Ongoing Production of a "Growing Instrument" Using Mycelium-Based Materials

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Abstract

This study explores "growing instruments" made from fungal mycelium, highlighting their natural unpredictability and role as musical instruments. Mycelium's growth and interactions with the environment create unique features not found in traditional instruments. Positioned within non-human-centric approaches in design and art, the research emphasizes the mutual creation and interconnectedness of diverse actors. By shaping mycelium into tubes and adding recorder heads, playable flute-like instruments were created. However, their condition and playability were highly influenced by environmental factors such as temperature and humidity. The study emphasizes embracing uncertainty and suggests that these imperfections can offer new insights into musical instrument design.

Keywords

Mycelium, Growing Instruments, Non-Human-Centered Design, Uncertainty, Musical Instrument Design

1 Growing Instruments and Mycelium

This study explores the creation of "growing instruments" made from fungal mycelium. The research focuses on three main themes:

- The role of uncertainty that exists beyond direct human control.
- A new way of conceptualizing musical instruments.
- The meaning and practice of performance.

Mycelium-based materials naturally grow and change in response to environmental factors like temperature, humidity, and the presence of microorganisms. Unlike traditional, static materials, mycelium is inherently unpredictable. In our work, we shape the mycelium into a tube and attach a recorder head to create a playable, flute-like instrument. This method follows a non-human-centric design approach, emphasizing the interplay between human intention and natural processes. A central idea in our work is the creative use of chance, for example as articulated by James Bridle [1]. Bridle argues that randomness is not simply disorder but a force that gives equal importance to all interacting elements. In his view, chance serves as a democratic force in creative processes, breaking down traditional hierarchies and allowing natural forces to guide design. This perspective challenges normal ideas of precision and stability and opens up new ways to think about making music.

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2 Growing Instruments and Music

The instrument we create is essentially a flute. Flutes, one of the oldest known musical instruments, work on a simple principle: changes in the tube's shape affect its resonance and timbre. This simplicity makes the flute a good candidate for experimentation with a living material like mycelium. Since the material continues to evolve over time, the instrument's sound may also change, offering an experience where performance and listening are influenced by natural growth.

The natural uncertainty of biological materials connects with experimental practices such as those of John Cage [2], who embraced chance in his compositions and discussed the relationship between mushrooms and sound, encouraging a departure from traditional musical norms. An instrument that grows and changes over time challenges ideas of fixed, unchanging sound and encourages a new form of musical expression that includes natural variation.

3 Research Background and Objectives

3.1 Non-human-Centric Approach Perspective

Recent developments in technology and art have led to increased focus on working with non-human elements. In the field of New Interfaces for Musical Expression (NIME), studies have looked at collaborations with nonhuman participants. For instance, one study by Ilsar [3] examines improvised musical interactions with dogs, asking how "musical" a dog can be. Another study by Mandelis and Husbands [4] explores systems that grow using artificial life. Furthermore, artists have started to incorporate microorganisms and plants into interactive installations. Projects using bacteria, fungi, and plant-based sensors (e.g., Ahn [5] and Miller and Christopher [6]) show that living entities can play active roles in creating art. These examples indicate that non-human agents need not be seen only as decorative elements; they can be essential contributors in the creative process. In our work, we use mycelium—a living, growing material—as a key element in making musical instruments. By accepting the unpredictable nature of biological processes, we seek to broaden traditional ideas of control in musical expression. This perspective echoes Bridle's view that chance and natural forces can ground creative practice [1].

3.2 Characteristics and Potential of Mycelium-Based Materials

Mycelium is derived from the network of threads produced by mushrooms and molds. It is a sustainable, eco-friendly material already used in fields such as architecture, packaging, and fashion [8, 9], and is also valued for its acoustic properties as a sound-absorbing panel [10]. Mycelium-based materials are typically used after the fungus has fully colonized the substrate and

has been dried to enhance mechanical strength, effectively inactivating the organism. For example, Rosenkrantz adopted this method, employing mycelium-based material to craft the guitar bodies of the "Mycocaster"[12].

In contrast, our research focuses on the period when the mycelium remains alive and continues to grow. We pay particular attention to the material's emergence, its gradual development of playability, and the growth and form changes induced by environmental factors, which in turn lead to variations in acoustic properties and timbre. Through this approach, we aim to design not only for momentary interactions, but also for long-term performance experiences that evolve alongside the living material.

4 Fabrication of Growing Instruments

We fabricated a playable, tube-shaped instrument using fungal mycelium combined with a recorder head. Our process involved preparing a commercially available oyster mushroom substrate, shaping the inoculated material into a single tube, and later attaching a recorder head and playing it once sufficient mycelial growth was achieved.

4.1 Fabrication Method

The oyster mushroom substrate was first crushed and evenly packed into a casting form designed to form a single tube shape. The inoculated substrate was then incubated at room temperature until the mycelium had sufficiently permeated the material. After incubation, the casting form was opened and the resulting tube was carefully removed and promptly dried under ambient conditions to promote hardening and facilitate handling.

4.2 Experimental Phases

4.2.1 Spring Experiment. In spring, we produced a mycelial tube using the above method and it succeeded. To examine the effect of tube length on sound, the tube was deliberately extended by returning it to the casting form and adding approximately 2 cm of additional crushed substrate along its length. After an extra week of incubation, the extended tube was removed and a recorder head was attached for playability tests. When played, the extended version produced a lower pitch compared to the original portion. Drying the instrument further hardened its structure, making it easier to handle and preserve.

