution of Agency: From Lizards to Humans*. MIT Press.

Abstracts

Ecological biosemiotics

A Foray into Meaning and Moral Relevance

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Contemporary animal ethics includes both "analytic" and "continental" philosophical approaches. On the analytic side, philosophers like Peter Singer (1971) and Mark Bernstein (2015) have developed accounts based around *sentience* as a least-common-denominator of intrinsic value. Sentience theorists argue that an organism's sentience, its capacity to experience pleasures or pains – to be better or worse off – justifies for it having value in and of itself. On the continental side, philosophers like Ted Toadvine and David Abrams, driven by post-structuralist scholars like Donna Haraway and Gilles Deleuze, have offered accounts of animal worth grounded in their experiences and animality. In each case questions of moral considerability remain either unchallenged or underrepresented. Indeed, animal ethics has shifted from solidifying a core account driven by philosophy of *why* animals matter (now taken as resolved and accepted) to minutae about psychology, knowledge, and abilities of specific organisms coming from a hugely diverse range of disciplinary perspectives (see Aaltola and Hadley 2015). Yet we remain stuck on sentience**.** However, I argue that increasingly strong scientific and biological evidence pushes moral intuition to extend the scope of moral considerability beyond the boundaries of sentience.

A good example of such evidence is the recent public success of accounts of the octopus (Godfrey-Smith 2017, Montgomery 2016, Demarillacq et al. 2015), reflecting the broad intuitive appeal of its capacities and moral worth. Importantly, books like these identify ways in which "traditional" philosophical accounts of moral relevance don't seem to apply to cases that come to seem intuitively plausible, thanks to increasingly empirical evidence. Similar arguments have recently developed about the capacities of trees too; e.g., their abilities to communicate, organize, and express distress (e.g. Wohlleben 2016). Neither octopi nor trees easily fit accounts of sentience – it doesn't seem to make sense that they "experience pleasures or pains" – yet they both have begun to creep into our cultural moral imagination as well as our scientific inquiries. Thus, a new account of moral considerability is needed.

This presentation outlines an in-progress philosophical project that develops a biosemiotics account of meaning making as the ground of moral considerability. I will outline the bifurcated problem of moral considerability as a tension between identifying the set of things that are morally valuable and the extent to which moral agents are responsible for them. I argue that a biosemiotic environmental ethic offers satisfying answers to both questions in ways that other approaches (like deep ecology, sentience theory, and ecophenomenology) historically have not.

In support of the first problem, I build on my and others previous work to support the case that an individual's capacity to make and interpret meaning within its world of experience (to *signify*) is reason enough to think that they are morally relevant. From this perspective, I argue that (at least) each and every living organism is morally relevant. In support of the second problem, I argue (following John Deely and others) that moral agents are best defined by their semiotic capacity; that is, their capacity to recognize and interpret signs as such. This not only differentiates semiotics from semiosis but also moral agents from moral patients. On this reading, semiotic agents are responsible for the semiosphere due to their capacity to interpret signs as such and, therefore, to see the value of semiosis.

My presentation will conclude with space for questions and critique, to strengthen the project with support of the biosemiotics community.

Aaltola, E. and Hadley, J. (Eds.). 2014. *Animal Ethics & Philosophy*: *Questioning the Orthodoxy*. Rowman and Littlefield, International.

Bernstein, M.H. 2015. *The Moral Equality of Humans and Animals*. London: Palgrave MacMillan.

Demarillacq, A-S., L. Dickel, & J. Mather. 2015. *Cephalopod Cognition*. Cambridge: Cambridge University Press.

Godfrey-Smith, P. 2017. *Other Minds: The Octopus and the Evolution of Intelligent Life*. William Collins.

Montgomery, S. 2016. *The Soul of an Octopus*. New York: Atria Paperback.

Singer, P. [1971]1990. *Animal Liberation*, Revised edition. New York: Avon Books.

Wohlleben, P. 2016. *The Hidden Life of Trees: What They Feels, How They Communicate*. Trans. J. Billinghurst. Vancouver: Greystone Books.

Life in Earth – a new look at the nature of life

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The global survey of biomass by Bar-On, Phillips and Milo (2018) has shown that subterranean life occurs at far greater depths, and is more abundant, than previously assumed. Life in the marine deep subsurface, i.e., subterranean life *under* the oceans, is actually more abundant than life *in* the oceans (ibid., see also Ruff et al. 2024). The existence of microbial, fungal and animal subterranean lifeforms raises ethical and political questions about the consequences of human activities in the marine deep subsurface and other subterranean environments.

As Dunn (2021) narrates, human beings are biased towards the organisms that look the most like us and inhabit a similar environment, while we habitually ignore the majority of odd and unfamiliar lifeforms. We know relatively little about the life that dwells in deep-sea environments – and even less about life in the deep subsurface. As is well known, photosynthesis is the dominant source of oxygen for most organisms. However, recent research documenting the assembly of 'dark oxygen' in deep-sea environments in the Pacific Ocean has revealed that photosynthesis is not the only source of oxygen on Earth (Sweatman et al. 2024). A further source appears to be 'geo-batteries' related to seawater electrolysis in seafloor areas covered by polymetallic nodules, i.e. multimetallic lumps. This discovery might change our outlook on how life has developed, and particularly our understanding of life in deep-sea and seafloor environments.

Recent research has further established that subseafloor cavities beneath hydrothermal vents are inhabited not only by microbes and viruses, but also by animals such as tubeworms and mussels (Bright, Gollner et al. 2024). Three tubeworm species included in the study of Bright, Gollner et al. (2024) uniquely rely entirely on a bacterial symbiont, which in turn "live off the chemicals released by the vents" for nutrition (The Economist, 2024). These tubeworms living in a subsurface environment below the seabed do not rely on nutrition originating from the surface – and ultimately photosynthesis drawn from energy from the sun – but rather on nutrients originating from deep inside Earth. This recent discovery of animal habitats in the subseafloor "expands the known macrofaunal biosphere" to new depths that was entirely unknown until a couple of years ago (Bright, Gollner et al. 2024: 2).

Based on these recent scientific findings, I will briefly discuss these core questions: To the best of our current knowledge, what is the full range of liveable environments on Earth, and the full spectrum of lifeforms on Earth? How do these discoveries change our outlook on the lifeworlds and biosemiosis of animals and other organisms, and how can they inform our efforts to develop more representative lifeworld models in biosemiotics?

Bar-On, Y. M., R. Phillips and R. Milo (2018). The biomass distribution on Earth. *Proceedings of the National Academy of Sciences (PNAS)*, 115 (25): 6506–11. https://doi.org/10.1073/pnas.1711842115. Includes Supplementary Information Appendix, https://www.pnas.org/doi/10.1073/pnas.1711842115#supplementary-materials.

Bright, M., S. Gollner et al. (2024), 'Animal life in the shallow subseafloor crust at deep-sea hydrothermal vents', *Nature Communications*, 15: 8466. https://doi.org/10.1038/s41467-024-52631-9

Dunn, Rob (2021). *A Natural History of the Future: What the Laws of Biology Tell Us About the Destiny of the Human Species*. Basic Books.

The Economist (2024), ‘Life finds a way: Tubeworms live beneath the planetary crust around deep-sea vents’. Available online: https://www.economist.com/science-and-technology/2024/10/16/tubeworms-live-beneath-the-planetary-crust-around-deep-sea-vents

Ruff, S. E. et al. (2024), ‘A global comparison of surface and subsurface microbiomes reveals large-scale biodiversity gradients, and a marine-terrestrial divide’, *Science Advances*, 10 (51): eadq0645.

Sweatman, A. K. et al. (2024), ‘Evidence of dark oxygen production at the abyssal seafloor’, *Nature Geoscience*, 17: 737–9. https://doi.org/10.1038/s41561-024-01480-8

Info-autopoiesis and the Environment

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How does Claude E. Shannon's mathematical theory of communication intersect with the environments we build and inhabit? Communication and the creation of meaning are not just abstract processes—they are fundamental to the way humans and other living beings shape the world around them. But how exactly is meaning embedded into the physical forms and artifacts that populate both human and non-human worlds?

This discussion explores the central role of artifact-making in existence. In the mid-twentieth century, Shannon's work marked the dawn of the so-called Information Age, coinciding with the rise of digital computers. Since then, the explosive growth of computing and artificial intelligence has sparked ongoing debates about the capabilities and boundaries of these technologies, including provocative claims about the potential for AI consciousness.

Gregory Bateson's perspective further enriches this conversation. Bateson defined information as "a difference which makes a difference" to living beings. This view expands upon in subsuming Shannon's ideas, emphasizing that living organisms are not passive recipients of information but active creators—what we might call info-autopoietic beings. To truly understand information, we must focus on the living context: how organisms perceive, interpret, and generate meaning from sensory signals within their environments.

This approach challenges the widespread but mistaken belief that information is a fundamental quantity that permeates the universe. Instead, it leads us to examine the unique characteristics of information in living systems, to distinguish between syntactic (structural) and semantic (meaningful) information, and to consider how these forms interact dynamically. These distinctions are crucial for understanding both the creation of artifacts—whether by humans or other organisms—and the inherent limits of our ability to make and imbue meaning in the built environment.

In essence, info-autopoiesis describes a recursive, self-reinforcing cycle: sensation leads to information, which prompts action, which in turn generates new sensations and information. This cycle underpins the ongoing, self-driven production of information by living beings, manifesting as artifacts within our constructed environments.

To put the scale of human artifact-making into perspective, recent research has found that the mass of human-made materials—what scientists call anthropogenic mass—has doubled every 20 years since 1900. While the total biomass of living things has remained relatively stable, plant biomass has declined by about half since agriculture began some 12,000 years ago. Remarkably, the weight of human-made objects now exceeds that of all living biomass on Earth (Pappas 2020).

Pappas, Stephanie. 2020. Human-Made Stuff Now Outweighs All Life on Earth. *Scientific American*. Accessed April 8, 2023. doi:https://www.scientificamerican.com/article/human-made-stuff-now-outweighs-all-life-on-earth/#.

Complexifying the functional circle: Relating von Uexküll and Merleau-Ponty

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With his conceptualisation of the functional circle, Von Uexküll (Sharov & Tönneson, 2021; Von Uexkül, 1926; 2010) provided a minimalist model of the ecological relationship between organisms and their Umwelten. This model made it possible to map any ecological relationship because of its simplicity. However, organisms evolved to include really complex ones, biosemiotically speaking. This raises the question about the extent to which a simplified model can explain the complexity of emergent biosemiotic processes.

Philosophers like Merleau-Ponty ([1945] 2102; 1968) tried to think through the implications of perception as embodied in the functional circle of human organisms. One of the partially answered questions remaining in the philosophy-biosemiotic dialogue is that of the complex semiotic experience of human organisms and its relationship to the biology of the organisms with such complex experience.

In this presentation, I explore a dialogue between Von Uexkull and Merleau-Ponty. I investigate how increasingly complex semiotic systems in higher and human organisms relate to the functional circle. If one assumes that only material differences will register on the perception organs of an organism, it means that complex biosemiotic processes, like social structures and cultures, need to be materialised to become part of the functional circle of an individual organism. Thus, the absential and the sential need to be explained as entangled in the organism. The goal is to add more materialism, particularly energy, to Merleau-Ponty and explore how Von Uexkull needs to be expanded to allow for the causative role of material absentials like ideals.

Merleau-Ponty, M. ([1945] 2102). *Phenomenology of perception.* (D. A. Landes, Trans.) New York: Routledge.

Merleau-Ponty, M. (1968). *The visible and the invisible.* (C. Lefort, Ed., & A. Lingis, Trans.) Evanston: Northwestern University Press.

Sharov, A., & Tonneson, M. (2021). *Semiotic agency: Science beyond mechanism.* Dordrecht: Springer.

Von Uexkull, J. (1926). *Theoretical biology.* London: Kegan Paul, Trensch, Trubner & Co Ltd.

Von Uexkull, J. (2010). *A foray into the worlds of animals and humans: With a theory of meaning.* (J. D. O'Neil, Trans.) Minneapolis: University of Minnesota Press.

Tuesday
28th July
@ the Wave

Modelling semiotic processes
Chair: Victoria Alexander

9.30 *A critical examination of the representations of wolf Umwelten in a Tourist package*
Andrew Mark Creighton

10.00 *The Systrophere: A Minimal Model of Pre-Symbolic Semiosis*
Tiiu Kyllönen

10.30 *The Face Behind the Sign: Physiognomic Science, Charles S. Peirce, and the Untold Origins of His Semiotic Project*
Devon Schiller

11.00 coffee break

The evolution and ontogeny of semiotic processes and mechanisms
Chair: Victoria Alexander

11.30 *The Evolutionary Cost of Identity*
Yagmur Denizhan and Vefa Karatay

12.00 *Ethological Accounts of Evolution of Communication and Major Transitions in Evolution. Semiotic Criticisms Focusing the Role of Sociality*
Sigmund Ongstad

12.30 *Artificial Intelligence, Real Persons and Biosemiotics*
John Pickering

13.00

Biosemiotics and cognition
Chair: Paul Cobley

14.00 *Binary Analysis Yields a Theory of Evaluative Contrast in Diatonic Music*
Devin Greenwood

14.30 *Objective Reality: Created, not Discovered?*
Chris Barnham

15.00 *Artificial life, synthetic stupidity, death*
Myrdene Anderson and Katja Pettinen

15.30 tea break

Biosemiotics of aesthetics
Chair: Paul Cobley

16.00 *The Geometry & Ecology of the Syntax*
Thorolf vam Walsum

16.30 *Aesthetic Embodiments: An Expanded Approach to Biosemiotic Literary Criticism*
Peter Lang

17.00 *Biosemiotics and the lexicon of taste*
Judith van der Elst, Frouke Wiarda and Guy van Belle

Day 2: Tuesday 28th July 2026

Abstracts

Modelling semiotic processes

A critical examination of the representations of wolf Umwelten in a tourist package

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In this presentation, I will examine how nonhuman animal Umwelten are constructed as a means to entice and structure tourist packages. Specifically, I will investigate Calm Air's promotion, 'Howling with Wolves in Thompson', and its construction of wolf Umwelten as a means to build collective representations of the nonhuman animal, developing a collective consciousness around it within the tourist group, and promoting and developing a consumer experience through enchanted representations. To accomplish this, I will present a study of the package's itinerary and descriptions, while applying semiotic and cultural sociological theory to help organise and interpret the study. The semiotic frame that I will apply pulls largely from zoosemiotics, especially Jakob von Uexküll's concept of Umwelt, and proceeding scholarship from semioticians like Timo Maran and Nelly Mäekivi. This semiotic frame allows a means to organise and critically compare wolf Umwelten, here specifically social and environmental aspects, as constructed by advertising and the tourist package with more zoosemiotic accounts. The cultural sociological frame, coming from Jeffrey C. Alexander's work, offers a means to establish wolves in relation to humans and the environment, presenting them as actors within a wider dramaturgical frame used to construct a collective consciousness through shared meanings. Lastly, I will use my previous work on Thompson, Manitoba and the associated 'wolf economy' – influenced by Jean Baudrillard, zoosemiotics, cultural sociology, and George Ritzer – to present a critical understanding of the wider economic and cultural context of local tourism. This presentation will conclude, arguing that Calm Air draws many lessons from Thompson's wolf economy regarding the construction and simulation of wolf Umwelt as intersubjective with humans, but builds upon this by emphasising the wolf as a mysterious and elusive entity, deeply ingrained in Cree culture. This anthropocentric view of the nonhuman animal's Umwelt, legitimised by indigenous knowledge, in turn allows a more effective means to construct a collective consciousness around touristic experiences. Such a construction is only exacerbated by the social organisation of the tourist package, which is inclined towards small groups and constant immersive wolf-centred narratives, excursions, and practices. The consequences of the meanings and organisation of this package allow an immersive form of consumption that greatly blurs the meanings of wolf Umwelten and complicates attempts to understand their real experiences.

The Systrophere: A Minimal Model of Pre-Symbolic Semiosis

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A core challenge in semiotics, cognitive science, and philosophy of language is accounting for the emergence of meaning in systems that lack symbols, representations, or pre-established semantic units. Traditional approaches assume an interpreting agent or symbolic mediation; few models demonstrate how semiosis can arise from dynamical processes alone.

The Systrophere is a minimal computational model for studying how multi-level order can arise from local dynamics. It consists of connected cells on an icosahedral sphere, forming an excitable medium governed by self-regulation. Local prediction error (akin to internal stress) dynamically regulates the coupling strength within the cell's local neighbourhood. The icosahedral lattice provides a closed geometry that allows continuous circulation across the system and thus enables long-term spatiotemporal patterns without a global controller.

Despite the simplicity of the local rules, the system develops structured order across multiple, interacting scales, exceeding what would be expected from dissipative nonlinear oscillation alone. At the microscale, individual cells develop habit-like tendencies by biasing responses to similar local conditions. At the mesoscale, persistent spatiotemporal scroll wave patterns act as dynamical units that coordinate and transmit constraints across the system. At the macroscale, order becomes visible only when the system is viewed as a whole. A quantified analysis using spherical harmonics reveals that particular harmonic modes gradually stabilise, and the magnitude of spectral fluctuations declines, even as the entropy within local interactions remain variable.

From a biosemiotic perspective, the model suggests that meaning-like structure arises from how constraints are historically negotiated and sustained across the system, not from symbol use or message passing. The observed transition toward higher-order consolidation via local stress sharing and adaptive coupling is consistent with self-organised criticality frameworks, suggesting that semiosis can arise as a property of systems poised between rigidity and disorder. In Peircean terms, semiosis in the Systrophere can be understood dynamically: Firstness appears as local qualitative variation, Secondness as constraint-laden wave interactions, and Thirdness as the emergence of habit-like global pattern regularities that increasingly govern the system's future dynamics, looping back to shape the cell layer.

The Systrophere thus provides a minimal, fully dynamical and analysis-ready testbed for studying pre-symbolic semiosis in a controlled, computable setting. Rather than treating meaning as something encoded, transmitted, or interpreted by an external agent, the model shows how meaning-relevant structure can arise from the historical stabilisation of constraints that shape their possible trajectories. The Systrophere thus treats semiosis as something measurable in a dynamical system, rather than as a representational achievement. It gives semiotic, biosemiotic, and computational approaches to meaning a shared object to study.

