

Symbiosis

Interspecific associations in collaborative practice

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Symbiosis is a pervasive occurrence in nature, describing the close and persistent interaction among organisms of different species aiming to extract benefit for at least one of the interacting organisms. While symbiosis has over the years been the subject of controversy in the fields of General Biology and General Ecology, nowadays there is evident consensus on the phenomenon's ubiquity, and its importance in accelerating the rate of life's evolutionary process.

Through observing the manner in which diverse organisms interact with each other, I have interpreted the mechanisms of symbiotic interactions into a framework for interdisciplinary collaboration between practitioners of diverse creative disciplines. By interpreting the different types of symbiotic interactions, mutualism, commensalism, and parasitism, as well as their key observable traits, interspecificity, closeness, and persistence, the framework provides practitioners with a set of actions and precepts that can be employed during each stage of the collaborative process. The development of the framework draws insight from the findings emerging from my own practice, which focuses on the collaboration between disciplines utilising sound and physical movement through the use of gesture control technologies. Further case studies from other similar practices are also presented, in showcasing the activation of the symbiotic framework within interdisciplinary collaboration.

Keywords—*symbiosis; interdisciplinary; collaboration; collective; framework;*

While the coalescence of skills, knowledge, and labour is proven to be an effective approach in researching complex problems, individuals attempting to work collectively are faced with several issues, such as determining hierarchy within the collective, the manner in which labour is shared, and the lack of a shared vocabulary that transcends disciplinary boundaries. Several models have been developed in addressing the aforementioned issues, with different approaches aiming to facilitate the multiple ways collective work can be conducted. In this paper I present a framework that is informed by the biological phenomenon of symbiosis. By examining the different ways organisms of different species interact and form relationships with the aim of improving their quality of life, I have interpreted the mechanisms and outcomes of the different types of symbiotic interactions into a set of strategies and methodologies that can facilitate a wide range of collective work, from directive to collaborative.

In the following chapters I describe the symbiotic phenomenon and its different types, and how their specific traits can be interpreted in collaborative practice. These are presented through case studies of art-science collaborations, as well as examples from my own work conducted through collaboration with artist practising different creative disciplines and using distinct expressive media. Finally, the collaborative model is summarised, along with notes on the current nomenclature of interdisciplinary research, and how the use of different approaches can better suit a particular collaborative environment.

I. INTRODUCTION

With further advances in knowledge, researchers are faced with new questions and problems which require more complex set of abilities in order to reach a resolving outcome [1]. As a way of satisfying the requirement of more diverse skills, many projects address this issue through collectively conducted research, where several individuals and disciplinary fields combine their abilities towards creating new knowledge. This approach is broadly defined as interdisciplinary collaborative research, with areas such as information technology, film and theatre, and economic sciences having all yielded fruitful outcomes through the work of groups of individuals aiming to address a specific issue by distributing labour and sharing insights.

II. SYMBIOSIS

Symbiosis is a broad term assigned to the multiple types of interactions between two or more organisms of different species [2], defined by a relationship that must be interspecific, close, and persistent [3]. The most widely accepted types of symbiosis are mutualism, commensalism, and parasitism, qualified according to the fitness outcome of the interacting beings. Leung and Poulin [4] suggest that “where both the host and symbiont reciprocally benefit from the relationship, the association represents mutualism, whereas if the symbiont utilises the host without benefiting or harming it, it is considered as a commensal. In contrast, if the symbiont is using the host as a resource and causing it harm as a result, then it qualifies as a parasite.”

In providing precedence from each type, arguably the most cited example of symbiotic interaction is that between the common clownfish (*Amphiprion ocellaris*) and various species of sea anemones, with the two organisms living in close proximity and deterring each other's predators [5]. Therefore, since the organisms simultaneously derive benefit from their interaction, their relationship is classed as mutualistic.

Not all symbiotic interactions are as easily identified, as is the case with the malaria protozoans (*Plasmodium*) and their mosquito host (*Anopheles*). While until recently it was thought that protozoan use the mosquito only as a carrier, therefore suggesting a commensalistic relationship, it has now been observed that the symbiont is able to manipulate its host's sense of self-preservation by compelling it to approach and bite humans more often than an uninfected mosquito would normally attempt [6]. Consequently, the protozoan benefits by increased chances of successful transition to a human body, while harming its host mosquito by exposing it to potentially perilous situations, thus qualifying the relationship as parasitic. This example illustrates that the underlying type of a symbiotic relationship can often be obscured when examining only the short-term effects of an interaction.

