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THEME: **BIONICLES**

Chronicles of Nature

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ABOUT THE COVER PAGE

Rahul H Nayak 8th Sem

The coverpage, acts as a pallete that nature portrays itself to be interpreted and learnt from nature for us to develop our systems . Nature itself shapes the system thus providing us with fluid lines, contours, ripple patterns, branching out as innate characteristic elements.

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Volume 5 2024

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VISION

Kalpa is a joint initiative of the students and teachers of RV College of Architecture, providing readers with a comprehensive understanding of a chosen theme. It delves into its core concepts and intersections with architecture and allied fields, fostering critical thinking, interdisciplinary dialogue, and a deeper appreciation of design and innovation

MISSION

Our mission is to produce in-depth research on each chosen theme, offering readers a rich and comprehensive exploration. Each edition features insightful interviews with leading professionals and articles contributed by experts, ensuring an engaging and informative discourse.

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DISCLAIMER

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FOREWORD

It is with immense pleasure that I present the fifth issue of Kalpa, the academic journal of RV College of Architecture. Over the years, Kalpa has established itself as a platform for critical discourse, showcasing innovative ideas and research in the field of architecture. Each edition has been distinguished by its unique theme, and this issue continues the tradition by delving into the fascinating realm of Biomimicry.

Architecture has always drawn inspiration from nature, and contemporary practices are increasingly adopting nature-based solutions to address pressing environmental challenges. Nature provides designers with a wealth of insights, from structural efficiency and material innovation to cultural relevance and sustainability. Biomimicry, as a design philosophy, offers a compelling approach to harmonizing built environments with ecological systems.

I commend the editorial board for their dedication in curating this issue, which highlights the relevance of Biomimicry in both academia and professional practice. My heartfelt appreciation goes to the contributors whose scholarly work has enriched this volume. I would also like to acknowledge the invaluable efforts of Ar. Seema Anand and Ar. Prashanth Dhawan, founding partners of Biomimicry India who have been instrumental in fostering awareness and application of Biomimicry principles within our institution.

My sincere congratulations to the entire editorial team for producing yet another insightful and thought-provoking edition of Kalpa. I hope this issue inspires readers to explore the boundless potential of nature-driven design.

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KALPA, a brainchild of RVCA academicians, immerses in a culture of research, fostering ideologies that shape architecture and its allied fields. As a discipline, architecture is inherently subjective, giving rise to an investigative approach that allows for the exploration of complex peripheral streams influencing design. This underscores the necessity of a strong research foundation—one that embraces systematic study, and is driven by context, to enrich the discourse on design and innovation.

The inspiration for the word 'Kalpa' lies in its ritualistic approach that endures significant cycles of learning, revolving around the processes of creation, dissolution and recreation. Kalpa evolves with five definitive wings that guide through Chandas (patterns), Shiksha (learning), Vyakarana (grammar of assembly), Nirukta (etymology) and Jyotisha (timeline). When looked closely, these concepts constitute the essence of research.

Nature has always been a source of inspiration to mankind, offering ingenious solutions that refine over time. As we unveil this year's edition of KALPA, we embark on a journey that celebrates nature as a model, measure, and mentor—a philosophy deeply rooted in the principles of Nature inspired design. The theme BIONICLES: chronicles of nature is an invitation to explore the intricate wisdom of nature and its profound influence on design and innovation.
Through this volume, we delve into Biomimicry—a realm where nature's efficiency meets human ingenuity. From biophilic design to ephemeral architecture and sustainable materials, this volume highlights strategies that foster a harmonious relationship between the built and natural environments.

Equally compelling is our exploration of Parametric Design Influenced by Natural Forms and Processes. This section unravels the mathematical precision inherent in nature's patterns and their translation into computational design, offering adaptive and innovative solutions that blur the boundaries between technology and organic aesthetics.

Through this edition, we aim to ignite conversations that push the limits of conventional design thinking. We extend our deepest gratitude to our contributors, whose insights and creativity have enriched this publication. KALPA – BIONICLES is more than a collection of ideas—it is a step towards a future where nature and design coexist seamlessly.

We aspire to further enrich KALPA's objectives by exploring thematic dimensions that challenge and refine the nuances of architecture and its allied fields. This edition embraces a diverse range of contributions, including articles and interviews, to ensure a broader reach and deeper engagement with our audience. This journey would not be possible without the unwavering support and encouragement of our Principal, Dr. Om Prakash Bawane, Vice Principal, Rakesh Kulathur Shivashankaran, our Dean, Professor Suresh K Murthy, and the dedicated faculty at RVCA. We also extend our heartfelt appreciation to the student teams whose consistent efforts have been instrumental in shaping the success of this edition.We hope this volume sparks curiosity, fosters meaningful discussions, and inspires new perspectives.
Happy reading! Cheers!

EXTERNAL EDITORS' NOTE

Ar. Seema Anand

Co-Founder Biomimicry India, , Educator, Architect

Architecture is an evolving dialogue between human ingenuity and the natural world. In this edition of Kalpa, we explore Bionicles, a theme that challenges us to rethink design—not as an isolated human endeavour, but as one deeply intertwined with nature's intelligence.

Biomimicry, bionics, and parametricism are not just emerging methodologies; they represent a fundamental shift in how we approach architecture. Nature is not merely an aesthetic reference but a living blueprint, shaped by 3.8 billion years of adaptation and optimization. As architects, designers, and thinkers, we have the opportunity—and the responsibility—to learn from these processes to create built environments that are not only efficient and innovative but also regenerative and responsive.

This volume reflects that shift in architectural thought. Through student research, professional insights, and interdisciplinary inquiries, the discourse moves beyond 'biomorphism'—where nature is merely imitated—toward a deeper biomimetic approach, where systems, structures, and efficiencies drawn from nature shape our design thinking. These contributions reaffirm that architecture must go beyond sustainability and embrace symbiosis, where human-made systems integrate seamlessly into the broader ecological framework.

As a biomimicry specialist, educator, and architect, collaborating with the students and faculty on this issue has been a deeply rewarding experience. Their curiosity, and ability to push boundaries are a testament to the power of design education that is rooted in exploration and innovation. My hope is that this edition of Kalpa serves as an invitation—to question, to experiment, and to engage with architecture not just as a profession, but as a means of restoring our place within the natural world.

STUDENT EDITORIAL NOTE

Driven by a growing need to reconnect with nature and understand its intricate workings, we often turn to its enduring wisdom. Seeking answers to questions like: How can we design systems that mimic nature's elegant efficiency? How can we learn to live in harmony with natural cycles and rhythms? What lessons can we learn from the interconnectedness of all living things? In these inquiries, we seek not just knowledge, but a deeper understanding of how to live in a way that respects and honors the natural world.

Kalpa, a collaborative venture between faculty and students at RV College of Architecture, fosters a spirit of inquiry that extends beyond the confines of the discipline. In its fifth volume, Kalpa delves into the realm of 'Bionicles,' exploring the expansion of nature-inspired design through an interdisciplinary approach that integrates architecture with other creative disciplines.

Our exploration revealed the potency of principles like biomimicry, bionics, biomorphism, and parametricism as powerful design thinking tools that hone the skeletal, behavioral and responsive characteristics of nature. By integrating these as inspirations and with a careful selection of materials and methods, varied disciplines are cultivating sustainable and innovative design solutions with an intent to embody qualities such as self-sufficiency, resilience, optimal performance, and versatility, offering invaluable lessons for the future of design.

We hope this edition serves as a beacon, inspiring both students and seasoned professionals to actively adopt nature-inspired principles into their respective fields, ultimately contributing to a more sustainable and resilient environment. Our aim is to introduce young learners across disciplines to the profound insights offered by nature, showcasing its reliability and abundance as a source of knowledge and inspiration.

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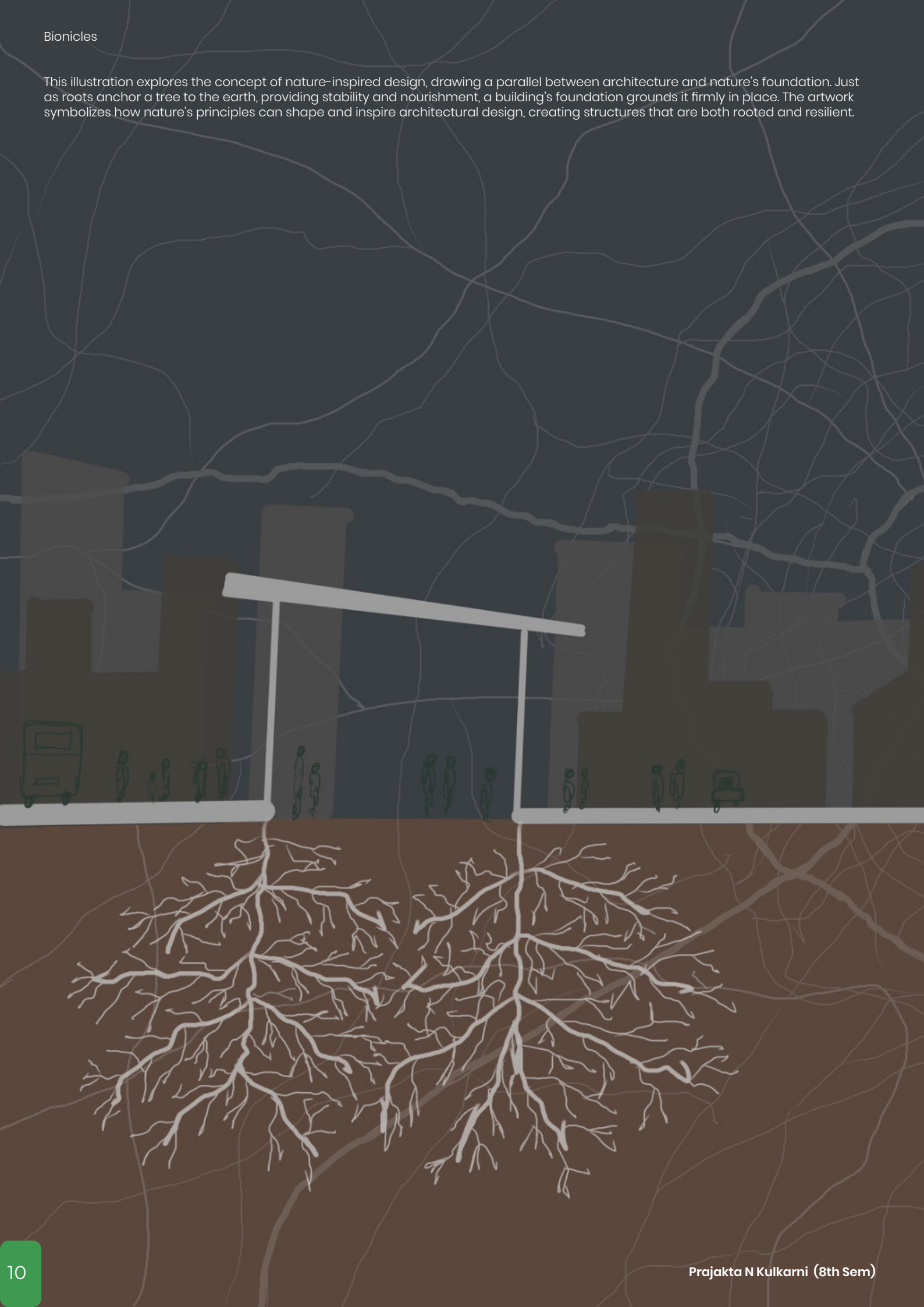
This illustration explores the concept of nature-inspired design, drawing a parallel between architecture and nature's foundation. Just as roots anchor a tree to the earth, providing stability and nourishment, a building's foundation grounds it firmly in place. The artwork symbolizes how nature's principles can shape and inspire architectural design, creating structures that are both rooted and resilient.



Prajakta N Kulkarni (8th Sem)

01 A Timeless Dialogue of Nature's Philosophy

Interview with: Ar Prashant Dhawan

Kalpa, Vol.05, 2024, pp. 11-17

Abstract:
Prashant Dhawan, co-founder of Biomimicry India Network, discusses biomimicry as a vital, cross-disciplinary approach to reconnecting with nature. He critiques modern society's trust deficit and "place blindness," where human institutions overshadow ecological realities. Biomimicry, he argues, helps us ask nature for guidance, offering holistic, time-tested solutions. He emphasizes the need to shape human culture and economy to fit within nature, rather than forcing nature to serve human constructs. By learning from 3.8 billion years of evolution, biomimicry ensures responsible decision-making, reducing unintended consequences and fostering a sustainable, reality-driven way of life.