The Face Behind the Sign: Physiognomic Science, Charles S. Peirce, and the Untold Origins of His Semiotic Project

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I propose here the first-ever historicization for Charles S. Peirce's (1839–1914) studies of facial signs, that is, for *Peircean faciasemiotics*. Theorized at a time during the long nineteenth century when scientific racism was at its peak, I contend that Peirce's semiotics of facial behavior is unusual, if not unique, in physiognomic thought and its protracted tradition. In contrast to many, if not most, of his contemporaries who study the relation between *outer* attributes, *inner* character, and *inside out* measurement, like Darwin or Galton, Peirce neither contests nor confirms the specific prejudices of physiognomic stereotyping. Rather, Peirce applies a pseudo-Aristotelian physiognomy toward developing his principal concepts, such as abductive inference, diagrammatic reason, and pragmatic logic. To Peirce, physiognomy is the foundational protoscience behind modern psychology. Most significantly for *semiohistory*, Peirce himself applies physiognomy in the theoretical systemization of his *semeiotic* thought. As I argue here, this history of ideas between classical physiognomy and contemporary semiotics across Peirce's life and his legacy not only precisely inspired the revolutionary emergence of artificial intelligence but also potentially informs the reflexive explication of facial recognition. For the critical analysis of this intellectual genealogy, I explore previously unpublished archival manuscripts. Peirce's studies in physiognomic science include, for instance: personal catalogues of library collections that record his reading an 1832 edition of Lavater's *Essays* and 1840 edition of Holcroft's translation; physiognomic sketches in series, profile, and application, based on Lavater's *Essays*, from his school days in the late 1840s and the early 1850s; his earliest known written paper, a treatise on physiognomy also inspired by Lavater, which he called both *The Dynamics of Persuasion* and *The Mechanics of Volition,* and he composed at the Cambridge High School in the early 1850s; logic notes for lecture series, first those given at the Lowell Institute in 1866, and second those given at the Johns Hopkins in 1883; an anthropometrical physiognomic experiment on exceptional scientific psychologies conducted at Johns Hopkins in 1884 with measurement instructions for physiognomic signs; and logic diagrams of physiognomic syllogisms from late in his life around 1906–1908 in contemplation of Aristotle and Lavater. Of course, different scholars have proposed diverse sources behind Peirce and his philosophy. Many reference his readings of Whately's *Logic*, Schiller's *Aesthetic Education*, or Kant's *Critique of Pure Reason*. Some consider his correspondence with Victoria Welby or his meetings with the Metaphysical Club. Still others point out his specific experiences in the experimental sciences, from geodesy, through metrology and physics, to psychology. However, as I illustrate here, these interpretations are incomplete. Most, but not all, of these histories begin from only Peirce's later professions. Whereas I trace *Peirceanism*, and Peirce's pragmatist approach for what today we term applied biosemiotics, to his childhood physiognomic interests, which he himself expresses in drawings and writings.

Abstracts

The evolution and ontogeny of semiotic processes and mechanisms

The Evolutionary Cost of Identity

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Individuality and identity are important and inter-related philosophical concepts in biology and beyond. There exists a long and complicate intellectual lineage that amounts to modern scientific viewpoints. Unfortunately, most of them suffer from the remnants of ancient doctrines like atomism and hylemorphism. Current biological theories usually take it for granted that the organism, in its full-fledged totality and complexity, is the possessor of these properties, namely biological individuality and identity. Enclosing surfaces are assumed to constitute the spatial criterion of biological identity, while genes the temporal one. Such a "snapshot" view that is based on an ontology of being, rather than that of becoming, has an obvious weakness in solving the hard problems of biology such as the origin of life or even what life is.

However, as the focus of biology shifts towards a process-oriented view of life, it becomes increasingly clear that biological identity is the outcome of an individuation process. As the individual becomes more and more structured, losing its metastable potential, it eventually reaches a point of no return. In this respect, multicellularity, which Hoffmeyer considers the source of the inevitability of death (Hoffmeyer 2015), can be seen as a special case rather than an absolute criterion. Although the vast majority of multicellular organisms are indeed mortal, there are exceptions like the *immortal jellyfish* or the *hydra* (sometimes referred to as an "eternal embryo") (Khokhlov 2014). We find a more abstract and encompassing conceptualisation of the notion of a life-span and the inevitability of death in Gilbert Simondon's Theory of Individuation where he asserts that "for each *type* of organization, there is a threshold of irreversibility beyond which all progress made by the individual (every acquired structuration) is a chance of death." (Simondon 2020, p. 263)

This clearly demonstrates an ironical dilemma: The cost of a well-individuated and well-preserved identity is the inevitability of its eventual termination, while the prize of preservation of inherent metastability and relational openness is longevity. A well-developed identity means strong commitment to and dependence on the norms that have emerged in the evolutionary/developmental course, as well as on the standardisation of processes and operational regimes, securing division of labour and compatibility across multiple organisational levels, thus rendering organisational complexity affordable.

In this contribution we will investigate the mechanisms by which metastability is lost in living beings, with special emphasis on semiotic individuation.

Hoffmeyer, J. (2015). Semiotic Scaffolding of Multicellularity. *Biosemiotics*, 8, 153–158. https://doi.org/10.1007/s12304-015-9231-6

Khokhlov, A.N. (2014). On the immortal hydra. Again. *Moscow Univ. Biol. Sci. Bull.* 69, 153–157. https://doi.org/10.3103/S0096392514040063

Simondon, G. (2020). *Individuation in light of notions of form and information.* (Trans.) Taylor Adkins. Minneapolis: University of Minnesota Press.

Ethological Accounts of Evolution of Communication and Major Transitions in Evolution. Semiotic Criticisms Focusing the Role of Sociality

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Hauser (1996) studies the evolution of communication (EOC), restricting perceptions of communication to information, signal, and cues. Although ethology applies a Sender-Message-Receiver (SMR) model for studying communication Hauser's perspective is systemic. Scott-Phillips (2013), also studying EOC, further considers communication as an interactive phenomenon, arguing that evolutionary biology recognises this fact when defining communication: Signals are actions causing reactions, where both are reciprocally designed. Still, Phillips holds as unlikely that mutually dependent behaviors emerge simultaneously.

Evolution and communicating are wide concepts. Smith & Szathmary (1997) introduced the notion *major transitions*, to catch an essence. They suggested eight transitions in evolution (MTE) where the 8th (and last) is a transition from primate to human societies. Their set has been widely applied and criticised. Evolutionary emergence of *sociality* has received specific attention leading to studies of evolution and kinds of socialities.

Recent ethological studies of evolution, communication, and their internal relations have more often adopted systemic and interactive perceptions. Evolutionary biology and ethological studies have nevertheless kept their SMR model when designing empirical studies favoring concepts for communication such as code, information, signal, and cues. While this priority may seem 'scientific' and functional studying early life, this discourse faces troubles when the perspective is stretched from Big Bang to humans. The positioning leads both to reluctance to discuss the social aspect's function in evolution and communication and to an insisting on that evolution causes communication.

By contrast, for instance Sharov (2021) has claimed that communication generates evolution, arguing that semiosis, which is communication, is necessary for life. Sharov further opposes the Modern Synthesis and the so-called Extended Evolutionary Synthesis, claiming that concepts such as sign, habit, and umwelt, and in addition conceptional sub-sets such as agency, autonomy, semiosis, interpretation, and goal-directedness are causes as well as effects of evolution. Also, from a socio-semiotic perspective one can argue that the social and hence the pragmatic aspect of communication are crucial. Pragmatics can trace and explain evolutionary developments of sociality of particular species when *communication* is seen as a complementary perspective to *signification*. Similarly socio-semiotic concepts such as utterance, life-genre, and lifeworld can characterise evolutionary traits especially focusing hominids. This study hence investigates the role of primates' sociality in relation to late stages in the evolution of (complex) communication.

All the above semiotic concepts contribute to development of more complex views on sociality and mentality. They even represent a necessary extension of the biological communication concept. These positionings further imply a *semiotic systemic* perspective, extending the SMR model without refuting the value of recent ethological, empirical studies of animal communication. An integrated system allows *sociality* to be seen both as a communicative driving-force and an evolutionary outcome. Advanced communicational forms could hardly have emerged without systemic, interactive, and semiotic communication. A macro, and hence a social perspective on the evolution of

communication seems inevitable.

Hauser, M. D. (1996). *The evolution of communication*. MIT press.
Scott-Phillips, T. (2010). The evolution of communication. *Interaction Studies*, *11*(1), 78-99.
Smith, J. M., & Szathmary, E. (1997). *The major transitions in evolution*. Oxford UP.
Sharov, A. (2021). Towards a biosemiotic theory of evolution. *Biosemiotics*, *14*(1), 101-105.

Artificial Intelligence, Real Persons and Biosemiotics

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A Spectre is haunting Humanity, the Spectre of Artificial Intelligence. A recent best-seller was entitled *If Anyone Builds It, Everyone Dies: Why Superhuman AI Would Kill Us All*.

Alarmism sells books, but is unhelpful in trying to understand the effects of disruptive technologies like AI. This is a vital political task now and for the foreseeable future. Moreover, the political becomes the personal if and when AI changes how we think of ourselves as persons and how we are to live with and relate to other persons with whom we share the semiosphere. It's here that biosemiotics can help.

In what sense might AI achieve personhood? While it may give a striking appearance of having done so, it is no more than that, an appearance, a simulacrum. However, when the simulacrum becomes accepted as reality, we have slipped into hyper-reality, as Baudrillard pointed out decades ago (Baudrillard, 1981).

A fundamental question here is whether some things should remain a human monopoly. We may accept that AI is a useful tool in education, medicine and law, but when we need inspiring teaching, humane treatment or a fair judgement, we want it from a person. The problem, in Baudrillard's terms, is that when a simulacrum of a person is sufficiently good to be indistinguishable from and hence treated as an actual person, human personhood becomes less authentic

To solve that problem, it is well to remember the emphasis that both biosemioticians and process-relational philosophers place on bodies. Bodies feel and hence have embodied intentionality. Bodies also die, and realising that is going to happen before it does is part of personhood. For Heidegger accepting that realisation is crucial to living authentically.

This paper will show that AI has neither such realisation nor embodied intentionality and never will. Biosemiotics deals with the sign-processes in and between living systems and for all that AI is sometimes presented as a living system by over-enthusiastic futurists, it clearly is not.

While AI is able to pass the Turing test, which in any case is a weak test, a more important question is whether it can pass what might be called the Deely test. According to Deeley "What distinguishes the human being from the other animals is that only human animals come to realize that there are signs distinct from and superordinate to every particular thing that serves to constitute an individual in its distinctness from its surroundings." (see Rattasepp & Kull, 2016 for the context).

AI systems aren't animals, with all that that implies about embodied intentionality, let alone human beings. While they may appear to talk intelligibly about signs and signification, they will not understand what they're talking about in the Deely sense of realising what a sign is apart from what it signifies.

This is sometimes dismissed as defending an outdated image of what it is to be a living system, including human beings. But this is an ironic misconception. What is outdated is the reductionist megalomania of those who believe that AI can achieve genuine personhood.

This paper will expand that claim using ideas from process-relational metaphysics and psychoanalysis. It will conclude, following Simondon, by suggesting how humanity and AI might co-evolve.

Rattasepp, S., & Kull, K. (2016). The Semiotic Species: Deelying with Animals in Philosophy. *The American Journal of Semiotics,* 32, 35-48.

Baudrillard, Jean (1981). *Simulacres et simulation*. Paris: Galilée. English translation appeared in 1994 as *Simulacra and Simulation*, translated by S. F. Glaser. Ann Arbor: University of Michigan Press.

Abstracts

Biosemiotics of cognition

Binary Analysis Yields a Theory of Evaluative Contrast in Diatonic Music

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Markedness is a term that refers to an emergent quality of languages in which meaning is conveyed through binary oppositions. It gives us a well-founded analytical framework for characterizing meaning patterns in language while grounding them firmly in perception (Battistella, 1990).

Musical discussions of markedness have ranged from interpretive analysis (Hatten, 1994) to existentialist semiotics (Tarasti, 2002) but have tended to avoid approaches focusing on structural semantics.

I will argue that perception is fundamental to markedness theory, and that a theory

of *markedness perception*—in which terms are defined by temporal relationships rather than fixed ones—makes a purely structuralist approach to diatonic markedness possible.

Using Roman Jakobson's approach from linguistics (sometimes called binary analysis), I will answer the following questions:

How is perceptual contrast being maintained at fundamental levels?

Can the structures identified be defined as semantic oppositions?

Do the terms of these oppositions relate in way that demonstrates evaluative nonequivalence?

Do markedness values in different modalities agree?

I will show that answers to these questions lead to the subdivision of the octave into two distinct semantic *terms* with features that set them into binary opposition: whole tone structures, defined by mathematical and perceptual contrast, with structural relations based in Roman Jakobson's binary analysis.

When expanded to include harmony and rhythm, binary analysis further reveals what linguists call *markedness assimilation*: the tendency for values to agree across distinct modalities (Battistella, 1990). This means that in addition to identifying the semantic terms, binary analysis accounts for how dialogue between them can organize the larger musical sign system.

In summary, binary analysis applied to a theory of evaluative contrast (*markedness perception*) yields a powerful new explanatory model for diatonic music, grounding all structural and expressive aspects of musical signification in perception.

Battistella, E. (1990). *Markedness: The evaluative superstructure of language*. State University of New York Press.

Hatten, R. S. (1994). *Musical meaning in Beethoven: Markedness, correlation, and interpretation*. Indiana University Press.

Tarasti, E. (2002). *Signs of music: A guide to musical semiotics*. Mouton de Gruyter.

Objective Reality: Created, Not Discovered?

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Descartes division between *res extensa* and *res cogitans* dualism has resulted in a damaging split between Nature and Culture. Biosemiotics often seeks to solve this problem by *extending subjectivity* into the mechanistic world (J. von Uexküll: 1982: 27-8; Stjernfelt: 1991: 440). In contrast, this paper seeks to tackle dualism from the opposite direction. It seeks to show how modernity has created (rather than 'discovered') objectivity.

Modernity accepts a perceptual model that *necessarily* separates our perceptions from each other and the perceiver from the world. The key factor causing this problem is our conviction that we know the identity of our sense data – a belief that both Hegel (Hegel: 1812: 58) and Peirce (CP7: 625) rejected. It is a model that leads directly to Hume's sceptical treatment of causation, induction and identity etc. (Hume: 1748). In the 18C, in what would otherwise have been an epistemological crisis, western science offered a potential way forward. It enabled knowledge of the world to be established by counting what Hume called *'constant conjunctions'*. Science demonstrated that, although we may not be able to see 'behind' our sense data, we can at least establish known *causal patterns* within them. It is no surprise that this is the historical period in which statistics first emerged (Hacking: 1975).

Significantly, in the same historical period, Locke also reframed our understanding of objects (Locke: 1690). Following Descartes, he categorised perceptions into 'Primary' and 'Secondary' qualities'. The former are *'in the object'* (e.g., size, shape, motion, solidity), whilst the latter are *'mind dependent'* (e.g. colour, sound, taste, smell). In this paper, I will show how this distinction relies upon, once again, the operation of *'constant conjunction'* between our sense data. The 18C thus saw a new objective vision of the world established – one made of physical 'objects' acting through mechanical causation (Whitehead: 1926: 69).

In the second half of this paper, I will explore the other key factors that led to this modern model of perception replacing the pre-modern model. The analysis will focus on Leibniz and the insights he offers into the pre-modern world view. This paper will, therefore, explore the philosophical context in which the notion of 'objectivity' arose - as the result of a specific set of philosophical circumstances. This assists our understanding of the philosophical opportunities currently confronting biosemiotics. Our discipline can argue that subjectivity extends into the objective world. Or, in contrast, it can demonstrate that the latter is, in fact, a philosophical creation of modernity itself.

Hacking, I. (1975) *The Emergence of Probability*. Cambridge University Press.

Hegel, GW. (1812/1977) *Phenomenology of Spirit*. Oxford University Press.

Hume, D. (1748/2007) *An Enquiry Concerning Human Understanding*. Penguin Classics.

Leibniz, GW. (1704/1996) *New Essays on Human Understanding*. Cambridge University Press.

Locke, J. (1690/1981) *An Essay Concerning Human Understanding*. Collins.

Peirce, C.S. (1931-58) *The Collected Papers of Charles Sanders Peirce*. 8 Volumes. Harvard University Press.

Stjernfelt, F. (1991) Categorical Perception as a General Prerequisite to the Formation of

Signs. On the Biological Range of a Deep Semiotic Problem in Hjelmslev's as Well as Peirce's Semiotics. *In the Semiotic Web 1991: Biosemiotics*. De Gruyter Mouton.

Von Uexküll, J. (1982) The Theory of Meaning. *Semiotica* 42: 25-82.

Whitehead, A. (1926) *Science and the Modern World.* Free Association Books.

Artificial Life, Synthetic Stupidity, Death

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Artificial life, or the imagining of it, was officially born as a named and self-conscious field in 1987, with the staging of *Artificial Life: The Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems*, organized by the Center for Nonlinear Studies at Los Alamos National Laboratory in Santa Fe, New Mexico. While its intellectual roots lay in earlier work in World War II on cybernetics, self-reproducing automata, and autopoiesis—dubbed "artificial intelligence" in 1956—the ALife conference marked a decisive moment of disciplinary consolidation: it reframed "life" itself as a possible object for simulation or even synthesis. The originator of the term "artificial life" and the event's organizer, Christopher G. Langton, later affiliated with the Santa Fe Institute, positioned ALife as an extension of the already established field of artificial intelligence—despite the fact that both "artificial" and "intelligence" remained unstable and contested terms across scientific and public audiences.

This paper foregrounds how the conceptual reconfiguration of life probed by artificial life research rests on an often-unexamined semiotic foundation: death. While death is commonly understood, within contemporary biology, as the termination of an individual lifespan, we propose instead that death emerges as a semiotic discovery—or invention—coeval with life understood as a bounded, individuated phenomenon. Prior to life—or that of self-reproducing (not replicating) and self-repairing eukaryotic cells around one billion years-before-present—a cosmos governed by transformation and entropy may have known recycling but not death in any biologically meaningful sense. Earliest self-replicating biochemical systems likely operated through continuous molecular turnover rather than organism-level mortality, suggesting that death, as such, was not a prerequisite for life's emergence but a later semiotic stabilization.

As life diversified, death acquired increasing semiotic force. With the emergence of complex organisms capable of repair, reproduction, and temporal extension, death became legible as a boundary event, while simultaneously as a by-product, inventing—or discovering in this case—"anticipation" and "time" itself. In humans, this boundary came to be further elaborated through language, culture, and symbolic systems that likely co-emerged long before *Homo sapiens* was formally established as a species. Death thus came to organize meaning across multiple scales: biological, social, political, cosmological, and subjective, and thence metaphorical. In contemporary nation-states, death underwrites population accounting, sovereignty, sacrifice, and historical narration; at the level of the self, it marks the definitive limit of agency while simultaneously orienting action toward those anticipated, probable, and even possible consequences.

Against this backdrop, contemporary "second wave" artificial intelligence, based on large-language models and generative AI—and its renewed proximity to artificial life—quietly unsettles the semiotic role of death. Today's large-scale algorithmic systems neither live nor die, but persist, degrade, replicate, and overwrite. Yet they inherit vocabularies—intelligence, learning, creativity—whose meanings were historically stabilized in relation to mortal, bounded organisms. We suggest that the persistence of the label "artificial," rather than "synthetic," functions to preserve an illusion of control

by bracketing the possibility of genuine synthesis with autonomous continuation. Read through a semiotic lens, artificial life and its contemporary unintended descendants thus expose a deeper tension: not between life and machine, but between systems whose meanings were shaped by death and systems for which death no longer operates as a constitutive boundary.