The difficulty with identifying symbiotic types is especially challenging when it comes to commensalistic relationships, as in contrast to their definition, they are seldom entirely neutral for the host. Observing the interaction between whale barnacles (e.g. *Cryptolepas rhachianecti*) and various species of baleen whales, the arthropods attach on the mammal's skin with the aim of deriving benefit through higher mobility and access to more food sources due to the deeper waters reached by the whale [7]. While the barnacle's attachment does not cause any direct harm to the whale, it inadvertently creates hydrodynamic drag, as well as skin irritations, therefore having a degree of negative effect on its host's fitness outcome. As such, the relationship is thought to reach a fitness equilibrium, where the host is prepared to tolerate the relatively minor harm caused by its symbiont, especially if any attempt of removing the symbiont can potentially cause more harm to its host.

The examples above are not exhaustive of the complex nature of symbiotic interactions, with many more types defined according to the specific nature and outcomes of a relationship between dissimilar organisms. A further layer of complexity is due to the dynamic nature of symbiotic relationships where certain conditions may force a relationship to mutate to a different type [4]. This mechanism informs one of the main points in developing my framework, where I suggest that different types of relationship can be assigned to different types of collaborative work and their respective stages. Furthermore, it is worth stressing that symbiosis is considered to be largely responsible for the rate of evolution of life, due to the antagonism among species in evolving defensive and offensive mechanisms that can better support their chances of survival. However, Angela Douglas [8] takes a different perspective, by defining symbiosis as "those relationships between organisms that permit some species to overcome their physiological limitations by exploiting the capacities of others". This angle is a further focal point of my interpretation of symbiotic relationships into a model for interdisciplinary collaboration; the potential to overcome limitations in individual skills,

knowledge, and creativity can be greater when research is conducted through a collective of diverse individuals and disciplinary fields.

III. COLLABORATIVE FRAMEWORK

Having examined the manner by which biological associations occur in nature, I will present the interpretation of the core traits of symbiotic relationships to corresponding elements of interdisciplinary collaborative practice. The first defining trait of a symbiotic relationship is interspecificity among the interacting parties, which I interpret as the association between two dissimilar disciplines and their practitioners. I then assign closeness, the second symbiotic attribute, to the element of direct contact between the practitioners. This is in contrast to the approach of indirect work methods, such as utilising a practitioner's work within individually conducted research. The final trait, persistence, is interpreted as an enduring working environment. This specifies that once the individuals have established closeness between their respective practices, they allow sufficient time of exposure between their expressive media as for each discipline to become enriched by extra-disciplinary knowledge.

The next interpretation concerns the fitness outcome of symbiotic relationships, with the effects of harm, indifference, and benefit corresponding to the level of liberty and restriction of each individual and their respective practice. Through this approach, the practitioners are able to determine a flexible level of hierarchy during their collective work. In practice, one of the individuals can contribute their skills towards realising a project defined by their collaborator. Contrastingly, both practitioners can contribute towards jointly defining the expected outcomes of the collaborative project. As such, a mutualistic approach suggests the latter case, where both disciplines are at full liberty of expression and involvement, while the former directorial approach is assigned to the notion of parasitism, with additional disciplines serving as means to overcome the limitation of a single discipline's capabilities.

Furthermore, I have identified three distinct stages within the collaborative process where the fitness outcomes can be applied independently. The first stage concerns the pre-engagement between the practitioners, where they will develop the work's brief and desired outcomes. This is followed by the stage of development, where the work begins to formulate through research workshops and assessment. The collaboration is completed by presenting the outcomes of the work through demonstrations, publications, or, particularly in the case of creative practice, performances. As with the other stages, the fitness outcome can be exhibited in the manner the practitioners and their specific contributions to the project interact during the presentation. A summary of the framework is presented in Table I, where the different strategies are placed according to fitness outcome and stage of the collaborative process.