In a world of constant chaos and change, architecture, even at its best, cannot stay still.To keep up with this endless entropy, we'd need an endless exchange of knowledge and a constant broadening of mind's horizon.

The fifth volume of Kalpa includes a theme revolving around exploring sustainability through nature inspired designs or as we title it: Bionicles: the chronicles of nature. Inspired by Janine Benyu's principles, Bionicles examines nature as a model, a measure, and a mentor and the interview below is a testimony to the application of these principles.

Q1. As the cofounder of Biomimicry India Network, we would like to know your inspirations and influence in this discipline.

I would like to take this question as something which should be much bigger than architecture, if I may say so. One of the key questions I would like to highlight in 2024, as we talk and we look around our planet, and when I say our planet, in many ways, the first thing that seems to occupy our imagination is the human species, which itself is a very big flaw. However, somehow when I say the planet, most of us would imagine what's happening in the city, in the economy, in the society, which, yet again gives us another flawed idea of where we live. There are two words, which I feel are central to all of us. One thing is what is real, and second is trust.

Now let's go a little deeper. Consider, we really look at human culture right now, one will see there is a huge deficit of trust. If we put our hand on our hearts, you'll find people really have lost trust in most of the institutions that we have imagined. We don't trust politics. We don't trust businesses. We don't trust religion. It is surprising that a lot of us actually don't trust religion. Even academia is not to be trusted fully. ***They give us knowledge, but can they give us direction?*** *So the impending question is that every human institution is prone to be hijacked by an agenda or incompleteness of knowledge.*

Yet, the capabilities of humanity are huge. So at one end you have huge capabilities, at the other end, the direction of these capabilities are not clear, because the question of 'whom do you trust?' remains. To me these are the bigger questions, whom do we trust? Where do we look? Whom do we ask?
And in that journey, one comes across a field which says, why not look towards nature? And that's where my journey started because at the first glance, it's an amazing revelation. It's an awakening. Why not look towards nature?

However, just that thought is not enough. Though it gives you a singular high, very soon you want to know, how?
How do we ask nature? Biomimicry, in my simple way of understanding, is a process of demystifying this asking of nature across disciplines, and across practices. Because nature is completely holistic. It does not recognize the silos that we have created.
biomimicry seems to me, seeks to answer the question: whom do you trust? My guess is, this can be the unifying threat that we could be looking for.

To the other question, on what is real? And why do we need to even talk about reality? Because in all fairness if I were to ask to mention ten brand names of companies and what they make really well,it wouldn't take a long time to enlist . However, if I were to ask ten names of fellow organisms and one function that they do really well. I think most of us will be silent or will be quickly googling or asking chat gpt.
Let us now really think about this: all these companies are less than 50 to 100 years old, and nature is 3,800,000,000 years old. So, what it is telling us is that, we have become so economically present that we have become place blind. If we become place blind, we are intrigued to know what is real. Let's put it another way:
What is real? Let us reframe this question. Reality is that which does not change based on what you believe or you don't believe. WIth this thought, one might realize that most of the things change if you don't believe. If you look at the currency note, I promise to pay the bearer. If you don't believe in that promise, it's just a piece of paper. So is it real? And, reality is also something which is experienced with all life, not just humanity. Biomimicry helps us reawaken to what is real and what are the cultural cultural stories that we created. Today, they have become so overpowering that we are mistaking them to be real.
Why should one consider this thought to be important? Because what is beginning to happen is that in our current generation, in our education and in our practice, we seem to be feeling that we need to shape life, the living environment, nature, so that it can fit in and nourish the human economy. Now here's where reality is important because the human economy is a fiction. It is not real. Imagine the seriousness with which we are hoping and expecting everything to fit in and flourish the human economy, which is not real.
That is catastrophic. The awakening should be: "how do I shape my economy and my culture to fit into nature?" This is real. This will not change. One can play around with the economy, but not with gravity.

This is a non-trivial thing. Firstly, biomimicry brings reality back into the game and instead of looking at sustainability in terms of silos, we get a holistic understanding. Secondly, biomimicry also helps us deal with the fact that we might not know everything. Simply put, if we don't know everything, it's a good idea to look at nature because without necessarily going through college, nature has experienced 3,800,000,000 years of evolution. So if something is there, it has been factored in without necessarily coming into our books.
When we adopt and learn from nature, we in some ways make a more responsible decision which will not have unintended consequences. I feel, biomimicry is a non-negotiable way of life. One should begin to adopt and develop and co create, together. Thus, biomimicry can be perceived as a vast field.

Q2. As far as my knowledge extends, biomimicry is interdisciplinary in nature. And, coming from a design field, I think that it is a wonderful way of design thinking. How would you interpret the same with your journey in biomimicry?

I completely agree with the fact that biomimicry is probably the most holistic and most integrated way of thinking and living. My journey has taught me that as you go more and more into observing nature, you begin to say that everything is interdependent

and interconnected. Many of the silos we have created are very important to run the industrial design of the economy, but they might not be very effective as we go to the next stage of our economy. If I may dare to give it a name, and it's not my name, it's lot of people have said that we are done with the industrial age. And, we have to design for the ecological age.

Interestingly, the ecological age cannot be designed on mechanical and industrial principles. These principles have to be the ones which are common with all of life. So in my journey my biggest awakening has been to explore the idea of a common design principle. Not only for humans, but a common design principle, which all inhabitants of this planet should be adhering to. Now that's a big question and a wonderful one too!
Something which is inclusive. Today we are talking about inclusion - Why consider inclusion of only humans? Why not include the cyanobacteria? Whether you have 3 legs or long tails or stripes, why not include all life? That would really be the ultimate solution. Biomimicry gives us certain design principles, which tell us how to be responsible inhabitants of this planet. Once this is known, one can go ahead and become an architect, a politician, a journalist or perhaps even a bank robber! It doesn't matter. Eventually, one has to come back and live life on this planet. Ironically most of us don't know how to live on this planet, but we know very well how to operate in this economy. How absurd is that? This has been a revelation and every day it becomes more and more clear to me that this is where we should be evolving and adapting. This has been my journey - it is true the journey has been very tough. The system which it challenges will not nourish biomimicry. Financially speaking, it has been tough. Nevertheless, it is very rewarding in the kind of resonance one finds with students and other sensitive individuals who can see the larger big picture. So it's a humbling journey and a process which I would be very happy to see more people join and make it a big movement.

Q3. How would you describe the current scenario of biomimicry in India, and its applications to the other streams and specialization fields of urban design and product design. What do you think is the current scenario?

The current scenario in India is very primitive. It is very strange, and interesting to know that the eastern philosophy, especially the ancient Indian knowledge systems and biomimicry have a very deep resonance. If one goes deep into the principles of nature, which is biomimicry, and you look at the ancient Indian texts, they are so amazing, the language might be different, but the essence is very similar because both of them recognize that humanity is part of nature. We are not separated from nature. The separation which happened in the industrial revolution in the west, especially when Rene Descartes, the scientist, talked about it as a duality (mind and body).
It was expected that biomimicry would flourish and India would be a thought leader. Unfortunately, there seems to be no serious funding or support for biomimicry. It is indeed a big opportunity. It will be considered a big loss if we end up studying books written by the West rather than writing the books ourselves. Having said so, I would also think that, while some efforts to teach biomimicry have started, there is a little risk that we have not put any quality control on who is teaching. There has to be a recognised certification or maybe a prequalification for one to teach Biomimicry. This is important simply because biomimicry can often lose its depth if it is just 4-5 examples which have been read on the Internet. It would be nice if, in India, we can introduce a system of certification that will further encourage and capacitate teachers to explore and instruct biomimicry in a more structured fashion and this, in my view, will eliminate the risk of wrong teaching.

Q4. Biomimicry, like we discussed, is an interdisciplinary way of life and design thinking. In practice, how would you like to explain the collaborative efforts and the teamwork that goes on into all of this?

That is a very good question. I think that a big challenge remains with our existing institutions.They have been separated into colleges and departments, while nature doesn't really recognize this. Biomimicry requires collaborative efforts. Working together need not be a physical congregation, but there is a need for a structured methodology or framework which is a highlighted problem diagnosed and understood in a multidisciplinary fashion. This is not very difficult actually: the strange part is that a lot of the tools and methodology that we have already developed can be easily adapted to enable this multidisciplinary collaboration. So one of the critical things which is now really well developed and offers a very good platform is systems' thinking. A certain base level education into system integration really helps in multidisciplinary collaboration. Here, one of the important aspects is how we ensure that the biologists and people who do life sciences are integrated into the process. A lot of these processes involve engineers, economists, architects, who've traditionally not worked with life sciences. The good news is it's not difficult because the tools exist. The problem is that we don't have leaders who are ready to give that initial funding and platform to enable this.

I think we are at a state where multidisciplinary collaboration is very easily possible. Look at the amount of tools that we have and most of the people I find are just wasting time, not knowing what to do. We also have a deficit of visionary leadership. We might have the tools, but we lack the imagination. Since our primary work has been education, we have been very fortunate that we have taught across disciplines, across age groups, and also in multidisciplinary cohorts. In cohort would mean that in the same class you'll have a chartered accountant student, you'll have BBA, you'll have a bioscience, molecular biology student, you'll have a design student. It is a good mix. We teach such courses regularly and have taught in more than 30 engineering colleges, many design schools. It is also a credit bearing course at the National Institute of Design (NID) and at Shrishti Manipal Institute of Art, Design and Technology. The pedagogy is not limited to theory, they have been demonstrated.

There's also been a small session at The Indian Space Research Organisation (ISRO) and we've done corporate workshops with companies such as Marico Industries, TVS, Mahindra and Mahindra. Why was this important? Because here, there is demonstrated scientific evidence that this is an integrated way of problem solving, which is agnostic to who and where you come from. It can be interpreted.
It would be wonderful to do some projects, but that, again, requires some kind of a funding or patronage from either from the government or private individuals, which is where, I think Biomimicry is stuck. India continues to carry a very colonial mind pretending to be very modern, but deep down it's very colonial. Today, nobody invests in this kind of a venture but are willing to fund only for scaling up. A venture is considered to be a foggy step which with time, gains clarity. Here I am today, hoping that Indians will start funding a venture like this which carries with it zero risk and at the same time is an awakening.

Q5. You have a lot of experience, and you have done a lot of research in this field. Would you like to share your works and research whether it's collaborative or real time execution?

Most of our work has been with students. I think at least 50 of these projects would be commercially viable and they would help create sustainable solutions. But all of this requires sustained funding and a platform which unfortunately doesn't exist. There have been many projects which have been across not only product design, but also process design and policy design. We are trying to do things differently, but resources are a very big constraint. Individuals cannot create new knowledge without having any active source of funding. But we do feel that, in this era where not only students, all of us have relatively less attention spans and a very rich media, communication of biomimicry can be gamified and conveyed through storytelling. With this thought, we initiated a project which was called "A New Ecology for a New Mythology" for the ecological age. It was an ambitious project, but due to lack of resources, it's moving very, very slowly. We are hoping it will be a new way of learning instead of boring classes. Everybody can learn together, not only as students but also as families. Why do we think that, on a dinner table learning cannot happen when it comes to learning about the planet? We can do it now. But one day, I think we'll get there.

Q6. Sustainability is often associated with words like efficiency, conservation, self organisation. The principles of sustainability and biomimicry are often perceived alike. While sustainability is the need of the hour, where would you intersect and differentiate these two fields?

I would think that biomimicry getting into academia across the board is inevitable. Inevitable because it's more about awakening. Once the obviousness of this course becomes clear, it will be adopted by everybody. What I also think should be happening in parallel is an investment in making sure that there is some certification of who is teaching. I have experienced that in a lot of colleges that impart biomimicry, students have only explored 4-5 case studies. That is a small issue that can actually highly dilute the purpose of biomimicry. So, in my view, a certification for teachers is important, so that it does what it is supposed to do.

Q7. Sustainability is often associated with words like efficiency, conservation, self organisation. The principles of sustainability and biomimicry are often perceived alike. While sustainability is the need of the hour, where would you intersect and differentiate these two fields?

Sustainability, that word only makes sense if it is combined with life, right? If one really asks the question, what are we trying to sustain?, as we go deeper and deeper, we see that we are trying to sustain water, we are trying to sustain top soil, we are trying to sustain air. We are trying to sustain these because these are life support systems.