Deacon, Terrence William. 2007. "Three Levels of Emergent Phenomena." In *Evolution and Emergence: Systems, Organisms, Persons*, edited by Nancey Murphy and William R. Stoeger, 88–110. Oxford: Oxford University Press.

Di Paolo, Ezequiel A., and Evan Thompson, eds. 2025. *Principles of Biological Autonomy*. By Francisco J. Varela. Cambridge, MA: The MIT Press. https://doi.org/10.7551/mitpress/14875.001.0001.

Gell-Mann, Murray. 1996. "Let's Call it Plectics." *Complexity at Large*. Santa Fe: Santa Fe Institute. Wiley Online Library, John Wiley and Sons.

Hoffmeyer, Jesper. 2008 [2005]. *Biosemiotics: An Examination into the Signs of Life and the Life of Signs*. Translated from the Danish *Biosemiotik: En afhandling om livets tegn og tegnenes liv* by Jesper Hoffmeyer and Donald Favareau; edited by Donald Favareau. Chicago: University of Chicago Press.

Hornborg, Alf. 2024. "Signs of Life and Death: The Semiotic Self-Destruction of the Biosphere." *Biosemiotics* 17: 11–26.

Langton, Christopher G. 1989. *Artificial Life: Proceedings of an Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems*. Routledge. https://doi.org/10.4324/9780429032769

Smith, Eric, and Harold J. Morowitz. 2016. *The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere*. Cambridge: Cambridge University Press.

Abstracts

Biosemiotics of aesthetics

The Geometry & Ecology of the Syntax

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This presentation would return to a central argument of Terrence Deacon's *The Symbolic Species* on the nature of the syntax and its unrealized consequences for the embodied workings of symbolic language. A core vein of Deacon's *Symbolic Species* runs that grammar and syntactical agency (the linkage and co-operation of symbolic tokens) is not, as Chomskian cognitivism would have it, spontaneous and naturally-innate, but evolutionarily and developmentally scaffolded on pre-existing layers of indexical work. From this, we mean to draw a significant yet hitherto-unrealized logical conclusion regarding the existence of the symbolic species: that the operation of the syntax is not only grammatically spontaneous, but has determinate affinity with geometrical form and ultimately ecological being.

One might ask: *is not the disproving of Chomsky in linguistics, like the disparagement of Descartes and modernity for its alienation from the animal, an old intellectual exercise at this point, to be given for the enjoyment of children?* Indeed, prior philosophers (especially those of the Deleuzian tradition) have often sought to restore language's worldly primacy of indexicality by decrying the limits of conceptualized grammar, and many frustrated cavalier thinkers have followed them in this. Yet, none have satisfyingly provided an authoritative methodological/theoretical alternative which would allow linguistics or semiotics to pursue linguistic research unbewildered. Thus, this presentation follows its opening of Deacon's counter-argument to Chomsky with a pragmatic consideration of the argument and its proposed resolution: first, why does the *nature* of the syntax matter, that is, how does a differing conception of the human syntax change embodied and/or political praxis, and what 'worlds' open to language by naturalizing a Deaconian syntax? Second, insofar as symbolic language derives from embodied indexical interaction, how might other archetypes of relation appear in the vacuum of ideality left by the 'cracked' Chomskyan syntax? The proposed answer is a return to Platonic/Euclidean cognition (conceived as classical *ensouled shapes*) with an examination therefore of the direct analogy between architecture and the symbolic mind. Time allowing, this geometrical theory of the syntax shall be demonstrated with a relevant reading from Chaucer's *Canterbury Tales*. In any case, the presentation will conclude with an indication of what may be viewed as *the next step* in the rewilding of symbolic agency, namely the *ecological* quality of syntactical operation, its eminently *sensual* complex invocation which lies just beyond its formal concept. I will conclude with a call for collaboration on the publication of these ideas.

Thus, this presentation means to breathe new life into a rather neglected argument of Deacon's, and vy for creative intelligence in the biosemiotic relationship with linguistics and cultural studies.

Aesthetic Embodiments: An Expanded Approach to Biosemiotic Literary Criticism

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The aim of this paper is to continue the development of biosemiotic literary criticism. In 2011, Wendy Wheeler suggested "The Biosemiotic Turn," a non-anthropocentric approach that "allows us to begin to see the evolutionary continuity between the expression of communicative forms and patterns in nature, and those we are familiar with in culture and in aesthetic expressions" (2011: 271). Timo Maran, in turn, asserts that developments in biosemiotics present a unique opportunity for the study of environmental literature and his work provides a methodology for understanding and analyzing both human and non-human sign processes. Maran writes that it is through literature/artistic modeling in general that "we are describing material nature by making analogies with living organisms or humans" (2014b: 148) and that such analogies make it possible to comprehend the semiotic competences of nonhuman organisms (and even non-living, non-organic things). Maran and Wheeler – as well as Louise Westling (2006, 2012, 2017) and John Coletta (2021) – have made significant contributions to the growing field of biosemiotic criticism. However, their work either largely focuses on introducing biosemiotics to a non-scientific audience or limits (directly or indirectly) the application of biosemiotics readings almost exclusively to nature texts.

It is important to now direct our attention to a wider literature. In this paper, I will explore how life, as an emergent, semiotic process is narrativized and represented across a range of literary texts. Building on the work of Wheeler, Maran, Coletta, and Westling, I will follow a Deleuzean/autopoietic approach to biosemiotics (Lang 2024) and present theory alongside examples from 20th century literature, namely the works of Marcel Proust, Clarice Lispector, and Richard Wright, which represent just a few examples of the ways in which emergent subjectivity is modeled in literature through narrative descriptions of ecological entanglements and creative embodiments. From a Deleuzean as well an autopoietic/enactive point of view, life is an inherently aesthetic phenomenon. Biosemiotics describes the processes from which bodies, subjects, and meaning coemerge. Literature, I argue, allows us to productively model the aesthetic dimension of individual (human and non-human) emergence and sense-making without undercutting or turning away from the core ecocritical and scientific concerns of biosemiotic literary criticism.

A focus on aesthetics is beneficial to the development of biosemiotic literary criticism in two key ways. Biosemiotics, as a discipline, is rooted in both the natural sciences and the humanities. Foregrounding aesthetic analysis attends to the broader philosophical and scientific concerns central to the field. More specifically, it addresses and complements recent discourse on the biosemiotic foundations of aesthetics (Kull 2022; Ireland 2022). Furthermore, an aesthetic approach, informed by theories of autopoiesis and enaction as well as the philosophy of Gilles Deleuze, equips biosemiotic criticism to produce trenchant (and increasingly necessary) social and political readings of literary and cultural texts. An expanded biosemiotic literary criticism has the potential to foreground nuanced but evolutionarily sound representations of emergent, embodied socio-political subjectivity capable of keeping pace with a world in constant – often violent – transition.

Biosemiotics and the lexicon of taste

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[(3)] Independent Media Artist and Curator

Organisms are endowed with sensing organs to make sense, navigate, and anticipate changes in their environment. Increasingly, the human species employs extrasomatic means of sensing to expand their range, but at the same time runs the risk of neglecting somatic means, skills and capabilities and become too much dependent on simplified abstractions and functionalities. In our artistic research project, Sonic Cheese x Atmospheric Terroir we address this; we seek to integrate instrument signatures with auditory, gustatory and olfactory sense experiences and interpretations drawing on expanded notions of *terroir* (Despret et al. 2022).

Terroir conceptualizes the idea that certain foods and drinks embody the environments in which they are made, including the natural ecology but also the local knowledge of the producers/artisans who have historically worked within it. It expresses the human ecological relationships in specific geographical regions. We propose to further enrich this concept by focusing on the atmosphere as a crucial, albeit ethereal aspect of understanding changes in local conditions (Erdbeer et al.2025). Playing newly created sound compositions during cheese ripening, based on the local atmosphere, integrating aerophonics and recorded events, we make use of the fact that microbial communities change behavior in response to soundwaves, thereby influencing the final taste.

The project is based on the relationships between plants, animals (+humans) and how this web of life entangled in a larger spheric system that can be measured through physical and chemical methods but also through bodily experiences. From July 26 to September 26, the project will be installed as part of the Watou festival in Belgium (https://www.kunstenfestivalwatou.be/nl/collectieven/). During the opening we will organize a tasting panel to discuss how we can interpret such experiences, produce and share knowledge based on aesthetic qualities for which our languages often fall short. We are interested in how we give meaning to experiences and manifestations of processes that are difficult to describe using our current representational systems yet are, we believe, important as signals in lifeforms (La Belle, 2021).

While rare, some animals engage in behavior similar to human food preparation, cooking is distinctive to human culture. Even so, though acknowledged, the aesthetic component of food, cultivation, and preparation, receives only limited attention as it does not adhere to classical definitions of art as detached beauty. And though considered essential to life and culture, neither food nor eating has ever been really esteemed by Western philosophers, expressed in a question by John Dewey: “Why is the attempt to connect the higher and ideal things of experience with basic vital roots to often regarded as betrayal of their nature and denial of their value? While this precludes ‘food as art’ for many, a new philosophical discipline, somaesthetics, founded by Schusterman, and rooted within pragmatism, resists the traditional aesthetic attitude of distanced, disinterested contemplation by advocating and aesthetics of active, creative engagement (Koczanowicz, 2023: 3).We believe that such sense experiences (including, auditory, gustatory, olfactory) can be creatively expressed, intersubjectively shared, and can give novel insight in the role of beauty in a collective knowledge system rooted in biosemiotics.

Despret, V., Serrano, D. P., & Alonso Díaz, A. (2022). *Microbiopolitics of milk*. Sternberg Press ; Documenta Fifteen.

Erdbeer, R. M., Hagenmeyer, V., & Stierstorfer, K. (2025). *Modelling the Energy Transition : Cultures, Visions, Narratives* (1st ed. 2025). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-69031-0

KOCZANOWICZ, D. (2023). *The aesthetics of taste : eating within the realm of art.* Brill. https://doi.org/10.1163/9789004534933

LaBelle, B. (2021). *Lexicon of the mouth : poetics and politics of voice and the oral imaginary* (First edition). Zed Books. https://doi.org/10.5040/9781501382802

Wednesday: BUILDING THEME DAY
29th July
@ the Arts Tower

9.30 Welcome Intro
Paul Cobley & Tim Ireland

Communication and Identity in the Built Environment
Chair: Paul Cobley

10.00 *An innate language of community: the civic centres of Alvar Aalto*
Yun Wu

~

How is the identity of a place communicated through visual media in large scale urban regeneration projects: Kings Cross & Battersea
Ina Manafova

~

Meaning in More-than-human Architecture
Xiang Ren and Simon Chadwick

11.00 coffee break

Semiotics of Morphology
Chair: Paul Cobley

11.30 *Back to the heart of the forest – structural thinking in anthropology and cell biology*
Marcella Faria

12.00 *Green Façades and the Shifting Meaning of Biological Growth in Built Environments*
Maria Papanthymou

12.30 *Sentient Technics: From a Cybernetic to a Biosemiotic Mode of Growth*
Josh Bacigalupi

13.00

Environmental and Ecological Perception
Chair: Tim Ireland

14.00 *(Hu)Man and Mycelium: Ethics and Experience of Co-Creation*
Britta Bielak

14.30 *Making meaning in measures, a spatial semiotic exploration*
Judith van der Elst & Frouke Wiarda

15.00 *Architecture of Behavior Space: An Interactive Interpretant*
Ole Møystad

15.30 tea break

Semiotic Analysis of Built Environment
Chair: Tim Ireland

16.00 *When Buildings Stop Carrying Forward: Semiotic Coordination Failure in Multi-Stakeholder Construction Systems*
Lars Herrmann

16.30 *Biosemiotics, trauma and the built environment: researching complexity*
Robin Johnson

17.00 *Nature, Architecture & Human Being*
Claudio Guerri

18.30 Gathering Dinner

Day 3:
Wedesday 29th July 2026

BIOSEMIOTICS AND THE (BUILT) ENVIRONMENT

Abstracts

Communication and Identity in the Built Environment

An innate language of community: the civic centres of Alvar Aalto

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In Vincent Scully's foreword to Venturi's 'Complexity and Contradiction in Architecture' he prefaces, almost in defence of Venturi's built work, that 'the symbolic image which prepares our eyes to see [Venturi's buildings] has not yet been formed' (Scully, 1966). He posits that the written work will help bridge this gap. Scully was right in his prediction that Venturi's writing would become a key theoretical foundation for those who reacted against the sweeping dominance of the 'International' orthodoxy of the Modernist Movement, seeking to reintroduce concern for place, memory and meaning. To many in the Postmodernist era, Venturi's book became a manifesto, renewing the connections to historical and cultural context. But Venturi does not offer a visual language to communicate these concerns, beyond his few built experiments, and in the decades that followed, attempts to construct a language resulted in a plethora of forms and symbols, sometimes playful or ironic and usually requiring perquisite knowledge to be 'in on the joke'. In semiotic terms this became very far removed from an innate, understandable communication of meaning that would help people to relate to their environments intuitively. Was there another way beyond the Duck and the Decorated Shed (Venturi, 1972)?

An alternative may be found in the work of Alvar Aalto, for whom the legibility of architectural language was rooted in an understanding of human nature – of the symbiotic associations between people, culture and ecology. Aalto defined culture as 'the balanced mentality generated by work, organisation and an uncomplicated everyday life in which irrelevant elements essentially appear silly' (Aalto, 1978). He relished in the harmony of the everyday and the 'everyman' but did not attempt to reduce the 'everyman' into a standardised, simplified form – diverging from the Modernists' celebration of the machine and Le Corbusier's Modulor.

Characteristically as a citizen of the newly independent Finland, Aalto celebrated the 'free individual'. He studied the needs of the individual to achieve contentment within their environment and applied this across all scales of his work – from the warm touch of a door handle to the communal embrace of an urban square. At the scale of a home, Aalto said that 'a dwelling is an area which should offer protected areas for meals, sleep, work, and play. These biodynamic functions should be taken as points of departure', rather than any inherited conventions (Aalto, 1978). Aalto rejected the idea of the 'absolute' and advocated for the 'organic'.

Reflecting upon 'people's predilection to surround themselves with a special world of forms, be it however primitive', Aalto described this as an expression of a person's distinct personality and values, a 'portable belonging'. In turn he viewed our reading of forms from the past as an understanding of the conditions and contexts which led to their organic development – and that when we retain inherited forms when the factors which originally influenced them have all changed – we create 'problems' of meaning (Aalto, 1978). Aalto's understanding of the evolving nature of meaning led him to rely not on symbolic language – instead he drew from his understanding of the psychological connections between people and their environments. In contrast to both Modernist and Post-Modernist assumptions, the architectural language that Aalto employs is not precious – it often changes, across one project as much as across his career. What is significant is how the language is employed, sometimes with humour, sometimes with solemnity, always with empathy. The meaning lies in its use (Wittgenstein, 1953).

Kevin Fellingham describes how architects make ‘small worlds of individual order. Architectural worlds, although physically present, are also a sort of fiction or version of reality that has been made to have an internal coherency, which the rest of the world seems to lack’ (Fellingham, 2017). Aalto conceived of his constructed worlds as sitting between technology (the human-made) and nature (Schildt, 1963) – his buildings and the lives lived within them are part of the ecology of the place.

In the period of economic and urban expansion that Finland enjoyed following the Second World War, Aalto designed civic centres for the regional towns of Seinajoki (1958-1988) and Rovaniemi (1966-1988). Writing about Rovaniemi civic centre, Aalto reflected that design at the urban scale was ‘an important task in reflecting the inner life of cities.’ He argued that the buildings which represent public life and ‘the citizen’s shared spiritual needs […] also form the city’s inner silhouette’ – he called this the ‘face of the city’ (Aalto, 1978). In this presentation, I will examine the designs for Seinajoki and Rovaniemi to understand how Aalto’s architecture innately communicated the identity of a community and the civic nature of its public buildings and spaces – offered as clearings in the forest, for the assembly of people.

Scully, V. in Venturi, R. (1966) *Complexity and contradiction in architecture*. New York: Museum of Modern Art

Venturi, R., Scott Brown, D. and Izenour, S. (1972) *Learning from Las Vegas*. Cambridge (Mass.) ; M.I.T. Press

Aalto, A. in Aalto, A., Schildt, G. and Wrede, S. (1978) *Sketches*. Cambridge (Mass.) ; M.I.T. Press

Schildt, G. in Aalto, A. and Fleig, K. (1963) *Alvar Aalto. Band 1, 1922-1962*. 4. Aufl. Zürich: Editions d’Architecture Artemis.

Fellingham, K. (2017) *The Way of All Flesh: Reflections on entropy at work on the buildings of Roelof Uytenbogaardt*. Cambridge: Cambridge Architectural Press

Wittgenstein, L. (1953) *Philosophical investigations*. Oxford: Blackwell.

How is the identity of a place communicated through visual media in large scale urban regeneration projects: Kings Cross & Battersea

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Contemporary urban regeneration increasingly relies on visual media - computer-generated imagery, diagrams, and promotional visuals, to communicate future visions of place. Long before construction, such representations shape how urban environments are anticipated, valued, and understood, mediating planning decisions, public consultation, and investment narratives. From a semiotic perspective, these architectural images function not merely as illustrations, but as sign systems that actively participate in the production of meaning within the built environment.

This work examines how visual representations in large-scale urban regeneration projects operate as semiotic processes, constructing narratives of identity, continuity, and legitimacy. It asks how masterplan imagery

communicates a place's identity, and how such imagery can be read as a means of deconstructing the deliberate narratives through which urban transformation is framed. In doing so, it examines how these narratives are made culturally persuasive. By treating architectural visuals as agents of semiosis rather than neutral depictions, the research foregrounds the role of visual media in shaping public perception and collective understanding.

Despite extensive theoretical work on visual representation, city branding, and place marketing, fewer studies have developed operational analytical frameworks tailored specifically to architectural imagery - its formal tropes, technical conventions, and targeted modes of circulation. Existing critiques often address the politics of representation in general terms, without systematically analysing how specific visual devices produce meaning at different stages of planning, consultation, and marketing. This study addresses that gap by proposing a semiotically informed framework for image analysis, integrating semiotics into the study of architectural representation.

Using a comparative case study approach, the work examines the regeneration of King's Cross and Battersea Power Station - two of London's most symbolically charged redevelopment projects, each transforming former industrial landscapes into new urban districts. The analysis combines qualitative content analysis with semiotic interpretation to identify recurring visual tropes and to examine how signs associated with heritage, public life, and sustainability are mobilised to construct coherent narratives of place. Attention is paid to the production of images across planning documents, public consultation material, and marketing media.