As an overview of the fitness outcomes during each stage, mutualism involves all practitioners to actively engage with tasks beyond their specific discipline, e.g. in the case of a music and dance collaboration, the composer would be

expected to reflect and contribute to the choreography developed by their collaborator, and at the same time expect to receive contributions on their sonic elements. The level of such a transdisciplinary engagement can range from simple feedback to robust alterations, largely dependent on how well familiarised the practitioners are with the discipline of their collaborator. Considering the transdisciplinary approach, the ultimate aim of mutualism is for the two disciplines to merge into a novel medium of expression, and for new emergent knowledge to transcend disciplinary boundaries or form an entirely new discipline [9].

When employing commensalism, the practitioners' engagement will reflect a multidisciplinary approach in that their labour will concentrate within the boundaries of their respective fields [10], with one or more of the involved disciplines aiming to provide existing knowledge towards creating new developments in the fields it is collaborating with. Furthermore, one of the disciplines may provide a completed research as the project's starting point, on which the collaborating practitioner can develop a work in response to the initial stimulus of the other discipline. While one of the disciplines is considered to be unaffected, a level of reciprocity can be expected, as with the biological traits of commensalism. As such, the initial stimulus may need to undergo certain modifications in order to better serve the development of the work, without however diluting its core elements.

The parasitic approach utilises the highest level of collaborative hierarchy in the framework, by assigning one of the practitioners as the principle director of a collaborative project, responsible for elements of the work across all involved disciplines. In this sense, as well conducting labour within their discipline, the director will develop the project brief and guide the collaborators in developing their work according to the brief's requirements.

TABLE I. COLLABORATIVE FRAMEWORK

Collab. stage	Fitness outcome		
	<i>Mutualism</i>	<i>Commensalism</i>	<i>Parasitism</i>
Pre-engagement	equal contribution towards brief development	one discipline serves as stimulus towards brief	instigating practitioner defines brief
Development	both disciplines & media influencing each other	practitioners use new skills set independently	instigating practitioner guides directed collaborator
Presentation	both disciplines display affect & interdependence while at liberty	affect of collab. evident on one discipline	one discipline restricted in supporting the other's expression

A. Case studies

The observations informing the framework have been predominately sourced through my own practice. A similar process can be applied when analysing other collaborative practices, where the interaction between the practitioners can be assigned to the approaches presented in the framework, and thus to the interpreted symbiotic traits. *Stratofyzika* is a Berlin-based collective consisting of sound artist Lenka Kocisova, dancer and choreographer Heather Nicole, and digital animator Alessandra Leone. Examining their stage of presentation, in this example concerning their work *THETA* [11], a dialogue between all involved disciplines is evident. This is achieved through Arduino-based sensors utilising Inertia Measuring Units attached on Nicole, which transmit gesture data to the software systems controlled by Leone and Kocisova, visual and sonic respectively. The movement data is then utilised by the two artists in generating sonic and visual events, which in turn are interpreted by Nicole in guiding her movement. Therefore, a system of interdependence is created between the three disciplines, while their practitioners are at liberty to interpret at will the sources of stimulus from the other two disciplines. As such, *Stratofyzika's* practice corresponds to the mutualistic presentation of the framework.

Looking at the pre-engagement involved in the developing danceroom *Spectroscopy (dS)*, an "integrated hardware setup and algorithmic framework for carrying out molecular dynamics (MD) using depth sensors" [12], a commensalistic approach is identified through the interaction between the creative and scientific individuals making up the collective. The dS system was designed primarily as an interactive visualisation software representing movement of particle as means of facilitating relevant scientific research. Once the team decided to make the system available for creative purposes, the team working on the sonification and choreography involved in the developed work *Hidden Fields* [13] drew on the capabilities of the existing technology without modifying it in any way. With one discipline remaining unaffected, visualisation, while the contrasting ones being at expressive liberty, the approach falls under the commensalistic pre-engagement type.

The final case study concerns the practice of Marco Donnarumma, an artist best known for developing *Xth Sense*, a control instrument designed to capture the subcutaneous sonic activity of muscles and the circulatory system, which are then used as both sonic material and control data towards modulating and processing sound [14]. Donnarumma's latest work utilising *Xth Sense* is *Corpus Nil* [15], which was developed with additional programming by Baptiste Caramiaux. Examining the collaboration's development stage, Donnarumma acting as the principal practitioner, provided a brief for Caramiaux to respond with an appropriate work of programming, as to allow the principal discipline to overcome its limitations. Hence, by restricting the discipline of computer programming, this collaboration displays the traits described in area of the parasitic development.