We are trying to sustain life. Hence, whatever is required for life to flourish, that is what we are trying to sustain. Now as you go deeper into the layers, it's not just water, air, you'll find life is interdependent, interrelated. Even the human body has trillions of cells. 60% of these are non-human cells, bacteria. How do you factor in all that? So that is where if you have to sustain life, why not understand and learn from life? Isn't it very obvious? That's where it comes in. So if we are trying to sustain life, life is studied by biologists. In fact, the word Bio is the Greek translation for life. So that's where I think sustainability's arrival into Biomimicry. It is like a river finding its source. Biomimicry is the ocean. And there are these various little rivers, which should finally merge into not only that, I would encourage you to think that these are very important words because we live in an industrial economy. People say, restorative design or regenerative design. I would like to ask them, restore what? When will you decide? Who will decide what is to be restored? How will you measure it? Regenerate? Regenerate what? To what extent?Will you keep on regenerating? If you really go deep into this question, you'll find the reference point for all of this will be nature.

Nature and what is biomimicry? Biomimicry is asking nature. Biomimicry should become the overarching thing and let it not be a priest. It can be co-discovered. And if we ask the questions deep enough, biomimicry will be the final destination. The arrival into a holistic framework would be biomimicry. So while talking about design, we come up with this existing culture of India. We know that we celebrate our culture, difference in culture. This is very close to the natural elements that we have like moon cycles, sun cycles - it is very close to nature. So how would you perceive nature, like the influence of this in biomimicry culture? Instead of doing everything new, we can adapt and evolve what we already were doing. I wouldn't say that we have to go back because nature doesn't go back. But nature adapts and evolves, it gives us direction and that's much more efficient and doesn't shock the system. The roots are not disturbed by civilization, yet we become modern. Modern in a way where it is place based, we belong and that is sustainable. So I think that is a very big area of research and opportunity. I strongly think India can take a lead in this.

Q8. In practice, what are the economics of this field? How is it understood by the world today?

In the current economic context, biomimicry, let me put it honestly, it's more like a necessary fashion. People like to talk about it because it sounds good, but when it comes to money, there's no serious money or resources being allocated to it. It is right now, something which everybody knows is right,

but nobody is willing to put the kind of resources required to make it important. This comes to the way we have designed our accounting standards. Our accounting standards calculate profit value in a way where a lot of things which are common are sensible. We all know this will be good for the commons, not only good for you and me, but it will be good for the fish, for the bird. But if it has zero value in the economy, one might not find its worth. Right now, I think we need to relook at our accounting standards. And I dare say in biomimicry, there are people working on what would be true value economics or true cost accounting. These are fields again where mainstream media is not working. Have you paid the bees for the pollination services they do? Obviously, you don't respect it. We don't pay. We have become so conditioned by whatever we have to pay for that biomimicry is seen as a non-negotiable. Nobody pays for it, and so it's struggling to survive. But if we change the accounting system and give it (biomimicry) the right value, then it will grow exponentially. Again, this needs audacious risk taking, bold leadership, and I'm hoping the younger people will see things as they are, not influenced by opinions. Once they have the ability to see themselves in reality: a reality which is true from the cyanobacteria to the president, that is real. Then I think these economic systems will also change. Currently, we need to get ourselves together

Q9. With all these years of experience, how would you state your key learnings in this field?

My key learning is that maybe a lot of effort in the last 200 years of human endeavor both in academia and practice has been to try and find some kind of a unified theory or some kind of answer or solution set to guide humanity. My humble feeling after doing so much is that maybe it is not a common answer, but a common question that will organize us. We can all find our own answers, but is there a common question? And that is where Biomimicry is so wonderful, because I think it is giving us that common question. And that common question is what would nature do here? If we simply adopt it as a common question, whether you are in Antarctica doing something, or you are in the Sahara Desert, or you are in Bangalore, we simply agree to the common question, what would nature do here? I think that one big question can unite us not only as humanity, but unite us with the cyanobacterias, the fishes, and the birds.

Q10. I would like to know what you think is the future of biomimicry.

My view is that in the future, biomimicry will be inevitable. It will be adopted by everyone, and it will grow. I can't give timelines, but just like everything has to adapt and evolve, I think biomimicry will also have to adapt and evolve. When I say so, and I say that purely as a personal opinion, I say it because that's been my personal journey. That currently, biomimicry is being seen from the standpoint of the perception of science as developed in the west. When we say science developed in the West, life is what you perceive through your five senses. It is what you see in your body, through your eyes. I've said it once earlier, but I also feel that we will reach a point in biomimicry where we will have to consider that life in indigenous systems, especially India, doesn't end there. There is life inside. Those are completely new areas, and I think today we have the capabilities and the courage to explore what that would be. Bio is not just life and is not dictated by the boundaries that we have drawn. Life is life. It is outside and currently biomimicry is engaged with it because there's so much to be done. I feel there will be a level where life inside, would need to be also considered and that would be wonderful because a biomimicry umbrella will not even allow the separation between science and spirituality. Both will emerge and that is my long term view.

Prashant Dhawan is the Co-founder of the Biomimicry India Network and "Biomimicry India". He is the first person from India to obtain a Master of Science degree in Biomimicry (from Arizona State University), and a Biomimicry Professional Certification from Biomimicry 3.8 Institute, USA. He also holds a degree in Architecture from SPA Delhi, and an MBA from ISB Hyderabad. He has conducted more than 275 Biomimicry workshops/courses in various educational institutes over the last 10 years.

Prashant is also a TEDx speaker with 2 TEDx talks on Biomimicry, and as an invited speaker he delivered a keynote talk at 29th International Council on Systems Engineering Symposium in Orlando, FL. , U.S.A.

Prashant prefers to call himself an amateur researcher of issues related to sustainable happiness and wellbeing."

The fading tree and emerging cityscape symbolize the transition from nature-driven creation (poiesis) to human adaptation (mimesis) and cultural evolution. The tree's roots and mycelium represent organic self-organization, while the built structures above reflect how design abstracts and reshapes natural forms. As the tree disappears, architecture dominates, illustrating how ideas evolve—sometimes distancing from their origins.

Suparna Devanathan (8th sem)

02 Poiesis, Mimesis and Memes

ARTICLE by: Ar. Dinesh Rao

Kalpa, Vol.05, 2024, pp. 19-25

ABSTRACT: This article discusses the philosophical and theoretical bases of architecture using the concepts of poiesis (creation), mimesis (imitation), and memes (cultural transmission). It explores how architectural practice has grown from a mere shelter-building exercise to an expressive, poetic form of human creativity. The discussion extends into biomimicry, the digital evolution of design, and the impact of artificial intelligence on architectural processes. It raises critical questions of whether architecture should imitate nature, evolve through self-generating systems, or respond to cultural shifts. Ultimately, it argues for a balance between artistic intent, adaptive methodologies, and emerging digital paradigms to create meaningful, responsive spaces.

Prologue

Source : Author

It will take, they say, 18 years just to clear the rubble of Gaza. As far as the eye can see, there's nothing but concrete, steel, and dust.
I look at the footage and wonder how we got here. Not the horrific death and destruction, which is too much to bear, but at the hubris of humankind. We appear to have gone from homo sapiens to homo concretus.

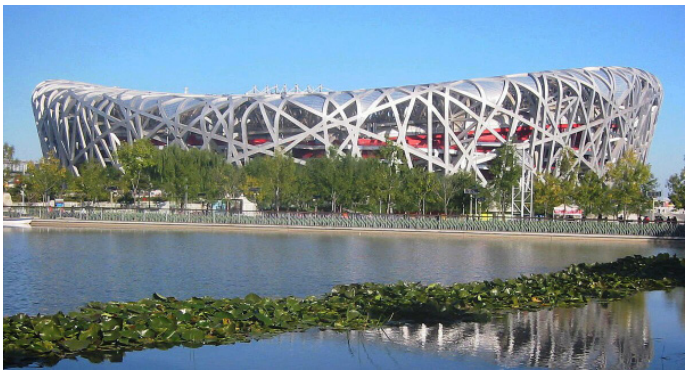
Buildings are currently responsible for 39% of global carbon emissions, 11% of that coming from materials and construction. By 2030, we've committed to reduce embodied carbon by 40%, and running energy demand to net-zero performance.[1]

The use of carbon content as an index of where we are is neither arbitrary nor abstract. We are ourselves a carbon-based life form, living in a carbon-based ecosystem. We literally owe our lives to carbon.The balancing of the carbon cycle is a necessary, if insufficient condition for us to continue existing as a species.

Poiesis

Source : ArtsDot.com

The urge to build, to create architecture, is deeply embedded in us. It spans much of human nature, from the need to shelter our furless bodies to the need to be remembered and honored forever. We sometimes use the building/architecture dichotomy to distinguish between these different urges.[2] I find this to not be a useful device. Birds build nests, beavers, dams and so on. Can we consider them to be uncreative? Is poiesis, or poetry, a uniquely human characteristic?



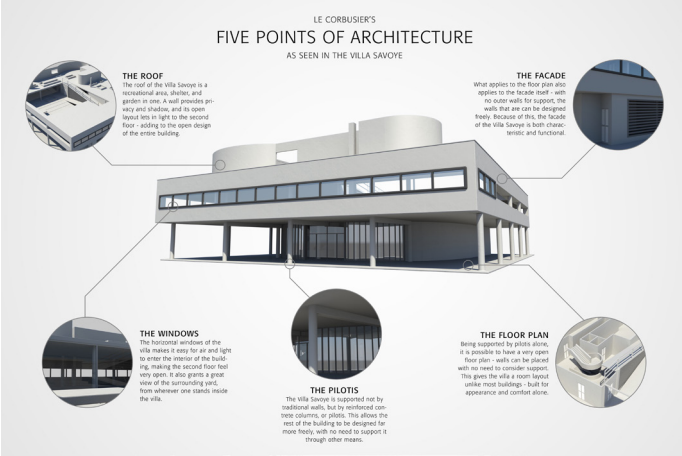
Source : Beijing Bird Nest, Wikipedia

Source : Wikipedia

It would appear that any artistic impulse, if it is to be realized (built) and relatable (understood) needs to have a reference, or touchpoint, outside of its own existence as an idea. Architecture, as a social and public art, has a responsibility to be expressed in shared poetics. While Vitruvius postulated the Urhütte, or primitive hut as the basis of all architecture, Gottfried Semper suggested that it was the space occupied by men gathered around a fire to be the archetype.

Traditionally, architectural poiesis has been based on typological inspiration, and was changed dramatically by the industrial revolution, new materials and structural possibilities, and new functional needs.

Mimesis



Source :Profile Bauhaus movemet, Behance

It is extremely rare that an architectural design situation is so completely defined by a set of requirements or parameters, that there's an obvious 'solution' that everyone 'gets'.

While a competent architect would certainly address the practical considerations, she would still probably have a multitude of approaches, leading to different designs. This requires the overlay or insertion of a larger idea or concept that will both guide the architect during the design process, and help communicate the design intent to the larger public on completion.

Source : worldarchitecture.org

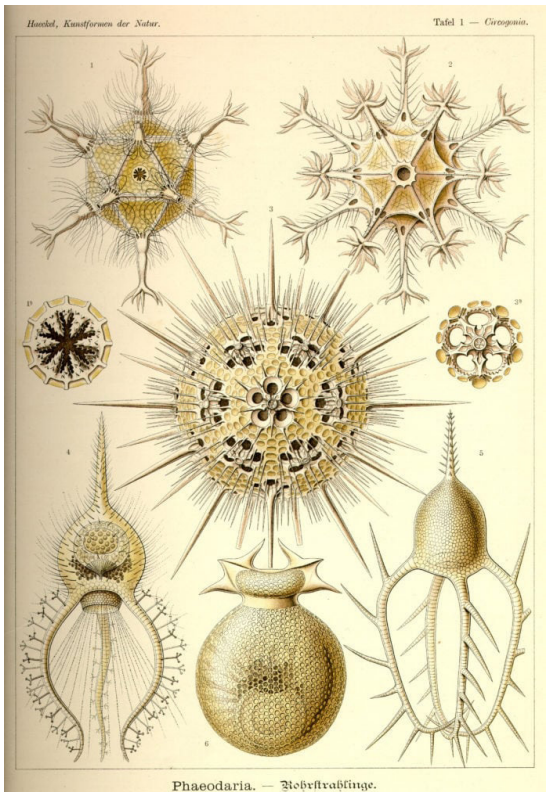
Biomimicry and biophilia are everyday words in architectural discourse now, but the idea of being inspired by nature is not new. D'Arcy Thompson's [3] and Christopher Alexander's [4] books were popular in architecture schools by the 80s.

Frei Otto described the 'self-designed structures' of soap bubbles and sand dunes as the lowest-energy and materially economical states of nature.

Ernst Haeckel's incredible drawings have inspired many.