What emerges is a study of narrative power: the capacity of images to translate architectural ambition into collectively held cultural meanings. The findings demonstrate that visual representation in regeneration is not merely descriptive but constitutive, shaping how urban transformation is imagined, legitimised, and remembered. By framing masterplan imagery as evolving signs situated within cultural and ideological frameworks, the study contributes to semiotic discussions of space, aesthetics, and environmental perception. It further advances debates on authenticity and branding by showing how visual coherence shapes the aesthetic and symbolic framing of governance and heritage, producing the appearance of organic and socially legitimate change.

Finally, the work proposes a transferable methodological model for analysing visual media in regeneration contexts, offering a critical tool for both scholars and practitioners concerned with how meaning is cast into built form.

More-than-Architecture: a critical position

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We are living in post-natural times, on a planet dominated by humans. Everything on earth has been touched by human activity, so that the ecological balance of the natural world has ultimately ended (McKibben 1998; Lucas 2023; Coates 2025). Architecture as both a discipline and profession has dramatically impacted this precarious planetary context. But the evolution of meaning and relevance within architecture is still inherited consistently from generation to generation. The detail of this is encapsulated within the codes of architectural language. Architects throughout history have borrowed, referenced, suggested, hinted at, and incorporated both architectural and non-architectural gesture, character and meaning as the culture of architectural practice has developed and evolved. This language can be deciphered, tracked and mapped to explore and reveal architectural responses to previous contexts and contemporary priorities. This paper sets out to critically approach this language in order to articulate how past and present architects learn from the as-found, being it an urban corner of central London or an indigenous mountain of peripheral China, and how they operate this tacit knowledge in their design of public buildings. By doing this the paper constructs a position of more-than-architecture, responding and reimagining a central question of our post-natural age – how to live in 'the Earth, the Sky, and the Ground Between' (Ingold 2025).

Abstracts

Semiotics of morphology

Back to the heart of the forest – structural thinking in anthropology and cell biology

Marcella Faria

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Saussurean linguistics was the first attempt to think the sign in structural terms. Important immediate unfolding of such view are the structural anthropology theorized as such by Lévi-Strauss in the early 1960s and, as we shall discuss in the present paper, the theoretical Biology advanced by the French scientists François Jacob and Jacques Monod a little after. Interestingly, both lines of reasoning are initially motivated by empirical/methodological concerns. For the anthropologist the question was how to observe individuals in diverse "primitive" societies in order to understand how choices are made in the establishment of kinship and other relational patterns. For the molecular biologists, the question was how to observe the molecules in "primitive" single-celled organisms (diverse strains of bacteria) in order to understand how choices are made to stablish alternative gene expression profiles and metabolic patterns. As relationships are structured from simple exchanges into circuits of progressive complexity with the differentiation and hierarchization of the agents and agencies involved, it is always a matter of recomposing a territory: the return journey to the heart of the forest in the case of ethnographic research; the return to the cell nucleus in the case of experimentation in cell biology. The constrains that animate what, in fact, takes shape in societies and cells emerge from and, at the same time, restrict the functioning of signaling networks. In communities - social, cellular, ecological and linguistic - the currency that dynamizes them, makes them adaptable and unique is the sign. Signs are beings whose nature includes transformation, so in order to apprehend, understand, and explain something about their behavior, it is necessary to put them into circulation and closely monitor their fluctuations, rules of conversion, and possibilities of translation. Their shared value is changeable, their stability and basis are always in negotiation within and between the levels of the whole under scrutiny. From this perspective, we will proceed to that kinship rules are not essentially signal transduction pathways. Even Lévi-Strauss's later work on the structure of myths (actualized by variation), the Mythologic, could be read as a treatise on embryology, cell differentiation, what biology calls cell-fate. Fate, like signs, is made of possible but arbitrary choices. Necessary once made, they seem deterministic, but beforehand, they are unimaginable.

Green Façades and the Shifting Meaning of Biological Growth in Built Environments

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In biosemiotics, biological growth is typically understood as an index of life: a visible manifestation of metabolic and developmental processes. Growth signals vitality and ecological continuity. Yet within built environments its meaning becomes unstable. The same visual phenomenon – vegetation spreading across architectural surfaces – may be interpreted either as sustainability and life or as neglect, decay, and loss of control. This paper examines the shifting semiotic status of biological growth in human-constructed space.

Approaching green façades and the recent trend of incorporating living trees into buildings through a historical and comparative lens, I trace changing regimes of legitimised growth in inhabited environments. In early settlements, plant growth was pervasive and spatially bounded rather than formally regulated. At some point of human history, with the emergence of geometric gardens and formal parks, vegetation became disciplined and translated into architectural grammar. Growth was permitted, but only within predefined spatial and geometric constraints. Modernist architecture subsequently minimized visible vegetation, reinforcing a sharp boundary between cultural order and biological process.

Contemporary “wild” green façades appear to signal a return of nature into the urban fabric. However, biological matter “out of place” may also evoke disorder, dampness, or abandonment. In some rural contexts, uncontrolled greenery on walls functions as an index of structural deterioration or insufficient care, marking a breach in the boundary between cultivated domestic space and surrounding nature. In urban architectural discourse, by contrast, similar vegetal proliferation may be framed as ecological integration and environmental responsibility. At the same time, historical associations of vegetation overtaking buildings – most visibly in the imagery of ruins – continue to inform interpretation, suggesting post-human recolonisation rather than harmonious integration.

Thus, biological growth in built environments does not function as a stable index of vitality. Its meaning depends on the dominant spatial oppositions structuring interpretation (nature/culture, order/neglect, artificial/natural), on the perceived distribution of agency between design and autonomous growth, and on the degree of alignment between vegetal forms and architectural structure. Green façades thus become sites of ontological tension between processual biological semiosis and design-oriented architectural order.

By tracing historical shifts in the legitimisation of growth – from bounded domestic space to geometric discipline and contemporary re-naturalisation – this paper contributes to ecological biosemiotics by demonstrating how biological indices acquire context-dependent and historically variable meanings within built ecologies.

Sentient Technics: From a Cybernetic to a Biosemiotic Mode of Growth

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The current human mode of material growth is not sustainable. As argued in Lewis Mumford's *Technics and Human Development - Myth of the Machine*, this sustainability problem stems from the myth that we can control the natural world and ourselves. The logic of this myth asserts that, if only we can contour our world like a machine with its clockwork precision and expected outcomes, we can live forever via a mode of extractive growth, which I call Cybernetic Technics. This unsustainable technics, predicted on this myth, will be outlined in the first of three parts of this presentation.

The second part will propose a solution to this problem: Sentient Technics, which is a body of work informed by both my architectural experience and biosemiotic research. Ironically, existing technics – the machines and the institutions that produce them – only generate objects that are "dead" upon creation (cf. Bookchin's *Towards a Liberatory Technology*), despite the promise of everlasting life in this cybernetic future. *Nature, on the other hand, continuously grows and complexifies global life that is simultaneously radically local*. In this spirit, one possible solution is to imbue our creations with attributes of life: technics capable of veritable semiogenesis, i.e., Sentient Technics.

In support of this proposal, the final section will describe a Lotmanian shift from the current mode of extractive growth – a Cybernetic Technics – to that of a more sustainable biosemiotic mode via Sentient Technics. Central to this argument will be a "trojan horse", whereby Sentient Technics will initially enhance the translation of local semiogenesis into commodities compatible with global exchange, addicting Cybernetic Technics to these novel local technics. In time, however, a transition will occur whereby semiogenesis, intrinsic to Sentient Technics, will phase shift to increase local *untranslatability* in the face of global extraction, thereby regulating the Cybernetic modes of growth based on local sympathies. Subsequently, it will be illustrated how Cybernetic Technics can transform into a sentient mode of adaptive and sustainable growth more aligned with the living dynamics of our only known biosphere.

Abstracts

Environmental and Ecological Perception

(Hu)Man and Mycelium: Ethics and Experience of Co-Creation

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This presentation will examine the ethics of mycelium domestication for material innovation. Despite the promise of novel, regenerative material futures for the built environment, collaborations with mycelium are still enmeshed with culturally embedded patterns of presumption, power and production. Continuing to pursue material research and product scaling through the methods and scale of industrial processes which have allowed and dominated the building materials industry, perpetuates human-centered systems of production that are non-responsive to non-humans, and force the domesticity of other organisms. While these may lead to novel product developments that are familiar, scalable, or profitable, we might question if we are actually finding new low-carbon, healthy, and sustainability materials, or if we're just tapping into new methods of extractive manufacture with new organisms.

As a designer, artist, educator, and entrepreneur wilfully engaged in processes of co-creation with mycelium that intends outcomes outside a framework of mere mutual survival, this presentation begins to examine the role of non-human, and non-voluntary, participants with care. The process of co-creating will be unpacked through the lens of inter-species communication, action, and reaction. We understand that mycelium perceive and navigate their environments primarily in response to environmental variables like light, gravity, moisture, temperature, chemical signals, and nutrient gradients. Co-creating with this organism, the power conferred to humans of environmental control for fungal behavioral manipulation can be as strong as the organism's insistence on 'misbehaving. While significantly variable in scale, detection, desire, and response, these fundamental environmental frameworks shaping the behavior and umwelt of mycelium also form the human spatial experience. Disentangled from presumed priorities of profit and scaling, returning attention to pathways of parallel experience establishes a baseline of empathy and awareness from which more critical, self-reflective, analysis and action can occur. Case studies will be presented to illustrate the process of material formation from both human and fungal perspectives. They will examine modes of research that employ modes of co-creating ranging from mutualism to destruction. This presentation highlights the paradox of regenerative design research dependent on the bodies of other species. Dissolving our illusions of separateness and reframing the language, intent and actions of our work can restructure modes of inquiry and world-building toward sympoietic interactions with our non-human kin.

Making meaning in measures, a spatial semiotic exploration

Judith van der Elst[(1)] *and Frouke Wiarda*[(2)]

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[(2)] Independent Sound Artist/Founder Art Science Community Appreciation Society

Technological developments over the last century and especially during the recent decades have produced and resulted in novel signals in and surrounding Earth's planetary spheres that influence and impact organic life in numerous ways. At the same time, such technological systems have been specifically designed to sense, record and interpret signals in our inner and surrounding worlds to better understand our place/ position and relationships to help navigate our environments successfully.

Several scholars have recently addressed the spatiality of Peirce's theory of signs, by saying for instance that "this theory when properly interpreted helps to see how the formation of spatial meanings and the actual production of space are intertwined aspects of the social process that Lefebvre calls spatial practice (Määttänen, P. 2007)." What remains often overlooked in these discussions is Peirce's expertise and innovations in geosciences that underpin or that are even closely intertwined with his major philosophical contributions. A notable exception is the work of Victor Lenzen, who is known to be instrumental in the recovery and subsequent publication of Peirce's manuscripts, and as a physicist and philosopher of science, described the major scientific contributions during Peirce's employment at the U.S. Geologic Survey, such as his contributions to geodesy by development of gravity pendulums and methods of using these measurements for determining the figure of the earth. Lenzen explicitly linked Peirce's recovered reports to his own methodology in physics and logic, arguing that Peirce's empirical approach to signs informed rigorous scientific norms, connecting its logical structure to broader semiotic principles. (Moore, E. C., & Burks, A. W. 1992).

As we currently seek to make sense of new digital and virtual knowledge spaces through which we collect and process such signals and mesh those with our bodily experiences in ever changing configurations, Peirce's scientific research on geodetic instruments and metrology appears even more relevant (Lenzen, V. F. 1972, 1965). A focus on the signals of instruments and measurements pioneered by Peirce can enrich current spatial sciences, systems, and instruments through the lens of semiotics, emphasizing spatial dimension of meaning making. Within this presentation we will highlight some of Peirce's innovations in geoscience, cartography, gravity and metrology and will explore the relevance for today's world in which we have become more acutely aware of the complexity and interrelationships of geo- and biosphere and the current instruments/ sensors we use to interpret its signals (D'Armenio, E., Rosso, A., & Voto, C. 2025).

D'Armenio, E., Rosso, A., & Voto, C. (2025). Semiotics of Space in the Era of Computational Logic and Digital Practices A Contemporary Perspective. *Signata*, *16*. https://doi.org/10.4000/14rhc

Lenzen, V. F. (1972). Charles S. Peirce as Mathematical Geodesist. *Transactions of the Charles S. Peirce Society*, *8*(2), 90–105.

Lenzen, V. F. (1965). The Contributions of Charles S. Peirce to Metrology. *Proceedings of the American Philosophical Society*, *109*(1), 29–46.

Määttänen, P. (2007). *Semiotics of space: Peirce and Lefebvre*. *2007*(166), 453–461. https://doi.

Architecture of Behavior Space: An Interactive Interpretant

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> If a house were something that came into being by nature, it would come about in just the way that it now does by art, and if the things by nature were to come about not only by nature but also by art, they too would come about in exactly the same way as they do by nature.
>
> Aristotle, *Physics*, 199a. Book II.

Aristotle implies that our built environment is an inherent part of nature, and his doctrine of 4 causes suggests itself as a human semiome.

Aristotle established two sciences: biology and logics. It is tempting to compare the pair with the inherent code duality[1] of contemporary biosemiotics since 1987 but let us stick to Aristotle's biology: the science of living things. Of life. It is the science of stuff that lives, moves and changes. And changes are triggered. They have causes, effects and purposes (telos). In order to make this behavior intelligible, Aristotle established his doctrine of four causes: the material cause (materials: stone, wood etc.), the formal cause (structure, form), the efficient cause (what did it, the builder), and the final cause (the purpose[2] or telos: dwelling, temple).

Aristotle never wrote any explicit theory about architecture, but because the work of architecture inherently comprises all four causes, he frequently used architecture as reference and as explanatory model for causality in nature – hence the intrinsic epistemological relation between architecture and biology.

Modern science seemed to overtake and totally out-perform Aristotle's understanding of science. The post-baroque 3 centuries turned to the physical object for true facts. Changes, relations, and anything to the effect of a 'final cause' were considered 'externalities' that blurred the view to true facts, implicitly pertaining to efficient and material causation only. Towards the end of the 20th it sank in that this was a reductionist bias that did little to make the world more intelligible. Nature, and architecture with it, seemed to remain in what Christian Norberg-Schulz termed 'groping uncertainty'. At the end of the 1980s Jesper Hoffmeyer launched the view that the basic unit of nature (life) was not the cell but the sign. He shifted our focus from 'being' to 'becoming', from something to someone, from body to swarm, and from object to behavior.

This paper will discuss the interplay between biology, semiosis, causality and architecture.

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1 "the chain of events which sets life apart from non-life, i.e. the unending chain of responses to selected differences, thus needs at least two codes: one code for action (behaviour) and one code for memory — the first of these codes necessarily must be analog, and the second very probably must be digital"

Emmeche, Kull, Stjernfeldt 2002, Reading Hoffmeyer, Rethinking Biology, Tartu University Press, Tartu.

2 Stjernfelt 2002:#15. "Final causes should not, however, be identified with purposes (which form a special subset of them), but should be identified as all processes which are attracted by a future state. Future states being general only (Peirce), final causes may make use of representation of such states by means of types."

Deacon: (in Logan 2012:9)[3] "(…) once one is dealing with non-linear interaction, which is the case when the number of components of a system exceeds two, one must invoke a figure/ground or field description rather than a linear cause and effect logic. Put in Aristotelian terms one cannot understand emergence in purely efficient cause terms but one must invoke formal cause and material cause from which emerges the final cause in the case of teleodynamic systems."

Think of an architectural object: a piece of an urban system, a neighborhood, or a complex building. Its function, its goal, its reason for having been produced has been given form. And this form "… is always grounded in the organization of its constituent material components and cannot exist without this grounding." (cf quote above) There is in other words a relationship between the form of the object, its reason for being there, and its material components. If the only components available to the builder were stones, and the only technology available was muscular power, the forms available were a wall, a column or an arch. The telos available would be whatever one could achieve with a wall, a column and an arch. There would in other words be a reciprocal relationship between the available stone, as material cause, the wall, column and arch that would represent the capacity of the stone to formally cause, and the available telos, or final cause. Semiotically this would be a rather tightly constrained scenario, a strict order, rather like that of the termites or nesting birds. "Something will tend to be assessed as more orderly if it reflects more constraint." (Deacon 2011:195)[4]. For birds and termites to explore new forms, they depend on finding new materials and/or learning new techniques of joining the material components together. It happens, but not often. In our case, as humans, we have been faster in developing new material technology, and every time our technology surpasses a material constraint to architectural form, we still have to apply a constraint in order to achieve a form. Then we have to replace the material constraint with a cultural one. The last 100 years of architectural development may provide evidence of this. It has opened a great semiotic freedom. On one hand this freedom introduces the possibility for a semiosis of the interplay between the actual and the virtual: «(...) what is not exhibited but could have been» (Deacon 2012:193). On the other hand, it seems to have disrupted the link between material causation and formal causation and opened the door to Norberg-Schulz' 'groping uncertainty' in the act. We may have to go back to the drawing board and to think fast. We seem to be winning a great semiotic freedom. Where is it taking us?

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3 Logan, Robert K. «Review and Précis of Terrence Deacon's Incomplete Nature: How Mind Emerged from Matter», Information 2012, 3, 290-306; doi:10.3390/info3030290

4 Deacon, Terrence, *Incomplete Nature – how Mind Emerged from Matter*, Norton & Company, New York London 2011.

Abstracts

Semiotic Analysis of Built Environment

When Buildings Stop Carrying Forward: Semiotic Coordination Failure in Multi-Stakeholder Construction Systems

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A structure is a semiotic system. Each discipline, each material, each future inhabits its own *Umwelt* (Uexküll, 1934/2010); a crack, a deflection, a deadline is a sign only for an interpretant whose world includes it (Peirce, 1931–1958). Coordination fails not for want of information but for want of a reader — when no interpretant exists in whose *Umwelt* the decisive sign can register, the semiotic niche too narrow for it (Hoffmeyer, 2008). Three cases trace one axis from three sides.

On a German retail site, every explicit sign-system agreed the logistics were sound. Yet a felt sense (Gendlin, 1997) caught what no plan showed: the fault lay not in any part but in their combination. The cranes ran on rails on a concrete deck a metre thick — not the ground around it — and no crane outside could find room. As the building rose between them it cut their reach, the pre-assembly stations falling away until the lift-sequence would jam — a moving three-dimensional dynamic no flat plan could hold (code duality). Without mandate, I drew the building into the sand and traced each crane's path with my arms — the body reading a configuration before it existed. The fix, never drawn: a third crane at the centre, taking each piece where the side cranes' reach gave out. Here the reader was the body; direction, human to human.