B. Author's practice

In further explaining the different approaches described in the framework, I will now present examples from my own artistic practice. As mentioned, my practice utilises sound as its predominant expressive medium, with the majority of my collaborative works conducted with practitioners utilising physical movement. In connecting the two disciplines, we have used a range of mass-produced motion sensors such as Nintendo Wii Remotes, Source Audio Hot Hands, Livid Minim, and Sonic Geometry OTO. Alongside several microphone techniques, the sensors transmit motion data from the performers to Ableton Live where different sonification systems are devised according to the requirements of each work.

A mutualistic approach is evident in my collaborations with actor and vocalist Ana Berkenhoff. Our developed works *Symbiosis 1511* [16] and *Symbiosis/Merlin* [17] employ mutualism during the pre-engagement and development stages, where we began our collaboration without conducting any preparation in advance, and went on to create the brief through discussing our desired aims and expectations for the work. This process resulted in a quick turnaround for both developed works, each completed within two days of initiating our collaborative process.

During my long-term collaboration with performance artist Frances Kay, commensalism has been our most often employed approach during most stages of the process. This is best illustrated on our work *Yellowed-out Beats* [18], which employed the commensalistic approach during all stages. The piece was based on an existing performance developed by Kay, involving a movement choreography scored to three popular music songs. For *Yellowed-out Beats* Kay was to perform the piece as usual, with the added modifications that she would listen to the songs through headphones instead of the venue soundsystem, as well as having motion sensors attached on her forearms. My labour involved developing a fixed-media electroacoustic composition based on material extracted from the songs, as well as developing an interactive sonification system responding to the gesture data transmitted by the sensors and a series of contact microphones placed around the stage where Kay performed the choreography. The resulting piece showcases a stage interaction where the two practitioners are seemingly disengaged from each other. However, it was the discipline of sound which derived benefit from the unaffected discipline of movement through extracting modulation information for the various parameters making the sonification system, thus allowing the system to be enriched in comparison to its sonic output without input from movement data. In addition, our process involved little exchange of information, with the two disciplines developed separately from each other, and only merging during the performance.

The final example showcases the parasitic approach, as well as the dynamic nature of the symbiotic framework. *Vi-We-Nous* [19] is a live piece I developed in collaboration with dancer and choreographer Teresia Björk during the summer of 2016, with our pre-engagement stage agreed to be of the mutualistic type. However, as the work entered its development stage, Björk began showing resistance to most of my

suggestions on the movement elements. Further to this, Björk's suggestions on the score I was developing became increasingly forward, where she started revealing a detailed plan of what the score and arrangement should sound like. As such, Björk eventually assumed a directorial role for the piece, thus mutating the collaboration to a parasitic approach.

As a final thought on this section, I need to stress that the different types of collaboration included in the framework do not hold any specific abilities towards affecting the quality of a work, but rather present different working approaches in collaborative practice. The appropriateness of each approach depends on several factors, such as rigidity of the work's arrangement, familiarity between the individual, and shared knowledge between the disciplines. As a general observation from utilising the framework within my practice, the mutualistic approaches tend to favour artists who are closer on a personal level, commensalistic approaches result in the fastest development but with less predictable outcomes, while parasitism provided the most controlled outcome according to the director's initial vision of the work.

V. CONCLUSION

It could be said that my interest in symbiosis was serendipitous, with the biological phenomenon initially utilised as merely a title for my collaborative performances. Through further investigation, I not only realised the importance of the phenomenon in regards to its contribution to the evolution of all known life, but also that it constitutes one of the most fundamental forms of collaboration. Through research and professional activities, I have experienced many of the problems presented by collective work, which provided motivation in developing a new framework for interdisciplinary collaboration.

The future direction for the development of the framework is to interpret further traits of the biological phenomenon, such as the host-symbiont relationship in regards to creating a reciprocal environment through bidirectional feedback sensors, as well as additional research on the many types of interdisciplinary research [20]. Furthermore, I intend to compare my findings in the context of existing collaborative models through both literary research and implementation within my work, as well as gather data of other practitioners utilising my framework within their practice through facilitating a series of commissions with emerging and established artists.

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