Source : calatrava.com

Much of taxonomy and typology was concerned with the encyclopedic mapping of natural forms (but rarely spaces!). This became a necessary database to investigate patterns, underlying structural principles, and the evolution of adaptation and complexity.



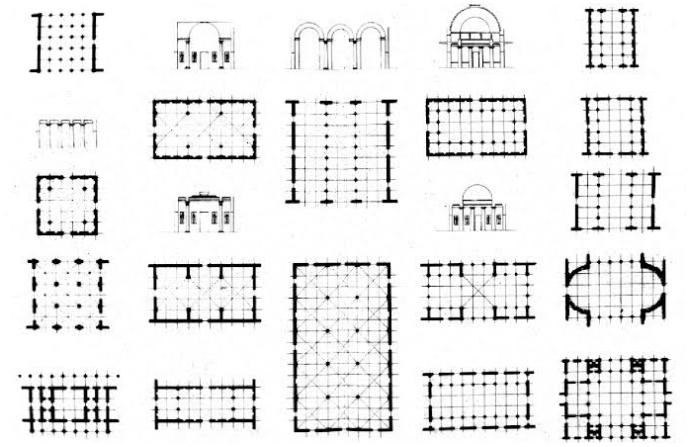
Source : GetArchive

This fascinating journey from what to how to why has great lessons for architects, including:

- Similar situations can manifest in varied responses
- Random mutations can be surprisingly successful
- Specificity can be a weakness of design
- Design must adapt to changing conditions
- Camouflage and flamboyance both work
- Habitats determine morphology

Source : Butterfly Chart, Judy Coates Perez

As an architect searching for a starting point, what determines one's choice of inspiration?
A structural principle?
An adaptive approach?
A climatic response?
An evolutionary path?
A materiality, a texture, a color palette?
A beautiful expression of form/space?



Source : semanticscholar.org

As Juhani Pallasmaa [5] bemoans, we have become globally a visual culture, privileging the sense of vision over all others. What we see is what we love. Or hate.

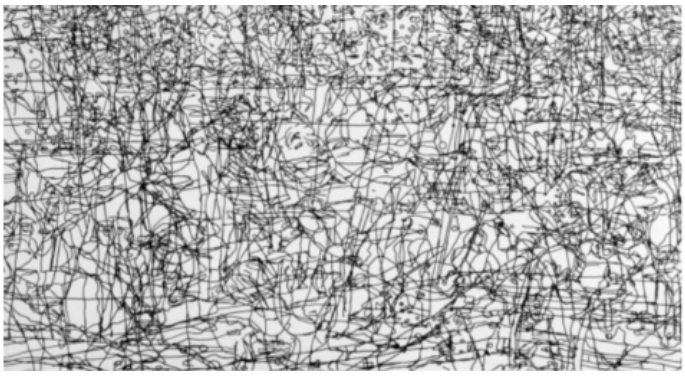
We're seduced by the perfect spiral of a nautilus' shell, the myriad symmetries of a snowflake, the rosettes on a panther, the fractal patterns of ferns. While they add enormously to an architect's design vocabulary, and free us from the tyranny of the right angle [6], is miming this the best we can do?

Source : https://images.app.goo.gl/cycHhmkBdCQB865A7

Source : Laundry Room Portico at Parc Guell, nobedtimesnoborders.com

Source : 3D printed house,Italy, re-thinkingthefuture.com

Or can we parse the relationship between form/space and formative forces?
Vocabulary and syntax are an easy, if reductive way to understand and communicate this relationship. Perhaps we need to think in terms of networks and not objects, situations and not locations, performance and not tectonics, form/space as consequence, not a priori creation.



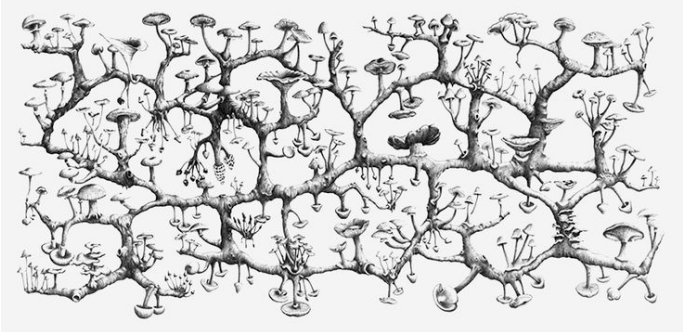
Source : Author

It may be interesting to see this from an AI point of view. Most large architectural practices today use AI design development to speed up their work. Typically, this is done by 'training' the software on the database of their own previous non-AI designs.

New parameters are chosen, and the computers churn out potential designs, which are then culled, modified by real human architects and sent into further iterations, until a satisfactory result is obtained. We could describe this as evolutionary mimesis.
The evolution of the software implies two things:
A movement from poiesis to autopoiesis
A movement from authenticity to mimesis,[7]

We have moved from "creating form" to "finding form" to "breeding form". Digital evolution is closely mirroring biological evolution. Software dreaming is a thing.

Multiplicity, fluidity and non-hierarchical structures, as put forward by Deleuze & Guattari,[8] have the capacity to upturn all of architectural theory all the way up to postmodernism. These, interpreted through the lenses of topological space, temporality, and instability, effectively become 'creative' in and by themselves. The algorithms will generate possibilities that a human couldn't dream of. We still get to choose what gets built, though. So far.



Source : The design of unfinished-Pinterest

Neri Oxman's Eden project is a cutting-edge example of these possibilities[9]. It claims to use data-centered algorithmic generative AI to resolve the typically adversarial relationship between architecture and ecology.

Source : Iryan Prauko

Exciting as all of this is, it's eating up the planet. Data centers already consume 1-2% of all global power. The mining of minerals and rare earth metals is ravaging people and ecologies. We continue to kick the can of sustainability down the road.

The Baubotanik movement holds that it's insufficient to mimic nature, and that we need to 'grow' architecture, rather than build it. This is a fascinating, if niche approach, but is not quick or scalable. The root bridges of Meghalaya are a great example.

Source :Living Baubotanik tree Tower, inhabitat.com

Source :living root bridge, Khasi, Meghalaya-Wikipedia

Memes

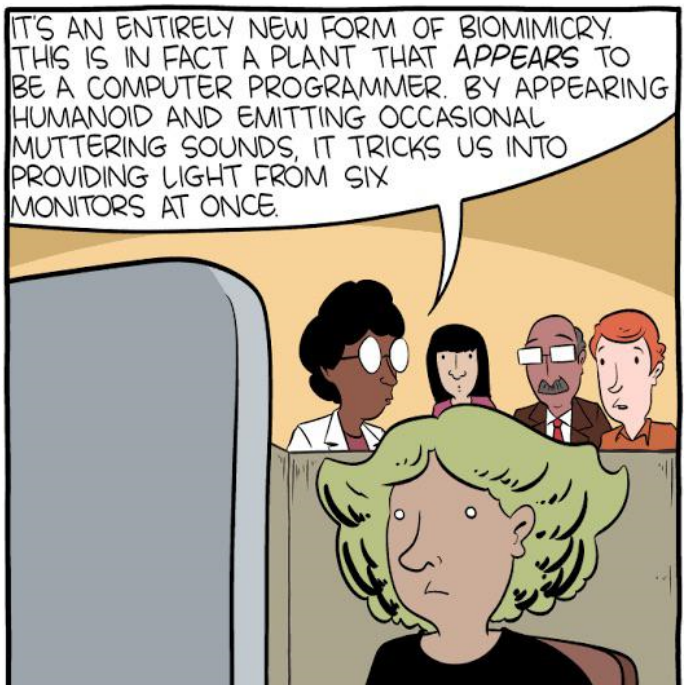
When ideas go mainstream, the surest sign of arrival is their memification. Simultaneous validation and critique, memes are a late-stage evolutionary product of society. They have been through processes of propagation, mutation, natural selection, and transmission, analogous to a biological virus.

Source : Americasbestpics.com

Source : Reddit.com

Source : Is It Green?, inhabitat.com

Source : Author



Source : Reddit.com

Maybe the real function of a meme is to stop us from taking ourselves too seriously.
"Intelligence and a sense of humor will get you through life".

Ar. Dinesh Rao

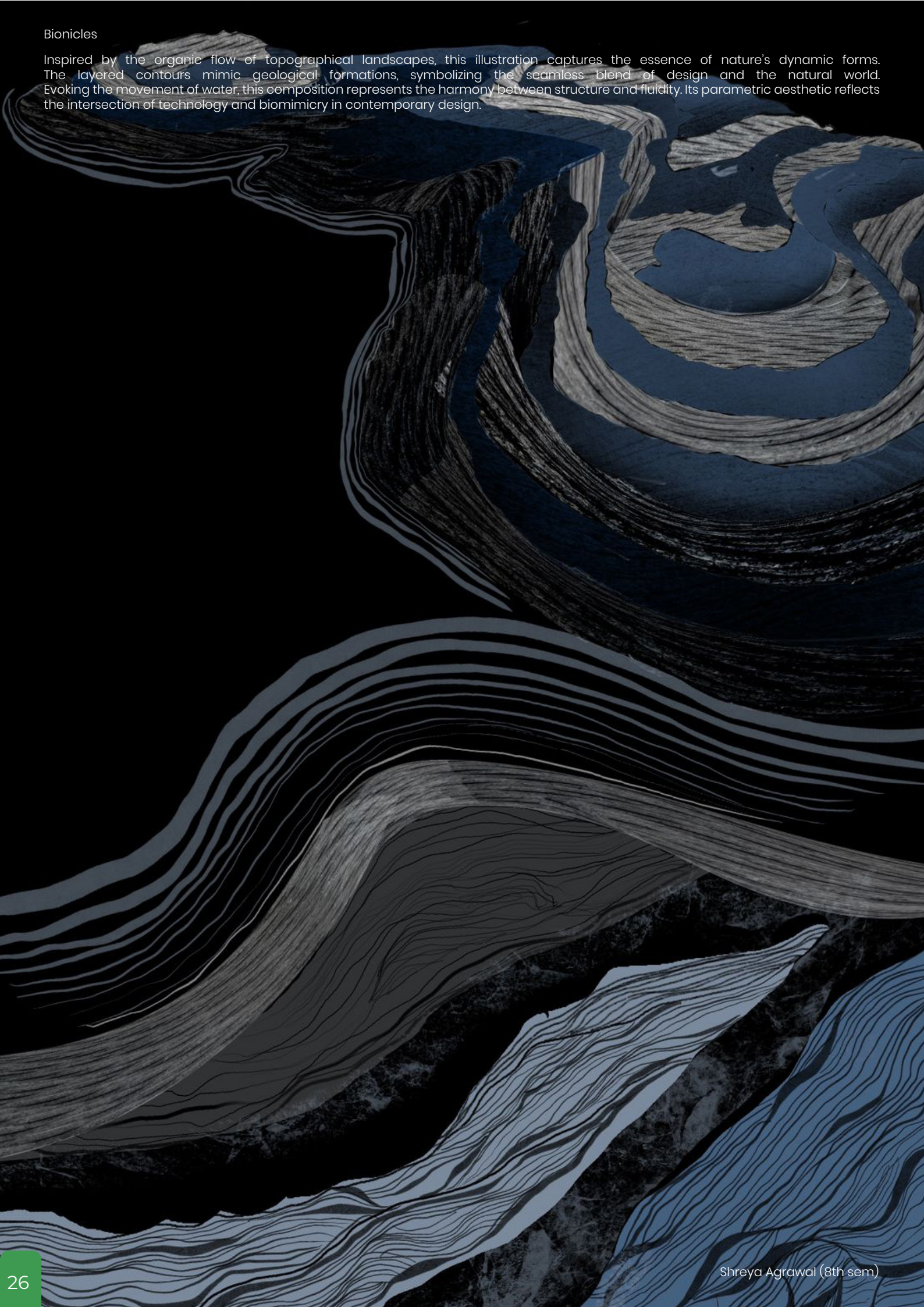
Dinesh Rao is a practicing architect with over 35 years of experience.
He is the principal architect at Monsoon Design, a design firm based in Bengaluru. He studied at the Faculty of Architecture, Centre for Environmental Planning & Technology(CEPT), Ahmedabad, and at the Eidgenossische Technische Hochschule (ETH), Zurich.He has previously worked at Architects' Combine (Mumbai & Bengaluru) and Archipart (Zurich).