4.2.2 Summer Experiment. During summer, high ambient temperatures inhibited mycelial growth. Under these conditions, none of the tested attachment designs proved effective, and we were unable to produce a playable instrument.

4.2.3 Autumn Experiment. In autumn, lower temperatures promoted improved mycelial growth. Beginning on November 10, an instrument was produced using plastic casting forms and integrated attachments. After approximately two weeks, the tube had solidified sufficiently to be removed from the casting form. Between December 7 and December 20, twelve performance sessions were recorded using the instrument. However, by December 21, mold had invaded about one-third of the instrument, necessitating the cessation of further performances.

4.2.4 Winter Experiment. For the winter experiment, we attempted to produce an instrument using glass casting forms and attachments, with an intended incubation period of about one month. However, the extremely low humidity during winter prevented the mycelium from solidifying into a strong structure, leaving the instrument unremovable from the casting form.

4.3 Analysis of Results

Our experiments resulted in three main outcomes:

- **Non-Growth Case:** Insufficient mycelial development left the material soft and unformed.
- **Mold Invasion Case:** Although a playable structure was initially achieved during the autumn experiment, mold rapidly degraded a significant portion.
- **Stable Playable Case:** With proper drying and favorable environmental conditions, the mycelium hardened to produce a stable, playable instrument.

These results demonstrate that the final state of the instrument is highly dependent on environmental conditions such as temperature and humidity. Despite recording twelve performance sessions during the autumn experiment, no clear or significant sound changes were observed over time; unfortunately, the expected variations in sound were not evident.

Figure 1: Mycelium tube connected to recorder head

Figure 2: Sample from autumn experiment

Figure 3: Mold-infested sample

5 Discussion and Future Prospects

We discuss our findings in terms of uncertainty, the concept of musical instruments, and performance practice.

5.1 Embracing Uncertainty

Traditional instrument design usually seeks stability and repeatability. In contrast, our approach accepts the unpredictable nature of biological growth. The uncertainty in mycelial change is not a flaw but a key characteristic. As James Bridle [1] explains, chance and randomness are creative forces that assign equal importance to all factors, breaking down conventional hierarchies and opening new possibilities. By accepting variable growth and the risk of mold, we challenge the pursuit of perfection and show that allowing chance into the process can lead to a more open, adaptable form of musical expression.

5.2 Reconsidering the Concept of Instruments

Growing instruments are based on the simple idea of sound production—air passing through a tube—but they evolve over time. This dual nature invites us to rethink what it means to be a musical instrument. Even traditional instruments change with use and exposure, yet growing instruments make these changes much more apparent. This work builds on ideas like those of Tanaka [13], who discussed how functionality and imperfection can coexist in musical instruments. In our study, the instrument's natural change becomes a part of its identity, inviting both performers and listeners to appreciate evolution as a musical quality.

5.3 The Significance of Performance

Playing a growing instrument is more than producing sound; it is an interactive practice that requires the musician to work with a living object. The performer must adjust to unpredictable changes, forming a conversation with the instrument. This method is similar to John Cage's approach [2], where chance and spontaneity are central to the creative process. Through performance, musicians engage with the instrument as it changes, blurring the traditional roles of composer, performer, and instrument. This active participation with uncertainty adds a new layer to musical expression.

5.4 Extended Theoretical Discussion

Our findings lead us to reflect more deeply on the role of uncertainty in creative work. Our experiments, which show varying growth patterns and environmental influences, suggest that aiming for perfect repeatability may not be the best goal in art. Instead, allowing natural variation can produce instruments that are truly alive—constantly growing, decaying, and transforming. Such instruments tell a story of natural change and encourage both composers and performers to view the instrument as an active part of the creative process.

5.5 Future Directions

Future research may focus on:

- **Refining Growth Methodology:** Developing clear protocols to optimize mycelial growth into stable, playable instruments with better control of temperature, humidity, and ventilation.
- **Innovative Design Approaches:** Experimenting with different tube shapes, attachment methods, and ways to modulate environmental conditions (e.g., cyclic changes in temperature or humidity) to encourage more visible changes.
- **Theoretical Exploration:** Deepening the discussion on how internal interactions and chance, as highlighted by Bridle, affect creative practice.
- **Extended Performance Studies:** Conducting long-term studies to document how a growing instrument's evolution influences both playing technique and audience perception.

6 Conclusion

This study shows that musical instruments made from fungal mycelium offer a new combination of sound, biology, and design. By using the natural, unpredictable behavior of living materials, growing instruments challenge traditional ideas of stability and reproducibility, instead celebrating uncertainty as an integral part of musical expression. Although environmental factors such as temperature and humidity pose challenges—especially in controlling mold form growth—the potential for creating instruments that change over time is clear.

The growing instrument stands as an example of non-human-centric design, where human intent and natural processes work together to create a varied musical experience. Future work that refines growth methods, tests new design ideas, and further explores the role of chance in art may help unlock more of the creative potential of these living instruments.

7 Appendix

The recordings mentioned in section 4.2.3 are available at: https://on.soundcloud.com/7NLrZLiiDbjrCeXt5

8 Ethical Standards

This work complies with the NIME ethical standards. No human or animal participants were recruited; only the authors themselves played the instruments.

9 Acknowledgments

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