When a prestressed bridge collapsed in Dresden in 2024 — the Carolabrücke — hydrogen-induced corrosion had advanced inside its wires for decades, concealed from conventional inspection. Every statutory inspection was met: the sign-system was working, yet it read a substitute and took it for the real state — a model no longer tracking what it modelled (Rosen, 1991), healthy semiosis aimed at the wrong object. A near-identical bridge nearby, of the same steel, now carries acoustic-emission monitoring; since its closure in 2026, with no load on it, it has registered every further wire as it snapped. The same steel, a different interpretant — adding no information but making a breaking wire a sign at all: the epistemic cut, a rate-dependent event becoming a rate-independent record (Pattee, 2001). One bridge fell because nothing read it; the other is read as it fails. Here the reader is the instrument; direction, material to human.

In a heritage railway project, my office was commissioned only for a masonry tower, to be raised to a new height — a change monument protection's statement had blocked for five years, since cleared. The federal railway would not return to the line for about as long; a provisional permit neared its deadline, no sign of renewal. The bridge it would carry belonged to another office, assumed settled. In a meeting to fix dates, a felt sense raised one question — when is the bridge renovated? — exposing that it had to precede the lowering, after which the steel would be unreachable, and that its emptied interior had no owner. No interpretant yet inhabited that future: the question did not cross an existing sign but brought one — and its reader — into being. Made legible, they resequenced the work and reconceived the space. Here a sign and its reader arose together; direction, future to human.

The built environment is not merely a site where sign processes occur but is constituted by them. When no reader stands where a sign comes due, the structure stops carrying forward (Gendlin, 1997). Body, instrument, the made future — three readers supplied where there were none. In each, a constraint had already reduced the possible to dimensions a reader could navigate; what was missing was the reader who navigates

them — neither alone is semiosis. One question runs through all three: what must become a reader before the boundary will fall? (The two project cases are one practitioner's accounts; the framing is heuristic.)

Gendlin, E. T. (1997). A process model. The Focusing Institute.

Hoffmeyer, J. (2008). Biosemiotics: An examination into the signs of life and the life of signs. University of Scranton Press.

Pattee, H. H. (2001). The physics of symbols: Bridging the epistemic cut. Biosystems, 60(1–3), 5–21. https://doi.org/10.1016/S0303-2647(01)00104-6

Peirce, C. S. (1931–1958). Collected papers of Charles Sanders Peirce (C. Hartshorne, P. Weiss, & A. W. Burks, Eds.; Vols. 1–8). Harvard University Press.

Rosen, R. (1991). Life itself: A comprehensive inquiry into the nature, origin, and fabrication of life. Columbia University Press.

Uexküll, J. von (2010). A foray into the worlds of animals and humans: With a theory of meaning (J. D. O'Neil, Trans.). University of Minnesota Press. (Original work published 1934)

Biosemiotics, trauma and the built environment: researching complexity

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That there should be a relationship between the built environment and human health seems intuitively obvious. Yet tracing and evidencing the likely mechanisms proves challenging. With multiple variables and levels of analysis confounding research efforts, these relationships are dauntingly complex and elusive.

Disentangling the physical from the emotional/symbolic/semiotic impacts is inherently problematic. Yet recent research - for example on social prescribing for health problems - is beginning to unravel this web; and here, at least, it seems that, depending on the nature of the presenting problem, the terms of the active engagement of participants - their Wirkwelt - are critical for effectiveness.

Meanwhile the relationship between past trauma and poor health, both mental, physical and behavioural, is well evidenced in epidemiological research; and the neurobiology of trauma - the essential link between past experience, current responses and future behaviour - is relatively well attested and understood. Neurobiology is one area where the organic and the semiotic intersect.

Efforts are therefore being made to translate this awareness into practical ways to engage and support those severely traumatised with past histories of neglect and abuse, to scaffold (Hoffmeyer) their recovery. One such has been the development over the past 20-25 years of an approach to developing 'in the round' support and recovery services for those who are homeless, where the prevalence of such histories of trauma is notoriously high.

The term 'a psychologically informed environment' ('PIE') was coined to identify key features of this new approach, whether in homelessness or in other related services aiming to meet such 'complex needs' more constructively. Despite the challenge of the irreducible complexity of a holistic, 'whole service' approach, an overall operational framework has been devised, specifying - with research-readiness in mind - observable and evidencable features; and a self-assessment process for such services was created, with peer-review for additional objectivity and accountability.

Identifying the key features - 'the active ingredients' - of such interactions remains a challenge for researchers and policy makers alike. Yet in a homelessness shelter, day centre or half-way house there is enormous scope for conscious design of the built environment, and what the PIE framework calls its 'social spaces' - meaning by this not just any communal areas, but the emotional messages - the semiotics - conveyed. The design of these spaces and interactions within them may trigger and aggravate or may soothe the stress reactions (flight, flight, freeze or fawn) imprinted by evolutionary history; but they also offer a wealth of natural experiments to explore what works, even in such complex, fully holistic environmental contexts.

This presentation/discussion, led by the original author of the phrase 'PIE', will explore the strength and weakness of evidence for the effectiveness of such services, and outline a new approach to appreciating the life world of a social care organisation, and gathering more meaningful data (sic) to identify 'what works' in developing holistic environmental interventions for complex human psychological needs.

Nature, Architecture and Human Being

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The built environment—and architecture, understood in a broad sense—mediates between nature and the human being. From a Peircean semiotic standpoint, this constellation may be conceived as a *genuine triad* (CP 6.322, 1909) because the three terms, taken together, constitute an indissoluble *continuity*—Peirce's *synechism* (CP 6.169, 1902)—within which each term assumes a specific functional role in relation to the Peircean *Categories* of *Firstness*, *Secondness*, and *Thirdness* (CP 1.300, 1894). Accordingly, nature may be considered in relation to Firstness, the built environment and architecture in relation to Secondness, and the human being in relation to Thirdness. Following the logic expressed in "Symbols grow" (CP 2.302, 1895), the human being can be associated with a *qualitative* dimension insofar as it constructs strategic–political values, *metaphorically* articulated, through which both architecture and nature are interpreted, negotiated, and oriented. Conversely, the built environment can be approached as a *quantitative* dimension insofar as it involves values that are measurable, comparable, and assessable through *metonymic* operations, through relations of contiguity and pragmatic substitution. Finally, nature may be understood as *quali-quantitative*: it is a pure *monadic* possibility (CP 1.424, 1896), yet to be differentially comprehended, a *Form* to which values are attributed *synecdochically*—parts standing for wholes and vice versa—thus enabling nature to appear as meaningful within cultural and technical practices. Because, for Peirce, everything is a sign, each of these terms can itself be analysed according to a further triadic articulation of *Form*, *Existence*, and *Value*. This entails mobilising the *nine aspects of the sign* (CP 2.243, 1903), aspects that Peirce did not explicitly deploy as an operational framework for complex semiotic analysis, thus allowing the relations and interdependencies among the three principal terms and their nine derived aspects to be examined systematically. Peirce's limited emphasis on practical, instrumentally oriented procedures becomes, in this context, an opportunity: it motivates the development of an explicitly operational model grounded on a triadic basis. On this basis, I developed the *Semiotic Nonagon* (Guerri 2003; 2014/2016), an analytical instrument designed to handle both simple and complex signs. The Semiotic Nonagon is a schema—an *iconic diagram* (CP 1.369, 1890) organised as a double-entry table—which not only offers a taxonomy of components but foregrounds their relative functions and mutual interrelations across the nine aspects. The Semiotic Nonagon preserves the central commitments of Peircean sign theory while introducing, for purposes of application, a methodological cut: it cuts the inaccessible hyperspace that would represent the sign and transforms it into a *diagram* (CP 2.277, 1902) that flattens sign-relations, displaying them in graphic extension on a two-dimensional plane and thereby rendering them operable on a sheet of paper. The presentation will introduce the Semiotic Nonagon of the sign Architecture, from which the corresponding Semiotic Nonagons of Nature and Human Being may be derived. The contribution is twofold: first, it formalises the triadic mediation that structures the built environment and its semiotic continuity with both nature and human agency; second, it provides a transferable diagrammatic procedure for analysing architectural meaning as a structured interdependence of the nine basic aspects of the sign.

Guerri, C. F. (2003) El nonágono semiótico: un ícono diagramático y tres niveles de iconicidad . deSignis 4, 2003, pp. 157-174.

- (2014) Nonágono Semiótico. Un modelo operativo para la investigación cualitativa. EUDEBA, 2nd ed. 2016.

- El nonágono semiótico: un ícono diagramático y tres niveles de iconicidad. deSignis 4, 2003, pp. 157-174.

Peirce, C. S. (1931-58). Collected Papers of Charles Sanders Peirce. Vol. 1-8. Harvard UP

Thursday
30th July
@ the Wave

Day 4: Thursday 30th July 2026

9.30 — Applied biosemiotics — Chair: Paul Cobley

Biosemiotics, AI, and the Ecology of Meaning: The Case of Sperm Whale Coda Vowels
Nicola Zengiaro

10.00

Shades of meaning: semantics of words and proteins in embedding space
Henrik Nielsen, Mariana Vitti-Rodrigues and Claus Emmeche

10.30

Autoimmunity: Proof of Concept for Biosemiotics
Victoria Alexander

11.00 — coffee break

11.30 — Teaching Biosemiotics

Rountable/Short presentations
Don Favareau

12.30 — *Biosemiotics* Journal Editorial Board Meeting

13.00

14.00 — Multi-level semiosis and integrative approaches — Chair: Claudio Julio Rodriguez Higuera

Goethe and Grammar: A Batesonian Abduction towards a Theory of Context
Phillip Guddemi

14.30

Semiotic stabilization
Kalevi Kull

15.00

The Axes of Edibility: Food's Suprasubjective Objecthood
Emanuela Bove

15.30 — tea break

16.00 — Peirce and Biosemiotic Technology — Chair: Claudio Julio Rodriguez Higuera

Semiotic Nonagon: Taxonomy, Hyper-relations, and Biosemiotic Inquiry
Claudio Guerri

16.30

A Peircean theory of technology
Alin Olteanu

17.00

Artificial Symbionts of the Afterlife: Navigating Presence of Absence in the Posthuman Umwelt
Peter Mantello

17.30 — Next Gatherings

Abstracts

Applied semiotics

Biosemiotics, AI, and the Ecology of Meaning: The Case of Sperm Whale Coda Vowels

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Recent work at the intersection of bioacoustics and machine learning proposes that sperm whale codas exhibit vowel- and diphthong-like spectral patterning and can be modeled through AI-driven acoustic translation frameworks. This paper employs biosemiotics to assess the benefits and drawbacks of operationalizing phonological analogies in AI systems, with the goal of clarifying the methodological and epistemological conditions under which an "ecology of meaning" can be responsibly mediated across species.

Building on evidence that codas show discrete, recurrent, and combinable spectral categories that correlate with timing-based coda types, it will review how these findings motivate translation-oriented modeling while also constraining its interpretability (Beguš, Sprouse, et al. 2025). Then, the presentation examines the specific claim that coda categories form a phonology-like system, including systematic spectral contrasts analogous to vowel quality, potential diphthong-like trajectories, and structured variation across individuals and contexts (Beguš, Dabkowski, et al. 2025). From a biosemiotic standpoint, these parallels are scientifically productive because they supply testable structure for computational models; yet they are also epistemologically risky because they may encourage category reification and drift, importing human linguistic expectations into signals whose meaning is not independently accessible (Paradise, et al. 2025).

The aim is to demonstrate that AI "translation" can be reframed as a model-based mediation problem: a disciplined way to map regularities in the signal while keeping interpretive claims explicitly tied to operational definitions, uncertainty, and ecological context. The contribution of biosemiotics is to treat translation claims as hypotheses about semiosis rather than as direct equivalences, and to specify evaluation criteria that distinguish pattern discovery from meaning attribution. The talk concludes by outlining practical guidelines for integrating phonology-like analyses into AI pipelines without collapsing the ecology of meaning into a purely technical mapping.

Beguš, G., Dabkowski, M., Sprouse, R. L., Gruber, D. F., and Gero, S. (2025). The phonology of sperm whale coda vowels. *bioRxiv preprint*. https://doi.org/10.1101/2025.06.09.658556

Beguš, G., Sprouse, R. L., Leban, A., Silva, M. and Gero, S. (2025). Vowel- and diphthong-like spectral patterns in sperm whale codas. *Open Mind*: *Discoveries in Cognitive Science*, 9: 1849-1874.

Paradise, O., et al. (2025). WhAM: Towards A Translative Model of Sperm Whale Vocalization. *arXiv preprint*. https://doi.org/10.48550/arXiv.2512.02206

Shades of meaning: semantics of words and proteins in embedding space

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Large Language Models (LLMs) are typically trained in a *self-supervised* mode: given a large corpus of text, individual random words are masked (hidden), and the network is trained to predict the masked words from their (syntactic) context in the sentences. Such a prediction is only possible because there is a certain degree of *redundancy* in written language. The self-supervised training gives the LLM a general "understanding" of the structure of human language that is exploited in the development of chatbots, behaving like semantic machines.

In a similar manner, protein Language Models (pLMs) are trained by masking individual random amino acids in a large corpus of protein sequences and training the network to predict the masked amino acids from their context in the sequences. Subsequently, the numerical vector representations (termed *embeddings*) of the amino acids in the trained pLMs can be used for predicting useful properties of proteins, such as 3D-structure, subcellular location, or function. The success of such models in modern bioinformatics points to the presence of redundancy in biological sequences, too.

In conventional bioinformatics, the function of an unknown protein is typically inferred by aligning its sequence to homologous sequences of known function. However, it has recently been shown that embeddings from pLMs can transfer functional annotations of proteins beyond homology, i.e., they can identify functional neighbours (e.g., enzymes catalysing the same reaction) in embedding space which are *not* neighbours in sequence space. This can be compared to LLMs which can identify synonyms (semantic neighbours) that are not similar in spelling, even though the models were trained on syntactic properties only. Conversely, LLMs can disambiguate between two words with the same spelling and different meanings based on the context (e.g., the word 'apple' meaning a computer, a brand or a fruit), just like pLMs use different vectors to represent the same amino acid (e.g., cysteine being part of an active site or part of a disulfide bridge) in different sequence contexts.

Does this mean that pLMs are semantic machines of biology? What is the relation between linguistic meaning and biological function? What does this tell us about meaning in molecular machines? Is there a parallel between word choice in human language and amino acid choice in natural selection? These questions will guide our presentation.

Autoimmunity: Proof of Concept for Biosemiotics

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How can we convince biologists that sign interpretation is a real phenomenon in biological processes? How can we convince researchers that Biosemiotics does not just add a narrative layer on top of microbiology and biological chemistry but offers real explanatory power? For the past few years, I've been studying autoimmune conditions and the related fields of allergy, hypersensitivity, and mental health. The fact that the adaptive immune system *learns* in the first place makes it an excellent object of study for biosemioticians. But the fact that the immune system is fallible, sometimes attacking the self instead of foreign antigens, provides some of the best evidence that interpretation, as misinterpretation, has taken place. And Biosemiotics becomes necessary to explain how the condition arises.

Chronic diseases (including brain inflammation) related to autoimmune conditions are on the rise and correlate well to the rise of the prevalence of environmental toxins. The role of toxins in chronic health conditions may have been overlooked in past decades due to the indirect or mediated effects toxins have on health through the semiosic processes of the immune system. Molecular mimicry is the most obvious semiosic mechanism, where the immune system learns "correctly" to identify an antigen (viral proteins for example) but that antigen happens to resemble self. We can understand such processes in terms of icon signs. There is also by-stander that can contribute to semiosis going awry. We can understand such processes in terms of indexical associations. In full blown autoimmune conditions, the initial triggers are no longer necessary to continue the attack on self. In such cases, that normally occur after acute or chronic inflammation, a symbol or code for human protein has become part of the convention of immune memory.

Once a pathology is understood, learning how to control or cure it can't be too far away. Currently, no remedies (beyond suppression) are known for autoimmune conditions except for detoxification. But there may be hope in re-training Th 1 cells so that they better regulate the Th 2 cells that have learned the wrong meaning of a sign.

Lyons-Weiler, J. (2020). Pathogenic priming likely contributes to serious and critical illness and mortality in COVID-19 via autoimmunity. Journal of Translational Autoimmunity, 3: 100051.

McFarland, G., E. La Joie, P. Thomas, and J. Lyons-Weiler. (2020). Acute exposure and chronic retention of aluminum in three vaccine schedules and effects of genetic and environmental variation, Journal of Trace Elements in Medicine and Biology, 58, 126444.

Montecalvo, A., A. T. Larregina, W. J. Shufesky, D. B. Stolz, M. L. G. Sullivan, J. M. Karlsson, C, J. Baty (2012). Mechanism of transfer of functional microRNAs between mouse dendritic cells via exosomes. Blood, The Journal of the American Society of Hematology, 119(3), 756-766.

International Panel on Teaching Biosemiotics

Donald Favareau (moderator)

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Not long after returning home from the inaugural Biosemiotics Gatherings in 2001, I began teaching my first course in Biosemiotics as a UCLA graduate level seminar in 2002. This was followed by what I am fairly certain was America's first undergraduate class in Biosemiotics in 2003, also at UCLA, and 22 years of what I know to be first undergraduate class in Biosemiotics to be offered in all of Asia at the National University of Singapore' honors college, the University Scholars Programme from 2004 to 2025. Since 2025, I have been teaching Biosemiotics, along with courses on Peirce, Bateson, and Wittgenstein, at the 109 year old "experiment in pedagogy" that is Deep Springs College, California – a tuition-free intentional community where 24 gifted students from around the world spend two years growing their own food and governing their own affairs while pursuing an internet-free environment of deep scholarship and learning.

In convening this panel, I am honored in being joined by six international scholars who have likewise taught Biosemiotics in the classroom to discuss some of the techniques that we have used and insights we have gleaned during the last two decades of teaching Biosemiotics, to reflect upon the changes we have seen in student receptivity towards this discipline during that time, and to suggest some ideas about how Biosemotics can be incorporated into a variety of courses, both in the sciences and the humanities.

Panel members include Myrdene Anderson (*Purdue University, USA*), Victoria Alexander (*DACTYL Foundation, USA*), Paul Cobley (*Middlesex University, UK),* Yagmur Denizhan (*Bogazici University, Türkiye*), Kalevi Kull (*Tartu University, Estonia)* and Claudio Rodríguez Higuera (*Palacký University, Czech Republic*).

Abstracts

Multi-level semiosis and integrative approaches

Goethe and Grammar: A Batesonian Abduction towards a Theory of Context

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Gregory Bateson often made a notable analogy, making what I will show to be a biosemiotic point, between the description of plant morphology made by Johann Wolfgang von Goethe in his 1817 book *The Metamorphosis of Plants*, and the analysis of grammar as it had been taught to young Gregory in school. The analogy was not merely to show that the structure of organisms, most specifically their homologies, had a pattern of organization that could fairly be called a grammar. Nor did Bateson argue, as Goethe did, for an archetypal or Platonic version of the organism – an *Urplantze*. No, what Bateson hoped for, in the first place, from his students was an analogy or juxtaposition from which they could make a leap of abduction between the structures of plants and of sentences. Ultimately by doing this they could approach that which in his mind unified the grammars of plants and of language; he termed this a theory of context, involving the classification of context. What had been described as grammar would be reframed as a "contextual shaping." (Incidentally he found it telling that the Greek word "metamorphosis" has as its literal Latin equivalent the word "transformation.")