He has mentored architectural design students and taught theory at BIT Bengaluru, MCE Hassan, and RVCA Bengaluru for over 30 years.
He continues to be a visiting critic at the major architecture schools in Bengaluru.He has been on the Board of Studies of the SIT School of Architecture, Tumakuru, and contributed to the syllabi & pedagogy of th for theatre, furniture, graphics, naming & visual identity, and professional architectural photography.

1. https://worldgbc.org/advancing-net-zero/embodied-carbon/
2. "Building becomes architecture only when the mind of man consciously takes it and tries with all his resources to make it beautiful, to put concordance, sympathy with nature, and all that into it. Then you have architecture."
Frank Lloyd Wright, 1867-1959
3. Thompson, D'Arcy Wentworth (1917) On Growth and Form. Cambridge University Press https://www.gutenberg.org/files/55264/55264-h/55264-h.htm
4. Alexander, Christopher et al. (1977) A Pattern Language Oxford University Press
https://www.patternlanguage.com
5. Pallasmaa, J. (1996) The Eyes of the Skin. John Wiley & Sons
6. Zaha Hadid: "There are 360, why stick to one?"
7. Katodrytis , G. Poiesis and auto-poesis in Architecture https://papers.cumincad.org/data/works/att/acadia05_048.content.pdf
8. Deleuze, G. & Guattari, F. (1980) A thousand plateaus. Les Editions de Minuit
9. https://oxman.com/projects/eden

Bionicles

Inspired by the organic flow of topographical landscapes, this illustration captures the essence of nature's dynamic forms. The layered contours mimic geological formations, symbolizing the seamless blend of design and the natural world. Evoking the movement of water, this composition represents the harmony between structure and fluidity. Its parametric aesthetic reflects the intersection of technology and biomimicry in contemporary design.



Shreya Agrawal (8th sem)

03 Algorithms of Nature :Bridging Nature, Mathematics and Form

ARTICLE by: Rohith Sreeram

Kalpa, Vol.05, 2024, pp. 27-33

Source : Author

ABSTRACT: Parametric design is the next revolution in architecture, with the use of computational tools to create fluid, dynamic, and optimized structures. This article delves into how parametricism draws inspiration from nature's organic forms and mathematical precision to generate complex geometries. It explores the relationship between natural patterns, material adaptability, and algorithmic design, illustrating how advances in digital fabrication enable intricate, responsive architectural solutions. The article outlines that through case studies and explorations of contemporary methodologies, parametric design will enable the remodelling of aesthetics, efficiency, and sustainability of the built environment.

Introduction

Nature has long been a wellspring of inspiration for design across various fields— architecture, textiles, graphic arts, fashion, and more. The profound influence of nature stems from its inherent beauty, its vibrant colors, the complexity in its patterns, and the harmonious balance in forms that exist in the natural world. By observing and understanding the intricacies of nature, designers tap into a limitless source of creativity, offering endless possibilities for innovation while grounding their work in organic, timeless principles.

The natural world is an artist's palette. From the the lush greens of forests to the rich hues of sunsets, nature presents an infinite spectrum of colors, each evoking different emotions and moods. Designers draw from this diverse palette to create visual compositions that resonate with beauty and meaning. The patterns in nature— whether it's the spirals of a seashell, the geometric symmetry of a leaf, or the organic flow of a river—offer a wealth of design concepts.

Stone and Softness:

Exploring Nature's Contrasting Materials in Design

Nature presents diverse materials, each with its own unique qualities that inspire design. Some, like wood, clay, and textiles, are soft, pliable, and are readily shaped by human hands, offering endless possibilities for exploration and transformation. These materials invite experimentation and bending while adapting to the designer's vision, encouraging creative expression through their flexibility. For instance, wood can be carved into intricate forms, fabric can be woven into patterns, and clay can be molded into sculptures, making them ideal for designs that are versatile and constantly evolving.

In contrast, stone presents a strikingly different challenge. With its weight and rigidity, stone is a material that demands respect for its enduring characteristics. Unlike softer, more malleable materials, stone resists change, requiring immense skill and effort to reshape. Its dense, solid structure makes it a material that speaks through strength and permanence, yet it also offers a unique form of beauty—one that emerges through slow, deliberate processes rather than rapid transformation. The colors, textures, and patterns found in stone—ranging from the veining in marble to the rugged surfaces of granite—tell a story of natural forces at work over millennia.

Stone in the Marketplace:

Redefining Its Value and Versatility in Design

In today's dynamic and competitive design landscape, the materials used in architecture, interior design, fashion, and product design are often inspired by nature's beauty. Soft, malleable materials like wood, clay, silk, bamboo, and leather are frequently celebrated for their versatility and the ease with which they can be shaped, molded, and manipulated into beautiful designs. However, stone stands apart as a powerful symbol of nature's raw strength, permanence, and enduring beauty. Its unique qualities—its textures, grains, colors, and forms—offer an authenticity that cannot be easily replicated by synthetic or softer materials.

Moreover, advances in technology are unlocking new possibilities for stone design. CNC cutting, 3D printing, and other digital fabrication techniques enable designers to carve, shape, and even etch stone in ways that were once unimaginable. These technologies allow for intricate, customized patterns, geometric shapes, and even delicate textures, making stone suitable for intricate artistic works as well as functional designs.

In today's market, the challenge is not just to use stone but to rethink how it can be integrated into contemporary design practices. By embracing its inherent qualities, exploring new forms, and experimenting with innovative techniques, designers can breathe new life into this ancient material. The ultimate goal is to showcase stone in a manner that redefines its role in design, making it a versatile, sustainable, and dynamic choice for the future.

Stone in Motion:

Parametric Design Inspired by Natural Fluidity

Parametric design serves as a transformative bridge between the timeless beauty of stone and the fluid, organic forms found in nature. Through the use of advanced algorithms and computational tools, designers are now able to capture the intricate patterns, flowing shapes, and natural textures that define the world around us.

By mimicking these organic elements, parametric design allows for the creation of innovative and complex forms that were once thought to be impossible with traditional design methods. This approach harnesses the power of computational processes to generate shapes that echo the subtle curves and lines of nature, which can then be translated into the solid, enduring material of stone. Stone, traditionally known for its hardness and permanence, often evokes a sense of rigidity and strength. However, parametric design enables us to rethink its potential, allowing designers to push the boundaries of how stone can be shaped and utilized. By abstracting natural forms and patterns—such as the fluidity of sea waves, the branching of trees, or the undulating contours of a mountain—stone can take on dynamic, flowing shapes that celebrate both its inherent strength and newfound elegance.

The fluidity of sea waves offers an exceptional source of inspiration in this context. The undulating motion of the ocean, its rhythmic ebb and flow, provides a rich visual language for designers. By interpreting these natural patterns, parametric design captures the dynamic, ever-changing lines and forms of waves, abstracting their movement into a rigid material like stone. The wave's graceful arcs, its continuous curves, and its organic, unpredictable nature can be mirrored in the stone's surface or structure, creating designs that are both sculptural and functional.

Crafting Waves in Stone:
A Journey from Concept to Reality

Our exploration of stone design began with a conceptual vision to replicate the fluidity and movement of sea waves, which served as a powerful source of inspiration. The sea, with its rhythmic ebb and flow, provided the perfect metaphor for transforming the rigid, enduring material of stone into something dynamic and evocative. To translate this vision into reality, we started by experimenting with varying depths and widths of concave flutes, ranging from 25mm to 100mm. This exploration focused on creating wave-like patterns that could evoke the movement of water, while still being rooted in the solid, enduring nature of stone.

The initial phase of experimentation was critical in laying the groundwork for our signature style. It highlighted the importance of texture and the subtle shifts between form and function, as each wave formation, even at a small scale, offered unique opportunities for aesthetic expression. The varying depths of the concave flutes allowed us to explore how different contours could capture light and shadow, creating a sense of fluidity even in a static material like stone.

As we moved forward in our design journey, we sought to push the boundaries of stone's potential. We turned our attention to the third dimension, specifically the YZ planes, to explore how wave formations could transcend the limitations of traditional 2D design. This transition from flat surfaces to more sculptural, volumetric designs enabled us to create truly dynamic wave forms that emerged from stone in three-dimensional space. It was here that we realized how essential it was mathematical principles into our design process, particularly in the precise curation of wave sets at regular intervals.

By leveraging the power of mathematical calculations and algorithms, we were able to generate waves that had both a visual and functional impact. These calculations allowed us to maintain consistency in the form while ensuring that each wave's size, spacing, and curvature adhered to a logical, balanced system. This approach enabled us to maximize the potential of stone, which typically resists manipulation, turning it into a material that could flow, breathe, and carry a sense of movement.
What emerged from this process was not simply a static design, but a dynamic, engaging experience. The wave-like forms began to take on a life of their own, with light playing off the varying depths and contours, and the overall design transforming from a series of flat patterns into an immersive three-dimensional expression of nature. This shift from 2D to 3D allowed us to create stone pieces that were not only aesthetically captivating but also highly functional. Whether as architectural elements, wall cladding, or furniture pieces, these wave-inspired designs brought an entirely new dimension to the material, adding richness, texture, and depth.

Conclusion :

The integration of mathematical precision with creative design has been fundamental in uncovering the true potential of stone as a medium for innovation. The blend of these two disciplines has expanded our understanding of how design can evolve when traditional forms meet computational thinking. Through this synthesis, we've been able to approach stone design from an entirely new perspective—one that balances beauty with functionality, movement with permanence, and art with engineering.

Ultimately, our approach to stone design has opened new possibilities in both aesthetics and functionality. By embracing the natural inspiration of sea waves, and marrying that with advanced mathematical techniques, we've been able to push the boundaries of

what stone can achieve. The result is a unique, signature style that celebrates both the material's inherent strength and its ability to adapt and transform in response to creative innovation. This journey continues to evolve, as we explore how mathematics, technology, and nature can collaborate to create design solutions that are not only visually stunning but also deeply connected to the natural world.

Fig 1.1 : Image of Carbon Black 30 mm 72" x 24" profile

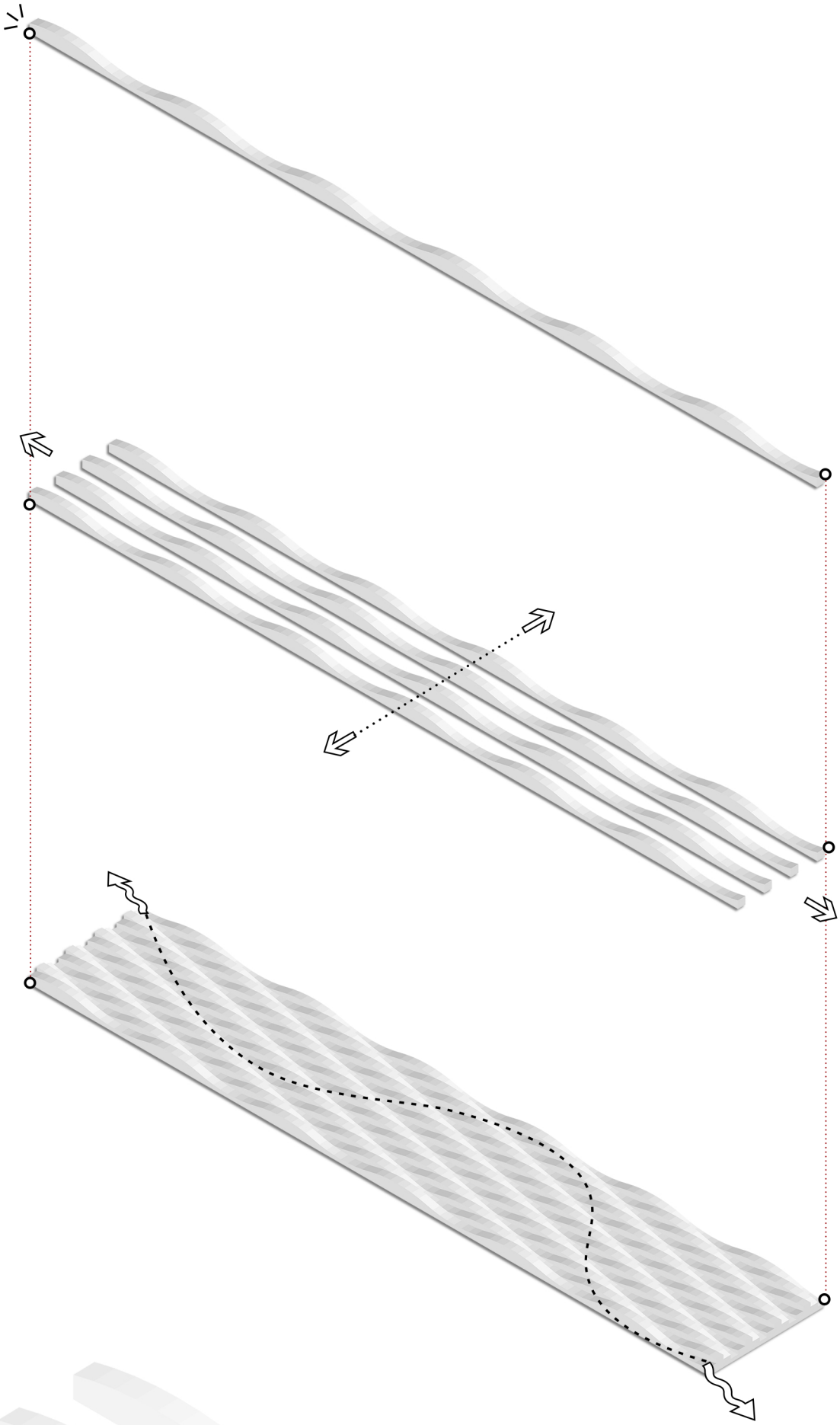


Fig 1.1 : Exploded view diagram of Carbon Black 30 mm 72" x 24" profile

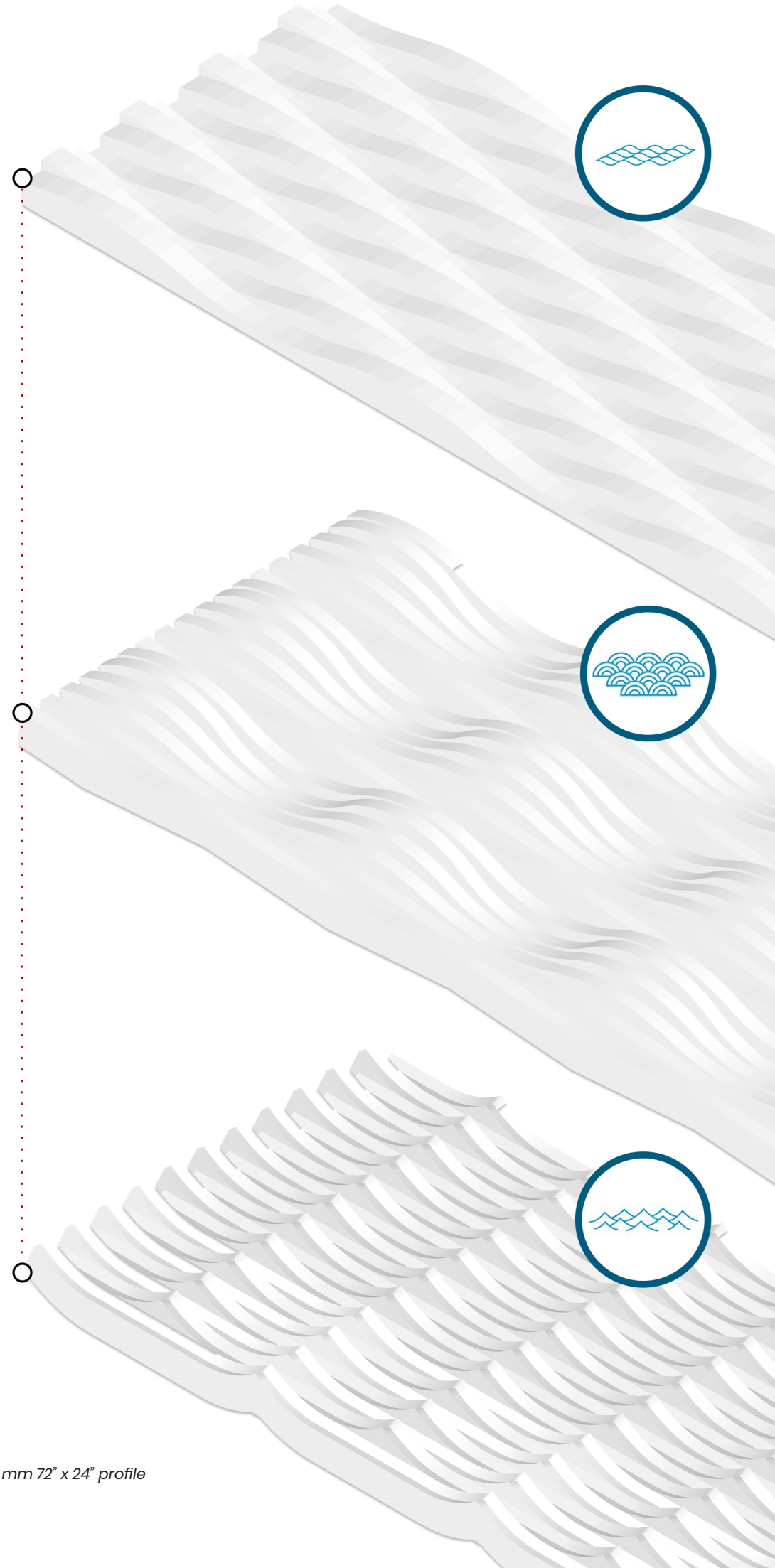


Fig 1.1 : Exploded view of Carbon Black 30 mm 72" x 24" profile

Rohith Sreeram

Sreeram Rohith is a highly skilled and passionate designer renowned for his expertise in crafting distinctive textures on natural stone, transforming them into captivating works of art for residential, commercial, and outdoor spaces. Specializing in luxurious stone finishes for facades and landscaping projects,my designs exude elegance and sophistication.

I have done some landmark projects such as Hospet Mane, an award-winning development recognized for its intricate stonework and exceptional design, and Amita Rasa, a stunning destination wedding venue nestled in the scenic foothills of Nandi Hills. I have been collaborated with some of the most prominent architects on renowned projects like Pattern House by Cadence, Western Valley House by STOMP, Ripples of Light by Collage Architecture Studio, and KOSH Retreat at Nandi Hills.

With a unique blend of technical proficiency and a deep artistic sensibility,I am driven by a relentless passion to push the boundaries of stone design, continuously redefining the possibilities of texture and form in his craft.

Email: ingrantesblr@gmail.com
Social Media: @sreeram__rohith

The inspiration behind the East Gate centre, Zimbabwe. The urban pulse and the service system designed by biomimicry of an ant hill. The illustration is in greyish tones to explain the depth of the ant hill better than the background while keeping it monochromatic.

A Himabhindu (8th sem)

04 Urban Pulse: (Re)Thinking Cities as Living Ecosystems

ARTICLE by: Rashmi Pavagada Subbanarasimha

Kalpa, Vol.05, 2024, pp. 35-39

ABSTRACT: Cities are often perceived as static, human-made constructs, but this article reimagines them as living, adaptive ecosystems. Drawing parallels between urban environments and biological systems, it argues that cities function as complex adaptive systems, evolving through decentralized interactions rather than top-down planning. The discussions relate to emergent behaviors in urban life, the role of resilience in city planning, and the tensions between state-led intervention and grassroots adaptability. Through case studies, focusing particularly on Bengaluru, the article examines how local communities and informal networks play a crucial role in shaping sustainable urban futures. It calls for a paradigm shift in city planning-one that would emphasize self-organization, adaptability, and the symbiotic relationship between built and natural environments.

"We shape cities, and they shape us."- Jan Gehl (2013)

Imagine walking through a bustling urban city.
The streets hum with life—cars zip down avenues, pedestrians weave through crowds, while markets, theatres, and cafes pulse with the collective energy of human interaction and lights flicker with a rhythm that seems almost alive. It's a choreography of countless individual actions, seamlessly creating the vibrant, living tapestry of urban life. In many ways, a city mirrors the intricate behaviors found in nature, such as an ant colony or a murmuration of starlings. Ted Schultz (2022), an entomologist discusses the phenomenon of evolutionary convergence and emergence within ant colonies that explains parts of their system acting in simple ways but produce collective behaviors that are remarkably sophisticated, without central direction. Ants don't have a leader barking orders, yet their colonies build intricate networks, solve complex problems, and adapt to challenges seamlessly. Similarly, individual birds follow basic rules—stay close, match speed, avoid collisions—but collectively, they form mesmerizing flocks that twist and turn as if guided by a single mind. Many zoologists believe rather than an individual being studied at a scale of colony or community helps to understand the construct of their complex social structures (Fuller-Wright, 2018).

Now think about cities. Like ant colonies and bird flocks, cities operate as emergent systems or or natural phenomena that enable urban life to function, interact, self-organize, adapt, and evolve as resilient systems. Millions of individuals—each making decisions based on their immediate surroundings—contribute to the ebb and flow of urban life. Traffic patterns, market economies, and even cultural trends emerge not because of a singular controlling entity but through countless interactions at the micro-level. Much like entomologists argue that ants should be studied as colonies rather than as individuals, viewing cities as living organisms rather than merely as collections of buildings offers a valuable heuristic or learning opportunity. This perspective helps us understand cities as complex, emergent systems that breathe, grow, and adapt, responding to the needs of their inhabitants and the pressure of their respective environment. This ontological shift—from traditional top-down city planning approaches, which often 'isolate the process from context and outcome' (Fainstein, 2005), to viewing cities as Complex Adaptive Systems (CAS) (Moroni & Cozzolino, 2019) — explores the politics of urban life, infrastructure, technological development, and the tension between natural growth and state interventions in and around city planning practices, reshaping and questioning the theoretical underpinning of contemporary city planning approaches.

City and Complexity

Although the concept of city planning is not new, the evolutionary understanding of cities and planning practices largely started in 1961 when Jacob (1961) urged us to consider the reality of how cities actually function, as opposed to how urban designers or planners envisioned them (Campanella, 2017). She unravelled the inherent drama, multiple layers, various actors, intricate process and hidden motives within and surrounding city planning practices. Subsequently, there has been a growth in literature recognizing cities as complex systems and its influence on the way we articulate urban phenomena (Moroni & Cozzolino, 2019).

Cities are complex systems due to the presence of multiple interconnected components (Moroni & Cozzolino, 2019) like actors, their social action and local practices, context, public policies, structure and interconnective networks that bind all of these components together. These components interact with each other simultaneously resulting in a complex, dynamic and difficult to predict system called cities. Portugali (2016) explains, "when we consider cities as a set of material components alone, the city is an artifact and as such a simple system; as a set of human components – the urban agents – the city is a complex system" (Moroni & Cozzolino, 2019).

Complex systems are often defined as large systems composed of numerous interconnected parts that continuously interact within a specific environment (Simon, 1996). Through these interactions, such systems exhibit the ability to react, adapt, and self-organize, much like urban living ecosystems. This self-organizing and adaptive nature enables complex systems to endure over time, even under changing conditions, by building resilience. These properties often give rise to emergent behaviors that are both non-trivial and difficult to predict (Heylighen et al., 2006; Tan et al., 2005). Recognizing cities as complex systems is essential, as it underscores their capacity to sustain human civilizations through endless triumphs and challenges. Cities demonstrate an inherent ability to adapt to uncertain conditions imposed by external forces, surviving and thriving by leveraging their diversity and redundancy to self-organize internally.

This nuanced understanding of cities as complex systems, encompassing heterogeneous structures and, more importantly, various human agents rather than material components alone, has a significant impact on emerging perspectives in city planning globally.

Tensions between Control and Emergence

While theoretical frameworks offer immense potential and promise, they also spark endless debates, questions, and criticism—particularly concerning the disconnect between these frameworks and their practical application in city planning. Despite the conceptualization of cities as CAS, state interventions often impose top-down control, overshadowing bottom-up emergence.
For instance, numerous scholars have observed that government-led smart city interventions, which leverage advanced technologies to enhance the quality of urban life, often prioritize online channels for interaction over direct engagement with human agents, effectively sidelining them in the process of city development (Brandt et al., 2018; Saunders & Baeck, 2015; Subbanarasimha et al., 2023). These interventions aim to track, monitor, and regulate human activities, ultimately influencing and shaping the trajectory of urban growth.

The tension between top-down and bottom-up approaches is not a new phenomenon. It has been a defining feature of human civilization's evolution, shaping hierarchical structures and governance throughout history. While top-down control plays a significant role, it is bottom-up emergence that enables cities to self-organize and adapt to both external interventions and internal disruptions. This adaptive capacity allows cities to thrive and endure even amidst uncertainty. A recent field study I conducted in Bengaluru on the bottom-up interactions among frontline workers, citizens, and government officials involved in a proposed solid waste management intervention under the smart city mission revealed that, despite widespread criticism of the city's unplanned growth (Aithal & Ramchandra, 2017; Paliath, 2024), it continues to

navigate through the ambiguous situations. This research (Subbanarasimha et al., 2023) highlights the pivotal role of informal interactions and end-users' work practices in sustaining waste management in Bengaluru, even during the worst phases of the COVID-19 pandemic and the country's longest lockdown. End-users—including frontline workers, civic groups, resident welfare associations, and even citizens operating beyond traditional boundaries—often innovate in diverse and resourceful ways to navigate the challenges posed by unplanned urban growth.