This comparison was so meaningful to Bateson that he featured it in his first lecture to undergraduate students in his 1976 Ecology of Mind class at the University of California, Santa Cruz. The Bateson Idea Group has been working on making these class transcripts into a book, which will include his lectures, his discussions with students, and some after-class discussions. From these lectures and discussions it becomes clear that his teaching style did not involve putting forward finished axioms and theorems in the style of Euclid, or setting out a would-be watertight explicit philosophical system in the grand manner of Kant (or in some moods Peirce). Rather, Bateson's teaching style often involved the presentation of examples, from which the student might inferentially or abductively develop insight. It is similar to what he did in his "metalogues" which were styled as discussions between a "father" and "daughter," and in which much of what was being said was in the interplay inside the dialogue.

This teaching style was tailored to the concept of context which Bateson was developing. In the case of the grammar of plant morphology, such features as stem, leaf, and bud form part of a system in which each only has meaning with relation to the other, thus making the whole a system of their interrelations. Similarly, a modern view of the sentence involves the parts of speech – noun, verb, adjective, etc. – which are defined in terms of their functions in the sentence and with respect to each other. Juxtaposing these we come up with a biosemiotics of messages-in-context.

I will mention one consequence of this biosemiotics. Messages-in-context of this Batesonian type are key to what Hoffmeyer, in his discussion of code duality, refers to as the *analogic code*. But the bringing of linguistic parts of speech into the discussion, smuggles a type of Batesonian relational communication into the heart of the *digital code* of human language itself. Code-duality thus shows itself as the kind of duality in which both aspects interpenetrate the other.

Semiotic stability

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The problem of structural stability of living systems is fundamental (Thom 1975). However, the general conditions of stability in semiotic systems have rarely been addressed.

Complex systems with nonlinear dynamics are characterised by unusual forms of instability compared to linear mechanical systems. These begin with autocatalysis as a mechanism of exponential growth, and continue with various feedback effects – either continuous, leading to periodic behaviour, or discrete and iterative, leading to deterministic chaos and fractals. Well-known mechanisms of stability in complex systems are homeostasis and homeorhesis.

Semiosis adds freedom because it includes plural possibilities and choice. This is a source of new types of instability. Freedom, by itself, is a condition of radical instability. Based on the simultaneity of the subjective present, semiotic freedom creates incompatibilities, distinctions, and contradictions as sources of instability.

The growth of semiotic freedom is accompanied by an increase in both the sources of instability and the types of conflict.

We observe that living and semiotic systems (organisms, species, cultures, ecosystems) somehow stabilise themselves independently of natural selection. The problem I propose to analyse is: what are the types of stability in semiotic systems? I propose to approach this problem by examining the types of semiotic instability.

Semiotic systems do not have a stable state or stable trajectory. Instead, the general condition of stability in semiotic systems may be characterised as the healthy, or the aesthetic.

Semiotic systems fail not when they change too much, but when change outruns interpretation.

Understanding the conditions for semiotic stability is necessary for finding a green way of living: live in such a way that one can always continue to live (i.e. without destroying one's own conditions for stability).

Dentico, Michele (ed.) 2025. Semiotics, Life, Ecology and Sustainability: Biosemiotic Critics. Bogotá: Pontificia Universidad Javeriana.

Kull, Kalevi 2022. The biosemiotic fundamentals of aesthetics: Beauty is the perfect semiotic fitting. Biosemiotics 15(1): 1–22.

Thom, René 1975 [1972]. Structural Stability and Morphogenesis: An Outline of a General Theory of Models. (Fowler, D. H., trans.; Waddington, C. H., foreword.) Reading: W. A. Benjamin.

The Axes of Edibility: Food's Suprasubjective Objecthood Across the Bio–Semiotic Continuum

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Across everyday practice and scholarship, articulations of what counts as food are peculiar in being heterogeneous yet locally coherent. A nutritionist may foreground compositional and physiological properties, whereas a gastronome may attend to sensory and cultural dimensions, suggesting that 'food' operates as a relational node whose salient qualifying features vary according to standpoint and context within stake-bound fields of signification. Taking this plurality as a diagnostic clue, this presentation argues that food is best approached not merely as a metabolic substance, nor as a site of interpretative attribution, but as an object whose identity is stabilised only within a web of relations that remains tethered to life's nutritional demands.

The proposed explanation is developed biosemiotically. Drawing on Stjernfelt's formulation of the *metabolic argument* foundational to living systems, it treats feeding as one semiotic–metabolic process, biologically unified yet analytically separable into two moments: one semiotic, in which an organism discriminates and recognises something as a prospective nutrient source, and one metabolic, in which incorporation realises, or fails to realise, the anticipated nutritional fulfilment (Stjernfelt, 2012). This coupling clarifies why signification is not an optional overlay on nutrition but a functional alignment mechanism that orients organisms towards those environmentally available portions whose uptake can sustain life. It also clarifies why partial accounts can be simultaneously productive and misleading: the analytic split enables talk of recognition without fulfilment or incorporation without recognition, as though either were sufficient to define food.

On this basis, Deely's *semiotic realism* (Deely, 2014) is introduced to characterise what sort of object 'food' is within such an understanding. Food is framed as suprasubjective: neither a private mental item nor a freestanding 'thing', but a relational object constituted through sign-relations while rooted in the physical order that constrains what can, in fact, nourish. This meta-level distinction explains how plural, locally coherent articulations of food can proliferate without slipping into arbitrariness: they unfold within an objective order of relations while staying answerable, in the last instance, to the realities of sustenance.

To visualise how human inquiry distributes emphases across this space, the presentation maps a biosemiotic continuum of food representation. Along this continuum, disciplinary vocabularies can be shown to *hypostatise* (cast as self-standing) distinct food-objects by prioritising different moments of the same semiotic–metabolic sequence: more *bio*-leaning framings stress composition, digestibility and metabolic throughput, while more *semiotic*-leaning framings highlight categorisation, normativity and symbolic elaboration. The upshot is a warning against extreme reductions on either side. Reducing food to mere substrate effaces the sign-mediated conditions under which edibility becomes actionable for organisms, while collapsing it into a purely symbolic object risks severing edibility from the biological constraints that make it matter in the first place.

Deely, J. N. (2014). Subjectivity, suprasubjectivity, and semiosis. *Chinese Semiotic Studies, 10*(4), 593–604. https://doi.org/10.1515/css-2014-0052

Stjernfelt, F. (2012). The evolution of semiotic self-control: Sign evolution as the ongoing refinement of the basic argument structure of biological metabolism. In T. Schilhab, F. Stjernfelt, & T. Deacon (Eds.), *The symbolic species evolved* (pp. 39–63). Springer. https://doi.org/10.1007/978-94-007-2336-8

Abstracts

Peirce and Biosemiotic Technology

Semiotic Nonagon: Taxonomy, Hyper-relations, and Biosemiotic Inquiry

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This paper proposes the Semiotic Nonagon (SN) as an operational framework for qualitative research in biosemiotics. Derived from Peirce's triadic semiotics, the SN functions as an empty two-way grid—a double-entry table—that makes triadic interdependence workable in analysis and teaching by flattening—only for practical purposes—the hyperspatial structure of the Peircean sign (continuity, synechism; CP 6.169, 1902). Rather than offering a taxonomy alone, it organises a field of higher-order relations and interdependencies among the sign's aspects, supporting a shift away from positivist framings towards a relative, relational account that can be systematically refined. In this way, each of the nine aspects of any sign is always the product of the intersection of a Correlate (CP 2.235, 1903) with a Trichotomy (CP 2.243, 1903). My interest in biosemiotics was strengthened through engagement with the work of Thomas A. Sebeok, with whom I was able to exchange views in the 1980s and 1990s (Guerri, 1988: 389–419). From 1973 onwards I studied the triadic semiotics of Charles S. Peirce through the seminars taught by Juan A. Magariños de Morentin. In that context, Peirce's triadic logic also provided a way of re-reading Vitruvius' intuitive triad (27–23 BCE, Book I, Chapter 3, § 2) concerning architectural values: Firmitas, Utilitas and Venustas. In antiquity, given the limited knowledge of structural calculation, solidity (Firmitas, i.e. Secondness) naturally came to the fore. Nevertheless, 1,500 years later, Vitruvius' Renaissance translator, Cardinal Daniele Barbaro (1567), reordered the triad as Venustas, Firmitas and Utilitas—a sequence shaped by the cultural context of the period rather than by a Peircean logic. From 1974 onwards, Magariños de Morentin (1984; 2008) and I worked on what he called the "Peirce scheme", which—at that time—was not yet Peirce's (Guerri, forthcoming). The logic of that scheme was progressively refined until it was named the Semiotic Nonagon (Guerri, 2003; 2012), and it was developed from three Correlates within a sign of Architecture—Design/Firstness, Construction/Secondness, and Habitability/Thirdness. The Semiotic Nonagon proved highly effective for teaching at the Faculty of Architecture and enabled me to recognise that, worldwide, habitability is typically reduced to a narrow functionalist or normative treatment, rather than approached as a complex semiotic phenomenon. Yet habitability is the basic and initial requirement—"Symbols grow" (CP 2.302, 1895)—the aspect that makes building necessary, and that therefore demands design and construction in order to obtain—sometimes—a work of Architecture. Habitability, considered only in its first aspect of the third Correlate of the sign Architecture—as a Form of Value (FV), that is, as a Legisign—requires an anthropological, sociological and psychological account of dwelling: a socio-cultural need. However, within a broader sign we may consider Architecture, or human constructions—the built environment—(Secondness), in relation to the context of nature (Firstness) and the human being (Thirdness). At a more abstract level, the SN can be used to model life as a sign, understood as a process and as a genuine triadic relation (CP 6.322, 1909), at once immanent to and external to each of three aspects: vegetative life (plants, Firstness), sensitive life (animals, Secondness), and rational life (human beings, Thirdness). These are treated not so much as three classes, but as three strata: three Semiotic Nonagons that coexist and intensify one another. During the presentation, several Semiotic Nonagons related to biosemiotic problems will be presented and offered for discussion.

Guerri, C. F. (1988b). Architectural, design, and space semiotics in Argentina. In Sebeok, T. A. & Umiker-Sebeok, J. (Eds.), The Semiotic Web 1987: A Yearbook of Semiotics (pp. 389-419). Mouton.

___(2012) Lenguaje Gráfico TDE. Más allá de la perspectiva. EUDEBA.

Magariños de Morentin, J. A. (1991). El mensaje publicitario. Nuevos ensayos sobre semiótica y publicidad. Edicial.

___(2008). Semiótica de los bordes. Apuntes de metodología semiótica. Comunicarte.

Peirce, C. S. (1931-58). Collected Papers of Charles Sanders Peirce. Vol. 1-8. Harvard UP.

Vitruvius Polio, M. (23-27 BC) I Dieci libri dell'architettura di M. Vitruvio, tradotti e commentati da Mons. Daniel Barbaro. Venice, 1556, revised edition 1567.

A Peircean theory of technology

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Semiotics can underpin the fast-developing philosophical discourse on technology, but it has been seldomly considered as such. Starting from Hoffmeyer's approach to technology (2009) via the notion of semiotic scaffolding, I propose a view on human-machine interaction where *human* and *machine* do not precede their interaction but are *prescinded* from their (intelligent) behavior as a unit. Aligning with external mind theory, this approach avoids asking where does mind (user) begin and end, so to localize where does the computing machine (tool) begin and end. Living with non-organic devices that exhibit intelligent behavior urges the need for theory to avoid construing knowing subjects as enclosed individual metabolisms and, thus, ascribing agency strictly to organic matter.

My proposal is founded on the scarce but prominent efforts both in semiotics to tackle technology and in philosophy of technology to incorporate semiotic insights. The framework hashed out is developed in light of the cognitive semiotic approach to study the mind in the interrogation of the imagination (or simulation).

Specifically, I adopt Hoffmeyer's biosemiotic view on technology as scaffolding that co-evolves with the organisms that model by scaffolding. In this key, I follow Emmeche's (2001) pioneering view on robots as agents that model *Umwelten* (environments) while lacking *Innenwelten* (situatedness). This aligns with externalist approaches to mind that regard environments as having active roles in mindwork. Moreover, I explain that, via biosemiotics, Peirce's semiotics offers an avantgarde mind externalism. Particularly, by abducting, minds behave conditionally, in the assessment of what *would be* the case. In this view, the self is located in the future (Interpretant), as extended through presently unfolding semiosis. This is the ground for Magnani's eco-cognitive computationalism, positing that ignorant entities are domesticated into the cognition of knowing subjects, and Malafouris' (2013) material engagement theory, that observes degrees of neurocompatibility in non-organic matter. I bring together these theories into a framework that supports the strong Mind-Technology Thesis, namely that *mind* and *technology* constitute two heuristics for the same philosophical inquiry.

Also, Peirce's semiotics is a warp for undermining classical humanism. Fuller (2022) regards Peirce's *synechism* as a starting point for post- and trans-humanism, which has also been implicit in Colapietro's (1989) Peircean theory of selfhood, albeit without a focus on technology. Most importantly, Hayles (2025) recently observed that Peirce's pragmatism and its uptake in biosemiotics constitute an important evolutionary perspective on AI. While praising biosemiotics for eschewing anthropocentrism, she nevertheless considers that this avenue falls into a biocentric fallacy. The theory I propose embraces most of Fuller's and Hayles' theories but with some critical amendments: (1) the notion of scaffolding ushers a transhumanism that accepts path-dependency and, respectively, (2) regarding consciousness and cognition as relatively small subdomains of semiosis avoids accusations of naïve biocentrism.

This theory still leaves a difficult question on the emergence of semiosis – whether (non-organic) parts of reality are asemiotic. Still, the options of reality as (1a) either pansemiotic or (2a) divided into semiotic and asemiotic are less assuming than those of reality as either (1b) pancognitive or (2b) divided into cognitive and non-cognitive.

Colapietro, V.M. Peirce's Approach to the Self: A semiotic Perspective on Human Subjectivity.

State University of New York Press, 1989.

Emmeche, C. Does a robot have an Umwelt? Reflections on the qualitative biosemiotics of Jakob von Uexküll. Semiotica 134: 653-693, 2001.

Fuller, S. The mind-technology problem. Postdigital Science and Education 4:247–252, 2022.

Hayles, K. N. Bacteria to AI: Human futures with our nonhuman symbionts. The University of Chicago Press, 2025.

Hoffmeyer, J. Biosemiotics: An examination into the Signs of Life and Life of Signs. University of Scranton Press, 2009.

Magnani, L. Eco-cognitive computationalism: Cognitive domestication of ignorant entities. Springer, 2021.

Malafouris, L. How things shape the mind: A theory of material engagement. The MIT Press, 2013.

Artificial Symbionts of the Afterlife: Navigating Presence of Absence in the Posthuman Umwelt

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With rapid advances in generative AI, LLMs, voice cloning, deep fakes and affect recognition,

artificial agents no longer simply recognize human emotion and cognition; they can now simulate them. Yet what happens when artificial agents are not simply synthetic stand-ins for the living but also deceased? This paper examines digital survival after biological death. It proposes a *thanasemiotics* where semiosis continues without life, where the digital remains of the deceased sustain meaning-making beyond metabolic closure. A growing industry dedicated to grief tech - AI-powered memorials, platforms, holograms, augmented reality, and chatbots is expanding our understanding and horizon of mortality beyond the grave.

Digital estate planners such as Deathswitch, Lifefile, and MyWishes sell products and services so people can safeguard their post-mortal legacy by ensuring heirs have access and control over their digital information. Start-ups such as Storyline, and Hereafter. ai create pre-mortem replicas for customers in preparation for the afterlife. Platforms such as Séance AI, You, Only Virtual, and Eternos create digital twins of deceased loved ones, trained posthumously digital remains such as social media data, posting patterns, SMS, emails, voice and video recordings. Tech giants are also sowing plans to monetize the digital afterlife, securing patents for AI agent designed to keep social media user accounts active long after they transpire. The ultimate purpose of these digital ghosts is to drive platform revenue by autonomously extending user engagement and in turn, creating a never-ending stream of lucrative data through behavioural tracking, ad placements, and sponsored ads.

Drawing on biosemiotics and computational media studies, notably, the shared notion of absence found in the writings of Charles Peirce, Terrence Deacon and Katherine N. Hayles, this paper examines how meaning, agency, and affect persist when the biological organism no longer does. I argue that grief technology inaugurates a new symbiotic ecology of signs, an afterlife of semiosis where mourning, code and machine learning co-constitute now porous boundaries between the living and the dead. Although these artificial symbionts are clearly not living conversational partners, the everyday interactions, experiences and emotions associated with these systems are in fact meaningful for living users. Hence, they point to a deeper entanglement of material and semiotic causality, where the material properties of digital culture and meaning making processes it brings to human agents cannot be separated.

Friday
31st July
@ the Wave

Implications and relations of biosemiotics to philosophy and humanities
Chair: Kobus Marais

9.30 *A common ground for Rosen and Prodi*
Arno Goudsmit

10.00 *Environmental and biosemiotic perception as reflected in the poetic texts of Jaan Kaplinski: From the history and present state of Tartu biosemiotics*
Ekaterina Velmezova

10.30 *Life beyond itself*
Barbora Jurková

11.00 coffee break

The biosemiotics of health and disease
Chair: Kobus Marais

11.30 *The Gut-Microbiome-Brain Heterarchy: A Biosemiotic Model of Distributed Regulation*
Rebeca Méndez-Veras

12.00 *The fermentation revolution: The holobiont in contemporary microbial discourse*
Prisca Augustyn

12.30 *Artificial Intelligence (AI) in healthcare: exploring the implications of AI for the clinician-patient relationship through a biosemiotics framework*
Sara Cannizzaro

13.00

Semiotic processes in biology
Chair: Jana Švorcová

14.00 *The Time of the Genetic Code: How Aminoacyl-tRNA Synthetases Generate a Molecular Specious Present*
Praveen Prathapan

14.30 *From Molecular Assembly to Basal Cognition: Biosemiotics, Codepoiesis, and the Emergence of Coherent Semiotic Fields*
Oscar Castro Garcia

15.00 *Exosome communication as an empirical model of cellular semiosis*
Jenny Öhman

15.30 tea break

16.00 *Metaphors To Survive By II: Becoming a (Meta)Sign in Biological Mimicry*
Róbert Bohát

16.30 *Living 'Organisms' Manifest Phenomenal Consciousness, Anticipatory Agency and Semiotic Freedom - Fabricated 'Mechanisms' Do Not.*
Gary Goldberg

17.00 Close

Day 5: Friday 31st July 2026

Abstracts

Implications and relations of biosemiotics to philosophy and humanities

A common ground for Rosen and Prodi

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Rosen's (1991) concept of 'closure to efficient causation' is a tool for specifying and elaborating impredicativities, which are self-referential logical relations, considered essential for understanding and describing the living organization.