For example, civic groups at the ward level established micro-level planning initiatives, utilizing both physical and virtual platforms to address everyday challenges faced by urban residents and to bring local concerns to the attention of city officials. These bottom-up efforts not only fostered collaboration among stakeholders during the pandemic but also continue to empower communities to actively shape their urban environment today. Moreover, these urban agents demonstrate adaptability to external uncertainties such as lockdowns, floods, and workforce shortages. Their resilience, creativity, and redundancy have played a crucial role in sustaining the city's functionality during challenging times. Meanwhile, the community of Pourakarmikas—the frontline workers responsible for solid waste management in Bengaluru—also demonstrated remarkable resilience during the pandemic. They relied on their network to support one another through communal business relationships and peripheral economic opportunities, ensuring that waste collection continued uninterrupted despite the uncertainties. Their collective efforts not only sustained essential city services but also highlighted the critical role of bottom-up emergence in navigating crises.

This resilience is largely attributed to the numerous micro-level planning initiatives led by citizens and civic groups, including civil society organizations and resident welfare associations, all operating in parallel across the city. Human agents often function as makeshift infrastructure when planned urban systems break down, ensuring the city can sustain and adapt to unexpected disruptions. Along with technological advancements to sustain growing urban populations, it is time to recognize the role of human agents, their networks, and channels of interaction, which often sustain cities locally. Understanding these elements will enhance the experiential richness and local knowledge within the city planning process.

Embracing the relationship between human agents and cities, along with urban development, offers valuable insights into how these connections exist, evolve over time, and, in some aspects, remain consistent. However, this relationship is often overlooked in practice and may not always receive the attention it deserves. By reinforcing the concept of co-production and emphasizing the role of human agents in city planning, this article raises several important questions for reflection: What should cities optimize for? who decides what gets optimized, and for whom? Is it time to rethink cities as living ecosystems and embrace their inherent complexity? Rather than labeling uncertain situations, informal interactions, and non-linear networks as 'unplanned' or 'chaotic,' can we reconsider why these terms are used, and by whom? How are these uncertain situations addressed at the micro-level? What are the emergent behaviors of a city? Can we approach city development as a bi-directional process that embraces both control and emergence? Ultimately, will this shift enhance connectivity between governments and the cities they serve?

Rashmi Pavagada Subbanarasimha

Rashmi Pavagada Subbanarasimha is a doctoral scholar at the International Institute of Information Technology, Bangalore (IIITB). She has over 12 years of experience in digital urban studies, urban planning, architecture, teaching, and research. Her professional and research interests lie at the intersection of urban infrastructure studies, public service management, city planning, and information systems, with a core focus on understanding the politics of built environments, technology, and society. Rashmi has worked on urban development plans, city infrastructure strategies, town planning schemes, digital infrastructure and service design, and state open data policy management. She holds a master's degree in Urban and Regional Planning from CEPT University, Ahmedabad, and a bachelor's degree in Architecture from BMS College of Engineering (BMSCE), Bangalore. Some of her recent research work can be accessed at: www.linkedin.com/in/rashmi-pavagada-subbanarasimha-516710271.

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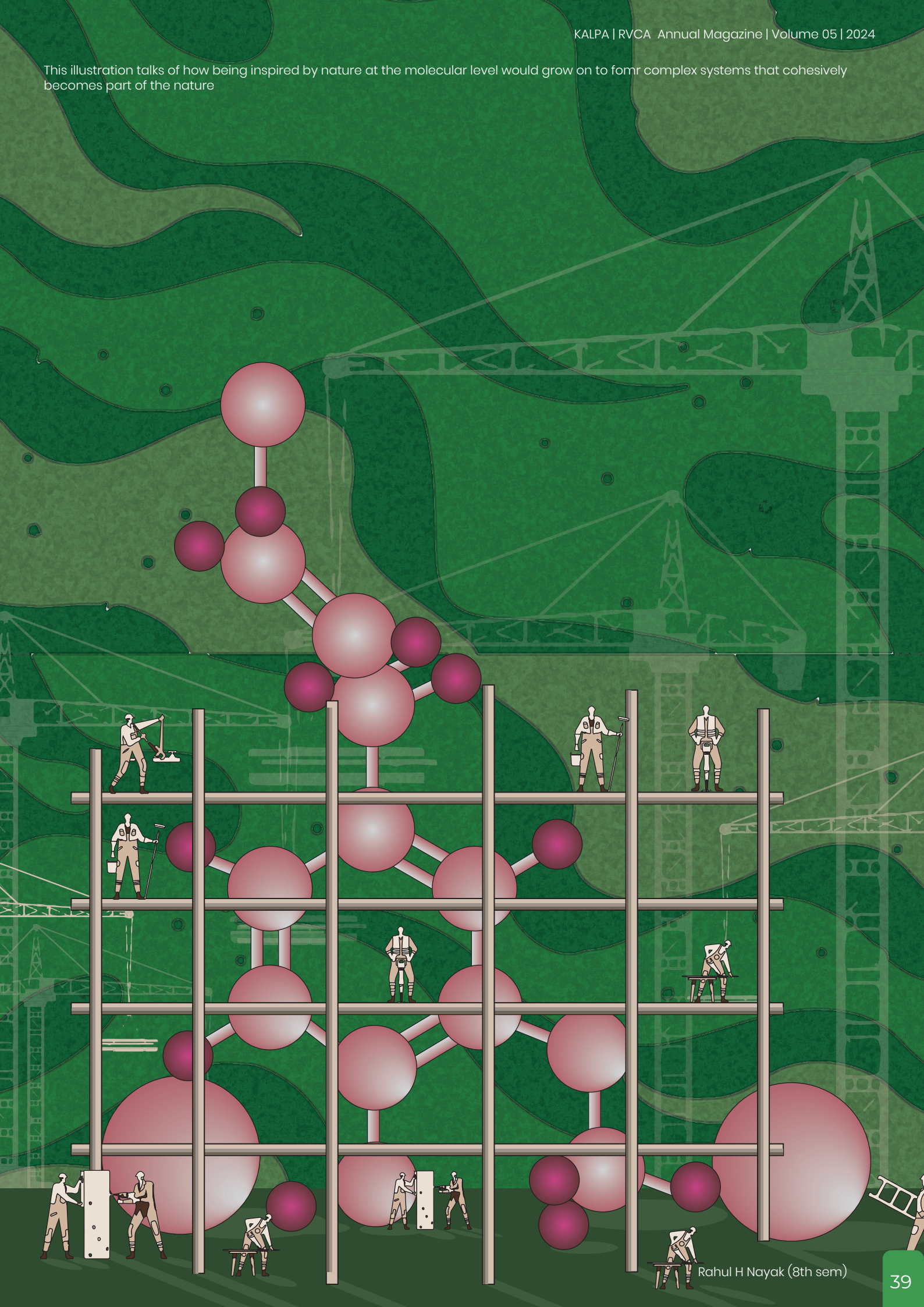
This illustration talks of how being inspired by nature at the molecular level would grow on to fomr complex systems that cohesively becomes part of the nature



Rahul H Nayak (8th sem)

05 Unveiling Green Chemistry : The Molecule Way

Interview with Thomas McKeag

Kalpa, Vol.05, 2024, pp. 40-43

Abstract: This interview with Thomas MCKeag explores his work in green chemistry: focused on minimising toxic substances drawing inspirations in nature's efficient processes. His journey into this field stemmed from a recognition of designing and curating processes at molecular-level, thus minimizing hazard and maximising sustainability. He discusses the importance of a systems-based approach, acknowledging the wide-ranging effects of chemical changes within production systems. The interview also covers the hurdles in translating these innovations into real-world applications, including the difficulties of working across diverse industries. Additionally, it touches upon the educational aspects of green chemistry, highlighting the need for interdisciplinary collaboration. He shares advice for those entering the field, stressing the value of specialised knowledge and passion. Overall, the interview offers insights into the principles, challenges, and educational dimensions of green chemistry from the perspective of a bio-inspired design practitioner.

Kalpa, our annual magazine, is exploring biomimicry and nature's influences on design. Nature as a mentor teaches a very self organised effort to 'doing things' with least damage. Design thinking explores these tenets through formative and programmatic interplays that enhance the built environment with values such as adaptability, dynamism, resilience to name a few. We are humbled to have this opportunity of talking to you to gain insights on 'nature' as an inspiration in 'greening' the earth. We thank you for contributing to us by answering the questions stated below:

Q1: We would like to firstly understand what green chemistry is. Could you throw light on how your approach to this strategy started and what were your inspirations?

Green chemistry is a new paradigm for performing chemistry using less toxic materials and methods. The field was founded by John Warner and Paul Anastas in their seminal book "Green Chemistry: Theory and Practice" (. Anastas, P.T. and Warner, J.C. Oxford University Press (2000). Many of the practices of green chemistry are inspired by the processes found in nature.

I came to green chemistry through my bio-inspired design educational practice, and my growing realization of how important design can be at the molecular linear scale. Happenstance, as you will see below, also played a role, but I was quickly inspired by the scientists and engineers at the University of California, Berkeley who were actually designing things, just not at the scale and using the tools that I was familiar with.

Q2: Can you walk us through your first project and its impact/outcome. How has the process evolved to this day?

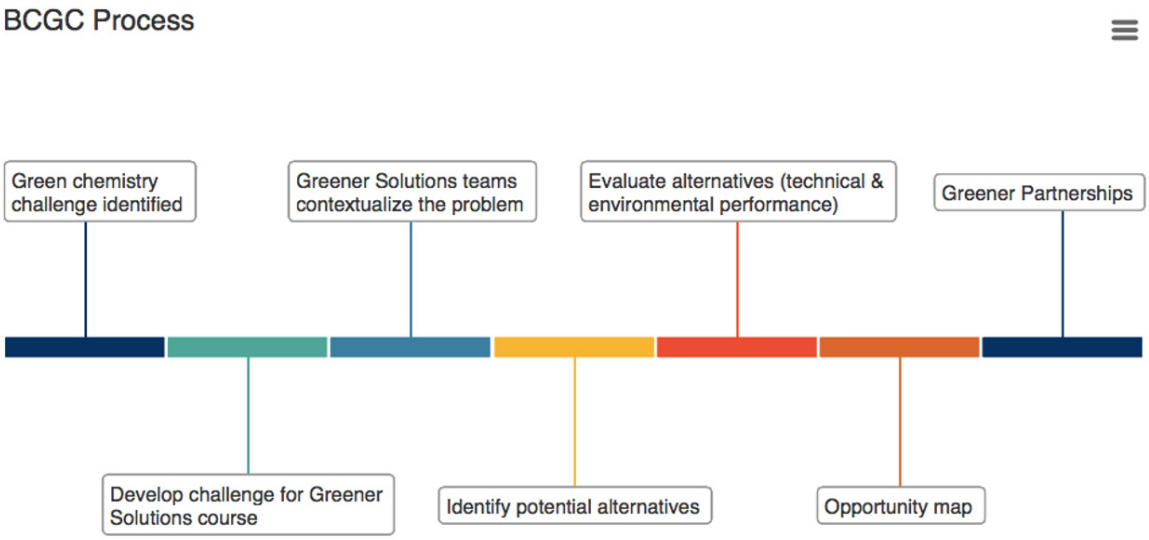
I was asked to join an interdisciplinary team to review the formula for a 3D printer resin for Autodesk in San Francisco, California, USA. The company wanted to make its demonstration Ember printer open source and also was keen to know how safe its resin was. It was in this project that I first collaborated with the UC Berkeley Center for Green Chemistry, eventually joining the group as development director, then becoming executive director.

We analyzed the components of the formula across a comparative chemical hazard assessment and then recommended several general bio-inspired design strategies.

These strategies can be viewed in a subsequent publication by Yale University Press/ Wiley (McKeag, T. A. (2018). Shaping the future of additive manufacturing: twelve themes from bio-inspired design and green chemistry. In Anastas, P. T., Tools for Green Chemistry (241-262). Weinheim, Germany. Wiley-VCH Verlag GmbH & Co. KGaA. ISBN: 978-3-527-32645-7)

This initial work was the start of several years of study, education and project work on additive manufacturing (AM), funded by grants from the US Environmental Protection Agency (EPA), and including graduate course work, presentations at conferences, and further publications. Graduate students in our Greener Solutions course devised several innovative alternatives to standard photo-activated resins, our center developed a green chemistry scorecard for judging AM materials, and we greatly increased awareness of material toxicity issues within the AM community through our outreach.