Pivotal in Rosen's thinking is the construction of models that represent these impredicativities. As a kind of natural extension of his ways of thinking, he proposed (1985) that a living system 'has' a model of itself and its environment, which helps it to anticipate events and to accomodate itself timely to new developments. This idea of internal model was an elaboration of Rosen's emphasis on final causation as a type of causality that had unjustifiably been ignored or put aside in Newtonian physics and its accompanying metaphysics. Now one of the hard topics in reading Rosen is that his emphasis on anticipation faded out (cf. Pattee, 2007). Was there something about it that eventually dissatisfied him?

I think Rosen has hit upon something that has troubled academic psychology for at least some 150 years, namely the naturalization of intentionality. When does the intentionality of a living being become empirically accessible, i.e. better than as merely some transcendental property, situated somewhere *beyond* the reach of an investigator's domain of observable phenomena?

Put differently, can a formalism equivalent to the type of Rosen's models be imputed to a living being, i.e. as some kind of model the living being is having of itself, using it for itself? This is something different from a relational model concocted and imposed by an external observer versed in category theoretic models of complexity. Here the idea of the existence of such a real model boils down to what William James has called the 'psychologist's fallacy', i.e. *"the confusion of his own standpoint with that of the mental fact about which he is making his report."* (1890, vol. I, p. 196). Of our interest here is not so much a mental fact sensu stricto, as an 'internal model', one that an organism is supposed to possess as a pivotal instrument of its adaptational capacities.

It is here that the writings of Giorgio Prodi on proto-semiosis are helpful. Prodi's (e.g. 2021, p. 118) major tenet is that in its most elementary existence, a sign is both interpreted and eaten/consumed. This is to be understood as a basic co-incidence of logical types, the sign eventually standing for itself, which is an impredicativity.

James, W. (1890, 1950). The principles of psychology. Dover.

Pattee, H.H. (2007). Laws, Constraints, and the Modeling Relation – History and Interpretations. Chemistry & Biodiversity, 4.

Prodi, G. (2021). The material bases of meaning. Univ. of Tartu Press.

Rosen, R. (1985). Anticipatory Systems: Philosophical, Mathematical, and Methodological Foundations. Pergamon Press.

Rosen, R. (1991). Life itself. A comprehensive inquiry into the nature, origin and fabrication of life. Columbia Univ. Press.

Environmental and biosemiotic perception as reflected in the poetic texts of Jaan Kaplinski: From the history and present state of Tartu biosemiotics

Ekaterina Velmezova

University of Lausanne / University of Tartu

Jaan Kaplinski (1941-2021) was and remains one of the best-known Estonian poets of the 20th and 21st centuries. Kaplinski was interested in biology and ecology as well as (bio)semiotics; he attended some Estonian schools on theoretical biology (sometimes presenting papers), had contacts with many (bio)semioticians, and studied the discussions that took place within the framework of the Tartu-Moscow/Moscow-Tartu semiotic school. Kaplinski was also interested in the scientific heritage of Jakob von Uexkull and Juri Lotman, and his philosophical poetry contains some traces of his environmental and ecological (biosemiotic) perception and thought. In the paper, we will analyze this using the example of three poetry collections by Kaplinski: *Tule tagasi helmemänd* 'Come back, amber pine' (1984), *Käoraamat* '**Cuckoo Book**/*Gymnadenia*' (1986) and *Helmemänni varju all* 'In the shadow of an amber pine' (2020). In particular, we will talk about the reflection in his poetry of such important biosemiotic concepts as *Umwelt*, *agency*, *sign*, *organism*, *complexity* (vs. *simplicity*) and *biosemiotics* itself.

A part of the paper will be devoted to disputes about (bio)semiotics and ecology between Jaan Kaplinski and biosemiotician Kalevi Kull: close friends, they did not always adhere to the same views (among other things, Kalevi Kull was much more reserved than Jaan Kaplinski about the spreading of so-called "exotic species" in Estonia, arguing from a (bio)semiotic point of view). That and other ideas were also reflected in Kaplinski's "environmental" poetry. In 1997 K. Kull published a review of J. Kaplinski's book *See ja teine* 'This and that' (1996). Later, in 2009, K. Kull composed an afterword to J. Kaplinski's book *Jää…* 'Ice…' in which the poet also reflected on nature and ecology.

Finally, we will raise the question not only of how much biosemiotics influenced Kaplinski, but also of how much Kaplinski's poetic work influenced the formation of Estonian (though not only) biosemiotics. Kaplinski was an important figure in the intellectual life of Northern Europe. Several times Kaplinski was invited to deliver lectures at the Department of Semiotics at the University of Tartu and at other academic institutions in Estonia; he also presented a plenary paper at the World semiotic congress that took place in Helsinki and Imatra in 2007. His texts were undoubtedly important for European scholars already studying semiotics because Kaplinski managed to convey (bio)semiotic thinking in his poetic language.

— HOFFMEYER J., 1996: Signs of Meaning in the Universe. Bloomington, Indiana University Press.

— KAPLINSKI J., 1984: Tule tagasi helmemänd. Tallinn, Eesti Raamat.

—, 1986: Käoraamat. Tallinn, Eesti raamat.

—, 1996: See ja teine. Tartu, Tartu Ülikooli Kirjastus.

—, 2009: Jää… Tartu, Võluri Tagasitulek.

—, 2020: Helmemänni varju all. Hea lugu.

— KULL K., 1997: "Mõistuse ökoloogia", in Vikerkaar, 1997, 11 (4/5): 195-213.

—, 1998: "On semiosis, Umwelt, and semiosphere", in Semotica, 1998, 120 (3/4): 299-310.

—, 2009: "Jää pärast", in Kaplinski 2009: 299-310.

— KULL K., VELMEZOVA E., 2018: “Jaan Kaplinski ja semiootika”, in Acta Semiotica Estica, 2018, 15: 196-213.

— TIIVEL T., PARIK J., KULL K. (koost.), 2018: Teoreetilise bioloogia kevadkoolid I-XV: 1975-1989. Tallinn – Tartu, TÜ Meediakeskus.

— VELMEZOVA E., 2022: “‘Oma valguses, oma ilmas…’: science meeting poetry”, in Favareau D., Velmezova E. (eds.), Tunne loodust! Knowing Nature in the Languages of Biosemiotics / Tunne loodust! Connaître la nature dans les langages de la biosémiotique [Epistemologica and historiographica linguistica Lausannensia, 2022, 4]: 353-357.

— VELMEZOVA E., KULL K., SOOVIK E.-R., 2021: “Jaan Kaplinski and his contacts with the Tartu-Moscow School of Semiotics”, in Sign Systems Studies, 2021, 3/4: 608-615.

Life Beyond Itself

Barbora Jurková

Can AI create life? Are AI-designed viruses the first step toward fully AI-generated life? And perhaps the most crucial question: are we asking an algorithm to solve the origin of life for us? These questions, paraphrased from media headlines, are appearing with increasing frequency. While often designed as a clickbait, their existence signals two critical shifts in our cultural and scientific discourse. First, they reveal how the general public is beginning to perceive technologies like Artificial Intelligence and Artificial Life in the context of complex scientific and philosophical questions that are deeply rooted in humanity. Second, they reflect the reality that these technologies are no longer mere tools and they have become active participants in researching the very origins of life on Earth.

In this paper, I argue that biosemiotics is uniquely positioned to provide a necessary framework for navigating this new problem, since it is an interdisciplinary field with incredible overlap to of humanities and science. This framework is crucial because the integration of AI into biology often brings back the purely mechanistic metaphors, reviving the view of *life as a machine* as a part of this new discourse. By using AI to *solve* such an important problem, we risk turning these metaphors into a self-fulfilling prophecy, narrowing our definition of life to something that can be viewed as a simple algorithm.

Biosemiotics offers specific conceptual tools to deal with this reductionism. For example, Jesper Hoffmeyer's concept of semiotic scaffolding explains how organisms rely on a complex history of meaningful cues to function and evolve. Unlike a computer script, biological life involves agency. By applying this biosemiotics approach to the discourse of artificially generated life, we can either move beyond the *software-hardware analogy* or turn it into something slightly different and use it to form a new framework. This perspective can then be used to talk about these complex problems and ground both public perception and scientific research in the qualitative difference between a programmed simulation and life itself.

Emmeche, C. (2007). The semiotic organism and the self-referentiality of life. Cognitive Semiotics, 1(Fall), 10–29.

Hoffmeyer, J. (2008). Biosemiotics: An examination into the signs of life and the life of signs. (J. Hoffmeyer, Trans.). University of Scranton Press. (Original work published 2005).

Katla, S. K., Lin, C., & Pérez-Mercader, J. (2025). Self-reproduction as an autonomous process of growth and reorganization in fully abiotic, artificial and synthetic cells. Proceedings of the National Academy of Sciences, 122(22), e2412514122.

Abstracts

The biosemiotics of health and disease

The Gut-Microbiome-Brain Heterarchy: A Biosemiotic Model of Distributed Regulation

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This paper proposes that the gut-microbiome-brain axis (GMBA) is better modeled as a heterarchical biosemiotic system than as a hierarchical control chain. *Hierarchy* implies a stable command structure and privileged controllers (e.g., top-down neural governance). By contrast, the GMBA is characterized by multiple partially independent pathways (neural, endocrine, immune, metabolic) that couple bidirectionally, bypass intermediate levels, and dominate differentially depending on state and timescale(Loh et al., 2024). The central claim is that this topology has a specific organization: distributed regulation with shifting loci of control, consistent with heterarchy. The paper then argues that the same organization is semiotic: it is composed of sign relations whose meaning is enacted by biological interpretive machinery under viability constraints.

The conceptual move is to operationalize both heterarchy and semiosis to avoid metaphor. *Heterarchy* is defined here as a multi-level organization that supports bidirectional influence, permits long pathways that bypass intermediate relays, and includes lateral coupling within levels, such that control is distributed and context-sensitive (Bruni & Giorgi, 2015). Semiosis is defined as a state-dependent mapping in which a sign vehicle produced by system A (molecular patterns, activity dynamics, ecological shifts) reliably alters regulatory dynamics in system B in a way that is conditional on B's internal state and relevant to its viability (homeostasis/allostasis, defense, energy management, reproduction, repair). Interpretation takes place by receptor-effector architectures: epithelium, immune thresholds, enteroendocrine transduction, vagal afferent gain, brainstem integration and interoceptive appraisal.

On this basis, the paper develops a layered structure of interpreters: (1) microbial community semiosis (resource sensing, quorum-related coordination, metabolite field shaping), (2) gut interface semiosis (barrier state, enteroendocrine signaling, mucus ecology), (3) immune semiosis (tolerance/threat calibration, cytokine motifs, trained responses), (4) neurovisceral semiosis (enteric circuits, vagal afferents, autonomic setpoints), and (5) affective-cognitive semiosis (interoceptive inference, salience, mood, action selection). The heterarchical feature is that none of these layers is a permanent executive. Acute stress can look top-down (autonomic/hormonal dominance), acute infection can look bottom-up (immune dominance), and chronic diet or antibiotics can reweight the entire semiotic scaffold by changing both sign production and interpretive mappings.

This paper is distinctive in three ways. First, it imports a precise heterarchy criterion from neurovisceral regulation into gut-microbiome-brain theorizing, replacing bidirectionality with a topological claim to be reevaluated (Hawkins et al., 2025). Second, it reframes microbial-host signaling as multi-level semiosis, clarifying what counts as a signal, where interpretation occurs, and how meaning is stabilized. Third, it yields testable predictions framed as semiotic reweighting: (H1) identical microbial sign vehicles (metabolites) produce different CNS-relevant outcomes across stress or circadian regimes because host interpretive gain and thresholds shift; (H2) dysbiosis increases ambiguity/noise in sign ensembles, amplifying interpretive conflict and regulatory oscillations; (H3) interventions that stabilize scaffolds (barrier integrity, rhythmic diet, vagal-afferent

modulation) tighten mappings and reduce cross-level interference.

The conclusion sketches implications for holobiont agency: decisions and affective dispositions emerge as achievements of heterarchical coordination among interpretive subsystems, rather than as outputs of a single sovereign controller.

Bruni, L. E., & Giorgi, F. (2015). Towards a heterarchical approach to biology and cognition. In *Progress in Biophysics and Molecular Biology* (Vol. 119, Number 3, pp. 481–492). Elsevier Ltd. https://doi.org/10.1016/j.pbiomolbio.2015.07.005

Hawkins, J., Leadholm, N., & Clay, V. (2025). Hierarchy or Heterarchy? A Theory of Long-Range Connections for the Sensorimotor Brain. *ArXiv.Org*. https://doi.org/10.48550/ARXIV.2507.05888

Loh, J. S., Mak, W. Q., Tan, L. K. S., Ng, C. X., Chan, H. H., Yeow, S. H., Foo, J. B., Ong, Y. S., How, C. W., & Khaw, K. Y. (2024). Microbiota–gut–brain axis and its therapeutic applications in neurodegenerative diseases. *Signal Transduction and Targeted Therapy 2024 9:1*, *9*(1), 37-. https://doi.org/10.1038/s41392-024-01743-1

The *fermentation revolution*: The holobiont in contemporary microbial discourse

Prisca Augustyn

In her philosophical investigation of *Fermentations* (2025), Anne-Sophie Moreau describes the recent fascination with kefir, kombucha, and sourdough as a cultural and philosophical shift in the human relationship with microbial life. Moreau believes that this *fermentation revolution* is not merely a culinary or lifestyle trend but a material and symbolic practice that enacts a broader cultural reimagination of our relationship with microbes. Moreau's *fermentation revolution* resonates with the work of biologist Lynn Margulis (e.g.1998) on the importance of *symbiosis* as a force of evolution and the concept of the *holobiont* that explains organisms not as singular, bounded entities but composite systems shaped by microbial partners. Recognizing life and the human body as fundamentally symbiotic, relational, and co-evolving rather than autonomous or extractive, Margulis tried to replace evolutionary narratives of competition with narratives of collaboration. (e.g. Margulis 1991)

The fascination with fermentation, according to Moreau, replaces entrenched negative narratives of hygiene and anti-microbial anxieties with stories of cooperation and dialogue. Instead of seeing microbes primarily as invisible agents of disease, practices like kefir fermentation bring microorganisms into the human *Umwelt* and the human body through the everyday practice of tending to symbiotic cultures like kefir. This pragmatic attunement to the wellbeing of microbial consortia for the health of the human body reframes microbial life as contingent and interdependent rather than as a domain to be dominated or instrumentalized.

Popular narratives of probiotics (e.g. Enders 2014, 2025) present the human body, especially the gut, as an integrated, adaptive, and communicative system in collaboration with microorganisms. Enders (2025) and Moreau (2025) describe the human body not as an isolated biological individual but as a dynamic evolving consortium of life, whose boundaries are ecological, functional, and semiotic rather than anatomical.

This paper interrogates narratives and concepts related to the *fermentation revolution* as a reflex of the foregrounding of symbiosis in biology (e.g. Margulis 1991, 1998) through recent popular science discourses of nutrition, health and wellness, philosophy, gastroenterology, and the commercialization of fermentation.

Enders, Giulia. (2025) Organisch. Berlin: Ullstein.

Enders, Giulia (2014) Darm mit Charme: Alles über ein unterschätztes Organ. Berlin: Ullstein.

Hoffmeyer, J. (2008). Biosemiotics: An examination into the signs of life and the life of signs. University of Scranton Press.

Margulis, Lynn. (1998) Symbiotic Planet: A New Look at Evolution. New York, NY: Basic Books.

Margulis, L. (1997). From kefir to death. In Slanted truths (pp. 83–90). Cambridge, MA: MIT Press.

Margulis, L., & Fester, R. (Eds.). (1991). Symbiosis as a source of evolutionary innovation: Speciation and morphogenesis. MIT Press.

Moreau, Anne-Sophie. (2025). Fermentations. Kéfir, compost et bactéries: pourquoi le moisi nous fascine. Seuil.

Artificial Intelligence (AI) in healthcare: exploring the implications of AI for the clinician-patient relationship through a biosemiotics framework

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Public expectations concerning the use of Artificial Intelligence (AI) in healthcare have been broadly positive (Ada Lovelace Institute and The Alan Turing Institute 2023). However, attempts at assessing the positive or negative implications of AI for society have mostly focused on technical issues such as tool performance and output accuracy (Bareis, 2024). In the context of AI healthcare communications, this may come to the detriment of losing track of the some of the fundamental preconditions for the clinician-patient interaction, for example the essential role of emotions, including empathy and compassion (Blease et al 2019; Amann et al 2023) in the communication of health-related information. Hence, the advent of AI in medical practice is expected to deeply shape the clinician-patient relationship (Mittelstadt 2022, Riedl et al 2024, Chen 2025).

In this respect, some claim that the clinician-patient interaction is being transformed into a triadic doctor-patient-AI relationship (Lorenzini et al., 2023; Chen 2025.), whilst others warn about AI displacing clinicians in favour of an AI-patient interaction (Čartolovni et al 2023, Riedl et al 2024). Hence, the implications of AI for the clinician-patient relationship can only be elusive. In this paper, I report on the results of a systematic literature review of 33 empirical studies across health & medicine, social sciences and computing, focusing on understanding the implications of AI for the clinician-patient relationship. The aim is to identify clinicians' and patients' perceptions of benefits and hopes, as well as challenges and concerns towards AI in medical communications using biosemiotics as a framework.

A biosemiotics reading of the implications of AI for the clinician-patient relationship allows us to counter the tendency to focus solely on technical understandings of the societal impact of AI, and to explore how the emotional dimension of the clinician-patient interaction is currently being addressed in empirical AI research. There are three key benefits to this reading: firstly, abduction-based theories of meaning-making (Sebeok 1978, Hoffmeyer 2008, Brier 2007) in biosemiotics can help us to recognize how current assessments of AI impinge on a disembodied notion of information; secondly, biosemiotics allows us to identify in the tendency to focus on the written output of an AI-mediated clinical interactions, a contemporary instantiation of the pars-pro toto fallacy "of mistaking the part for the whole" (Deely, Williams and Kruse 1986: viii); thirdly, as a perspective that abolishes binaries (Cobley 2016) and foregrounds continuous systems change (Lotman 1990), biosemiotics foregrounds the necessarily *ambivalent* character of AI's implications for the clinician-patient interaction.

These observations can help to demystify analytical paradoxes surrounding the uncertain implications of AI for the clinician-patient relationship, reinforcing both a holistic view and an inclusive experience of it. Furthermore, they can strengthen biosemiotics' role as a critical analytical framework for the applied social sciences.

Ada Lovelace Institute and The Alan Turing Institute, (2023) How do people feel about AI? A nationally representative survey of public attitudes to artificial intelligence in Britain. Available at: https://adalovelaceinstitute.org/ report/public-attitudes-ai

Amann, J., Vayena, E., Ormond, K. E., Frey, D., Madai, V. I., & Blasimme, A. (2023) Expectations and attitudes towards medical artificial intelligence: A qualitative study in the field of stroke. PloS one, 18(1), e0279088.

Blease, C., Kaptchuk, T. J., Bernstein, M. H., Mandl, K. D., Halamka, J. D., & DesRoches, C. M. (2019) Artificial Intelligence and the Future of Primary Care: Exploratory Qualitative Study of UK General Practitioners' Views. Journal of medical Internet research, 21(3), e12802.

Brier, S. (2008) Cybersemiotics: why information is not enough! Toronto: University of Toronto Press.

Čartolovni, A., Malešević, A. and Poslon, L., (2023) Critical analysis of the AI impact on the patient–physician relationship: A multi-stakeholder qualitative study. Digital health, 9, p.20552076231220833.

Chen, Q., (2025) Artificial intelligence in healthcare: rethinking doctor-patient relationship in megacities. Frontiers in Health Services, 5, p.1694139.

Cobley, P., (2016) Cultural implications of biosemiotics (Vol. 15). Dordrecht: Springer.

Deely, J., Williams, B. and Kruse, E. (1986) 'Editor's preface: "pars pro toto"' in J. Deely, B. Williams and E. Kruse (eds.) Frontiers in semiotics. Bloomington: Indiana University Press. Pp. viii-xxii.

Hoffmeyer, J. (2008) Biosemiotics: an examination into the signs of life and the life of signs. Scranton: Scranton University Press.

Lotman, Y.M., (1990) Universe of the Mind. A semiotic theory of culture, pp.20-35.

Lorenzini, G., Arbelaez Ossa, L., Shaw, D.M. and Elger, B.S., (2023) Artificial intelligence and the doctor–patient relationship expanding the paradigm of shared decision making. Bioethics, 37(5), pp.424-429.

Mittelstadt, B., (2021) The impact of artificial intelligence on the doctor-patient relationship. Council of Europe. https://rm.coe.int/inf-2022-5-report-impact-of-ai-on-doctor-patient-relations-e/1680a68859.

Riedl, R., Hogeterp, S.A. and Reuter, M., (2024) Do patients prefer a human doctor, artificial intelligence, or a blend, and is this preference dependent on medical discipline? Empirical evidence and implications for medical practice. Frontiers in psychology, 15, p.1422177.

Sebeok. T. A. (1979d [1978]) 'Looking in the destination for what should have been sought in the source' in The sign and its masters. Austin, TX: University of Texas Press.

Abstracts

Semiotic processes in biology

The Time of the Genetic Code: How Aminoacyl-tRNA Synthetases Generate a Molecular Specious Present

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A central assumption in molecular evolution is that ribozymal catalysis preceded protein catalysis. Yet the genetic code—understood as the operational mapping between codon-signs and amino-acid-objects—is regenerated in every cell by aminoacyl-tRNA synthetases (aaRSs). Only aaRSs establish the correspondences that ribosomes must presuppose. This creates a temporal inversion: evolutionarily, ribosomes appear older than proteins; semiotically, the mapping that renders ribosomal activity meaningful is renewed only through aaRS activity. The evolutionary timeline and the semiotic timeline run in opposite directions.

I contend that this inversion is not an anomaly but a window into the molecular origin of biological time. Drawing on Kull's account of the specious present—the short, experientially extended "now" in which meaning is constituted—and Nomura's E-series framework, in which living systems generate an intersubjective time code, I show that aaRS activity is the simplest biochemical instance of such event matching. I analyse specific features of aaRS specificity, editing, and discrimination as concrete E-series operations and contrast them with ribosomal decoding as a B-series execution of already habituated correspondences.

Aminoacylation links an amino acid (event□) to a tRNA identity (event□) within a field of optionality in which aaRSs must discriminate among alternative correspondences. This selective co-adjustment of boundaries is an E-series operation: it creates a present-time act in which multiple potential futures are collapsed into a single realised correspondence. The charged tRNA produced by this act is a habituated, trace-like structure that ribosomes use without optionality. Ribosomal decoding is therefore a B-series execution operating in a third-person, tenseless ordering of events yet riding on an E-series generative moment.

Thus, aaRS and ribosome activity instantiate two complementary temporal architectures: 1) **Generative present (E-series):** aaRS-mediated correspondence selection—a boundary operation generating a semiotic "now" in which new mappings may arise through interactive event matching. 2) **Habitual present (B-series):** ribosomal decoding—mechanised implementation of an already established mapping along an earlier/later sequence.

Current evolutionary models that attribute coding solely to ribozymal templates implicitly conflate these architectures. Only aaRS-like catalysts, whether ribozymal in origin or proto-protein, could generate the extended, option-rich present required for new correspondences to emerge. Ribosomes presuppose this semiotic spacetime and do not originate it.

I propose that the origin of biological interpretation is best understood as the emergence of a molecular E-series: a system in which generative and habitual presents become asymmetrically decoupled, enabling the creation of sign-relations. From this perspective, the genetic code is not a 'frozen accident' from an RNA world but a continuously renewed spacetime practice of meaning-generation via event matching at the molecular scale.

Recognising aaRS activity as the biochemical instantiation of an E-series clarifies how organisms maintain causal coherence across levels of organisation, why semiosis is intrinsically temporal, and how life began not merely with replication or metabolism but with the first generative present.

From Molecular Assembly to Basal Cognition: Biosemiotics, Codepoiesis, and the Emergence of Coherent Semiotic Fields

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In simple cells, chemical oscillators, bioelectric gradients, and cytoskeletal networks form coupled systems that regulate movement, metabolism, and environmental responses. Molecular motors, such as actin–myosin and kinesin–dynein complexes, convert chemical energy into organized motion, creating spatial patterns and intracellular flows that carry information. When these interacting processes become stabilized through code-like constraints—such as protein, bioelectric, and morphogenetic codes—the cell acquires the capacity to discriminate conditions and adjust its activity. Basal cognition thus emerges from the self-organized coordination of molecular codes within a coherent cellular field.

Understanding how minimal agency and basal cognition emerge from molecular processes remains a central problem in theoretical biology and code biology. This work develops an updated codepoietic framework to explain how meaningful organization arises from the exaptation of molecular architectures in simple cells. Building on assembly theory, the project investigates how subcellular objects—protein complexes, organelles, and regulatory circuits—are constructed, reused, and stabilized under biophysical constraints that act as proscriptive filters, enabling biomolecular exaptation at the subcellular level.

Assembly spaces can be interpreted as semiotic landscapes structured by interacting codes. In this context, the cell constructs a biomolecular Umwelt in which semiophysical fields—mechanical, rheological, and bioelectric dynamics—interact with semiochemical fields such as molecular signals and gradients. These coupled processes generate coherent semiotic fields characterized by oscillatory synchronies, rhythmic contractions, and noise discrimination.

Molecular motors play a central role in this organization. Actin–myosin systems and kinesin–dynein transport along microtubules function not only as mechanical devices but as code-bearing structures that transform chemical energy into organized motion and spatial information. Their coordinated activity contributes to cytoplasmic streaming, intracellular transport, and tension-based morphogenesis.

Protein assemblies thus operate as dynamic coding substrates. Actin and tubulin codes interact with bioelectric and morphogenetic codes, where membrane potentials and ionic gradients establish large-scale coordination. Gene regulatory systems act as adaptive, history-dependent networks that integrate chemical, mechanical, and bioelectric inputs, enabling context-sensitive responses.

Codepoiesis is understood as the capacity of living systems to generate and coordinate multiple interacting codes across scales. Through this process, exaptation and adaptation become integrated at the subcellular level, producing conditions for basal cognition and minimal agency. The project offers a unified framework linking assembly theory, molecular motors, bioelectricity, and gene regulation within a coherent semiotic model of cellular organization.

Exosome communication as an empirical model of cellular semiosis

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Contemporary biological science is dominated by big data and advanced models of living organisms. However, experimental studies need to go hand in hand with theoretical work as we otherwise risk to have a lot of data but not much knowledge. I argue that the concept of biosemiosis is operationally unavoidable in cell biology, specifically the study of long-range vesicle-mediated signalling. Intercellular communication by vesicles termed exosomes exhibit unique signalling features that challenges the view of cell signalling as a primarily deterministic and specific process. What makes it differ from other signalling systems, such as hormonal or neurological, is that exosome-mediated information is produced as a *representation of the state* of the releasing cell that is correspondingly *confined in space and time*, and *without a specified recipient*. Especially relevant is that receiving cells take up the exosomes and their content selectively. It means that two recipient cells do not necessarily interact and/or react in the same way to exosome-mediated information. In exosome research, this poses a bottleneck problem when trying to understand how exosomes can be safely used as therapeutic delivery agents. How can uptake and release of exosome cargo be mechanistically specific without deterministic response? I argue that a biosemiotic approach is needed to answer this question. In addition, I propose that exosome signalling can be used to empirically test biosemiotic hypotheses. If exosomal communication help cells decide how to react in response to influence from environmental factors (nutrients, inflammation etc) when information is *ambiguous*, depending on both current and previous exosome-mediated information, it indicates semiosis. I here present three generic experimental designs with currently available techniques, that can give indications to whether this information flow system indeed requires the concept of semiosis to explain it.

The experimental designs presented here, explore cell's sensitivity to; sequential exposure, to ambiguous input, and the ability to delay responses to exosomal content (the information is not deterministic but incorporated into the interpretive capacity of the cell for future potential events forcing the cell to a decision). In practice, cells are separated into two populations, one releasing cell population and one receiving cell population. The releasing cells are exposed to some kind of stress such as inflammation. Released exosomes are collected at different time points creating groups of exosomes corresponding to quiescence, stimulated state, and resolved state, respectively. The different exosome populations are then presented to the receiving cells in the "wrong" order. Subsequently, the receiving cells are in turn stimulated, and the state of these cells are monitored with known markers and compared to cells that received the exosomes in the "right" order. If the receiving cells react differently or not at all, it indicates that the cell creates meaning based on time-space constraints. In a second experiment, receiving cells are instead of sequential exposure, presented with several exosome populations at the same time, thereby forcing the cells to act in response to ambiguous information. If the receiving cells react differently depending on previous exposure to stressors, it is an indication of interpretation made based on experience. In the third experiment, the recipient cells are repeatedly exposed to the same sequence of exosomal populations and future responses of the recipient cells are monitored as above. If, for example the time to first

response to a stressor is decreased after repeated exposure to a specific sequence, it indicates anticipation.

These are three possible designs that are simple and can easily be performed with current methodology. I propose that the permutations and questions that can be investigated within this framework are relevant for both exosome signalling research and biosemiotics.

Metaphors To Survive By II: Becoming a (Meta)Sign in Biological Mimicry

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The goal of this study is to combine the ecological semiotic approach to mimicry by Coletta (1993) and the cognitive semiotic approach proposed by Bohát (2021). Both studies provide evidence of isomorphism between mimicry and metaphor. This can be summarized *inter alia* by comparing basic semiotic definitions of both. First, a basic definition of metaphor: "There exists an A that 'is' B if and only if A is NOT a B". Similarly, mimicry could be defined as follows: "There exists a species A that 'is' species B if and only if species A is NOT species B"; in mathematical symbols:

$$Mi = \{\exists\, A = B <=> A \neq B\} = Me$$

This semiotic and processual isomorphism will be supported by several case studies in plant and animal mimicry that align well with Coletta's argument that organisms are "simultaneously semiotic and ecological phenomena." (1993, p. 223) He puts human metaphor making in parallel with biological entities' "solving complex visual puzzles" by means of "indexical stretching" or production of "icons of the environment" (such as toad crypsis, i.e. a toad looking like a stone to avoid predation, Coletta 1993, pp. 223 - 225). This idea can be further extended to harmless mimics' becoming a sign (an icon) of a venomous model (as when a hoverfly mimics a wasp); when the hoverfly is avoided by a predator due to its aposematic color pattern signaling a venomous sting when there is none, the hoverfly becomes a counter-factual sign of a sign - a metasign (from a human semiotic point of view) - or a "figure of sight" analogous to the linguistic figure of speech - metaphor. (compare Coletta, 1993, p 225) I propose an extension of Coletta's "figure of sight" to a "figure of perception" as this metaphoricity of perceiving or experiencing one species ***as*** a different one (i.e. a biological metaphor - biometaphor) can include not only the sense of sight (such as Batesian mimicry of the great orange-tip butterfly caterpillar resembling the Asian vine snake), but also the perception of sounds (as in drongo's "deceptive" mimicking of meerkat alarm calls) as well as the perception of smell (like Pouyannian mimicry - when a wasp perceives the scent of an orchid as that of its female). Naturally, most metaphors can be recognized as such in human cognition, while most cases of mimicry are not recognized as counterfactual by animals. Yet, reports show that mimics do not always succeed - drongos have been observed as having "to change the type of false alarm call when their previous food-theft attempt failed". (Flower et al., 2014) This indicates that meerkats - the target audience of drongos' false alarms - might have a degree of success in recognizing the counterfactual nature of the vocal sign. Similarly, in egg mimicry of cuckoo's nest parasitism - some birds do get fooled into feeding a cuckoo hatchling, while some others recognize the cuckoo's egg and destroy it. On the other hand, human linguistic metaphoricity is not always recognized and reflected on as such, and cases of Vavilovian mimicry - "the adaption of the weed mimic to be perceived … as visually, physically, or biochemically indistinguishable from the crop model" has historically fooled intelligent, reflective human "operators" (McElroy, 2014).

I'd like to present a draft Peircean account of the semiotic and cognitive nature of this mimicry and metaphor isomorphism and its implications for the "nature vs. culture" divide, for our understanding of animal cognition, for ecological implications of such figurativeness in ecosystems as well as for questions of firstness and secondness.

Bohát, R. (2021) Metaphors to Survive by: Mimicry as Biometaphors: Embodiment of Sign and Cognition (not only) in Animals? In Delahaye, Pauline (Ed.): *Linguistic Frontiers* 4 (1); Special Issue: on Zoosemiotics and Animal Ethology; Sciendo.

Coletta, W. J. (1993) The Semiotics of Nature: Towards an Ecology of Metaphor and a Biology of Mathematics. *The American Journal of Semiotics*, *10*(3), 223–244. https://doi.org/10.5840/ajs1993103/410

Flower, T. P., Gribble, M., & Ridley, A. R. (2014). Deception by flexible alarm mimicry in an African bird. *Science (New York, N.Y.)*, *344*(6183), 513–516. https://doi.org/10.1126/science.1249723

Maran, T. (2011) Becoming a sign: The mimic's activity in biological mimicry. *Biosemiotics*, 4,243–257.

McElroy, J. S. (2014). Vavilovian Mimicry: Nikolai Vavilov and His Little-Known Impact on Weed Science. *Weed Science*, *62*(2), 207–216. http://www.jstor.org/stable/43700650

Living 'Organisms' Manifest Phenomenal Consciousness, Anticipatory Agency and Semiotic Freedom - Fabricated 'Mechanisms' Do Not

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'*Semiotic Panpsychism*' makes the claim that all naturally occurring, autopoietic, relational systems are living 'organisms' manifesting phenomenal consciousness, goal-directed, *anticipatory* agency, and progressively increasing 'semiotic freedom' through the course of evolution. Organismic functionality is furthermore linked to bidirectionally negotiated *transactions* involving the exchange of energy/mass/information between a conferring 'emitter' and an accepting 'absorber' that 'go all the way down' to the subatomic level. '*Semiotic Freedom*' is the expanding capacity to communicate relevant meaning in a transactional context. It is proposed that 'Semiotic Freedom' is related to the **excess** of analytical *semantic* over synthetical *syntactic* descriptions of relational systems as determined by the mathematical theory of categories (Rosen, 1991). Growth of Semiotic Freedom has been proposed as a driving force in evolution—organisms with higher semiotic freedom implying increased communicative capacity, can survive through coordinated communitarian cooperation (Hoffmeyer, 2010). Non-living, fabricated 'mechanisms' are *open* to efficient causation, and do NOT contain continuously operative *closed causal loops*. Mechanisms are strictly deterministic, computable, and operate algorithmically. Mechanisms are confined to *a state-based ontology* with bounded, rudimentary entailment capacity—by definition, they conform to the 'mechanistic formalism' that requires a partitioning of their description that segregates between states and the time-dependent dynamical laws that govern their evolution through phase space. Mechanisms have equivalent semantic and syntactic descriptions and thus lack semiotic freedom (Rosen, 1991).

Living 'Organisms', by contrast, are *closed* to efficient causation and DO *contain closed causal loops*. Organisms are autopoietic, non-deterministic, non-computable, and non-algorithmic. Organisms manifest non-zero semiotic freedom that can be scaled up through species-oriented natural selection on the phylogenetic timescale—they communicate meaning and evolution confers the possibility of phylogenetic expansion and elaboration of this capacity.

Self-referential calculus incorporating imaginary numbers is required to describe the dynamic behaviour of autopoietic organisms (Varela, 1975). Quantum theory similarly requires incorporating imaginary numbers (Renou, Trillo, Weilenmann, et al, 2021) suggesting that it is '*organismic*' in nature—and NOT actually a deterministic 'mechanics.' This may well be connected to the transactional interpretation of quantum theory (Kastner, 2022) which postulates a hidden semiotic relational reality of potentiality—the so-called '*quantum substratum*' (QS)--wherein possibilities for actualization are bilaterally negotiated before actualizing.

Thus, all *organisms (but **NOT** mechanisms)*:

Manifest phenomenal consciousness.

Manifest anticipation.

Are purposive agents manifesting intentionality.

Rosen, R. (1991). *Life Itself. A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life.* Columbia University Press.

Hoffmeyer, J. (2010). Semiotic freedom: An emerging force. In P. C. W. Davies & Niels Henrik Gregersen (Eds.), *Information and the Nature of Reality: From Physics to Metaphysics* (pp. 185-204) Cambridge University Press.

Varela, F.J.G. (1975). A calculus for self-reference. International Journal of General Systems, 2(1), 5–24. https://doi.org/10.1080/03081077508960828

Renou, M. O., Trillo, D., Weilenmann, M., Le, T. P., Tavakoli, A., Gisin, N., Acín, A., & Navascués, M. (2021). Quantum theory based on real numbers can be experimentally falsified. *Nature*, 600(7890), 625–629. https://doi.org/10.1038/s41586-021-04160-4.

Kastner, R.E. (2022). *The Transactional Interpretation of Quantum Mechanics. A Relativistic Treatment. 2nd Edition*. Cambridge University Press.