Below is the process that we employed in our Greener Solutions graduate course. Team members were instructed in bio-inspired processes during the alternative investigation phase (shown in yellow). The course product was always an "opportunity map" which recommended strategies for healthier alternatives within a framework of feasibility.



Source : Author

Our process was always evolving as our collaboration network grew and we learned more about the various industries with whom we were collaborating. In general, we became more aware of the technical implications of linear scale and more attuned to a systems approach. There really is no such thing as a drop-in replacement for a single toxic chemical, and all factors within the production process must be taken into account in presenting alternatives.

Q3: Nature is known for its efficiency and sustainability—how have these qualities been incorporated in the material sciences to balance both functionality and the aesthetics of design?

Much of my individual work has been in additive manufacturing and I think it is a great example of a relatively new technology that incorporates basic principles of efficiency and sustainability in nature: just-in-time manufacturing, functionally graded materials, composite construction to balance stresses, recycling of basic materials, to name a few.

Q4: What are some of the biggest challenges you face when trying to translate these innovations in practice?

There is always an intense ramp-up in acquiring a working knowledge of a field or industry to a level where one can ask intelligent questions. Frankly, this is a pursuit that I enjoy, but there are limits to one individual's capacity to absorb technical information and then synthesize it into coherent investigation strategies, let alone solutions. This is the reason all of our Greener Solutions projects were done by interdisciplinary teams, carefully chosen for a balance in engineering, chemistry and public health expertise.

Staying in the problem space sufficiently to consider a range of factors, being keenly aware of the physical implications of linear scale, and studying, in a systems thinking way, interactions, as well as components, that will yield an outcome. These are all admonitions that the practitioner should heed, in my opinion.

Q5: How has innovation and technology aided your approach, especially when materiality brings in its complexities?

There have been great advancements in the ability to observe the nano-scale world in real-time and this has led to new insights about both materials, and, excitingly, processes that occur in nature. I write about one example of this in an article in issue 24 of our online journal Zygote Quarterly, and one of the young engineering professors at UC Berkeley, Dr. Grace Gu, one of many whom I found inspiring.

Q6: Your innovative strategies are spread across varied markets and scales, be it clothing, industrial use, beauty, household products etc. What or who has been the easiest recipient of this technology (both market-wise and end user response) and on the other hand, who has been the most challenging?

BCGC does indeed have a record of diverse partners from various industries. These partners, almost entirely, have come to us for help with an issue, so our projects begin with a motivated partner. In my experience within the market, however, personal health and safety, whether in food or personal care, is an area where adoption is usually easiest, with the market pull from concerned consumers motivating companies who want to do the right thing or to gain an advantage or keep their customers.

Ironically, while the additive manufacturing industry may seem the most similar to nature from a technical standpoint (the antithesis of "heat, beat and treat" of traditional manufacturing), it has been challenging to inculcate its green chemistry adoption. Proprietary formulas, intense competition and fast changing and disruptive technologies make the industry participants hesitant to share information. This is why the Autodesk project cited above was such a ground-breaking opportunity for us.

Q7: In terms of outreach, what has been your experience in advocacy - be it in education, policy or even law?

Most of my experience has been in education, although at different levels, both formal and informal. I have had limited experience in affecting policy or law. Within education, I think the green chemistry community has made great strides, particularly with progressive companies, although green chemistry approaches are still a tiny fraction of activity in the chemical industry itself. Toxicology and public health are still not standard requirements in the education of chemists, but that is slowly changing. The United States, unfortunately, regulates chemicals through a bewildering patchwork of different agencies and powerful lobbies have consistently thwarted more comprehensive regulation.

Teaching innovation does require the synthesis of different fields of knowledge, so I found in drafting a so-called "export model" of our Greener Solutions process that,

as in nature, you should not produce a blueprint, but rather a recipe; one that can be adjusted for local conditions, capabilities and audience, and accept that the result may not be the same, but might work for the recipient.

Q8: Lastly, what would be your words of wisdom, firstly, with students in exploring this specialisation as a practice and secondly, to young practitioners who are pursuing to set a mark?

For bio-inspired design practitioners I would refer you to our latest issue 36 of Zygote Quarterly and my article on D'Arcy Thompson: "On Growth and Form: Six Lessons for Designers". Although a broad knowledge of many fields is necessary, do make sure you have one deep expertise that you can bring to an interdisciplinary team of equals. This is the so-called "T" model advocated by many (broad at the top, but deep in at least one subject). Focus on your passion: what gets you out of bed every morning. Without that, work will be drudgery and you probably will only be successful in spite of yourself.

Q9. What would be your advice to academicians across the globe with regards to consideration of context and geographical analysis and its impact on

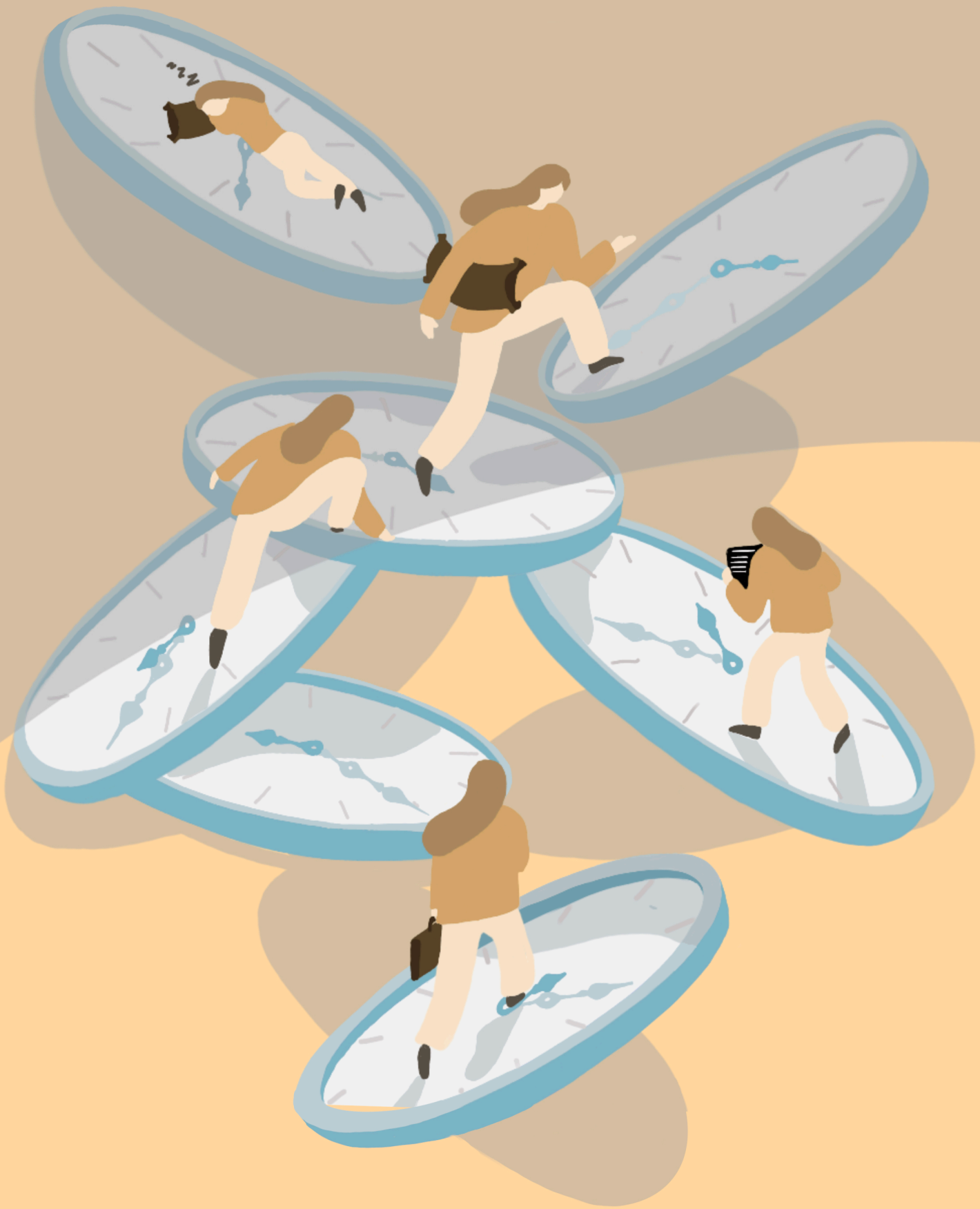
If I understand the question correctly, I would make sure that you make a typology of all the factors that you might want to investigate or present. For example, whether the subject matter could be considered universally accepted or applicable, or specific to certain conditions. Framing, as mentioned in the above ZQ article, is important, and an attempt to be as comprehensive as possible in investigating parameters is, too. This was the impetus to my developing the Bio-Design Cube (Zygote Quarterly issue 6), as an aid to initial conceptual design.

Thomas McKeag

Tom is the former executive director of the UC Berkeley Center for Green Chemistry (http://bcgc.berkeley.edu), dedicated to advancing green chemistry through research, education and outreach. BCGC hosts the graduate course Greener Solutions, a collaboration with public and private organizations to find safer functional alternatives to common chemicals used in products and processes. Bio-inspired design instruction is an integral part of this course.

Tom is a founding editor of Zygote Quarterly magazine (http://zqjournal.org), taught the BioWerks studio course in Industrial Design at the California College of the Arts, SF, 2006-2015, and was the Biomimicry Column writer at Greenbiz.com, 2009-2015. In 2013-2014, he was a resident Fulbright Nehru senior scholar at the Indian Institute of Science in Bangalore, India. He is the author of Green Chemistry in Practice:Greener Material and Chemical Innovation Through Collaboration (Elsevier) https://shop.elsevier.com/books/green-chemistry-in-practice/mckeag/978-0-12-819674-8

This image visually represents the circadian rhythm, demonstrating how light and darkness influence our daily routines, moods, and overall health.



Sanya Nair (8th sem)

06 Rhythms of Light

ARTICLE by: Priyanka Praful

Kalpa, Vol.05, 2024, pp. 45-48

ABSTRACT: Lumin Essence emphasizes that lighting goes beyond mere illumination; it is about aligning with our natural rhythms. The article delves into the captivating realm of biophilic lighting design, exploring how light can be harnessed to enhance human well-being. It discusses how lighting influences mood and regulates key hormones in the body, while showcasing the inspiration drawn from nature in crafting these designs and the tangible benefits they provide. Through case studies focused on office environments, the article highlights significant improvements in workplace culture achieved through nature-inspired lighting solutions. Ultimately, it underscores how nature remains an unparalleled source of inspiration and a cornerstone of well-being.

In today's modern world, artificial lighting has replaced natural sunlight in most indoor environments. As we spend more time indoors, the impact of artificial lighting on our health, productivity, and overall well-being has become increasingly evident. The human body has evolved to respond to natural light and its variations throughout the day. This connection to natural light, often referred to as our **circadian rhythms,** plays a significant role in regulating our sleep-wake patterns, mood, and energy levels. Unfortunately, modern life, with its long hours in office spaces, limited exposure to sunlight, and the use of artificial lighting, often disrupts these natural rhythms, leading to a range of health and productivity issues.

To bridge this gap, **biophilic lighting design** has emerged as a powerful solution. This design philosophy aims to mimic the benefits of natural light by replicating its dynamic changes throughout the day. The introduction of **tunable LED lighting** has enabled the customization of indoor lighting to align with the body's circadian rhythms. This approach has shown significant potential in improving health, boosting productivity, reducing energy consumption, and creating a more sustainable work environment.

The Role of Circadian Rhythms and Natural Light

The human body's internal clock, known as the **circadian rhythm,** is influenced by the natural cycles of light and dark in the environment. These rhythms govern not only sleep-wake cycles but also various bodily functions, including hormone production, alertness, and body temperature. The body responds to natural light in predictable ways: the bright, blue light of morning sunlight wakes us up, promoting alertness and productivity, while the warmer light of evening signals the body to wind down and prepare for rest.

Natural light plays a vital role in regulating these processes, especially in the morning and evening. Morning sunlight, which is rich in blue wavelengths, helps stimulate the brain, increasing **alertness** and **mental clarity.** In contrast, the gradual transition to **warm light** during the evening triggers the production of **melatonin**, a hormone that facilitates sleep. This natural progression of light throughout the day keeps the body's rhythms in sync, promoting better sleep, mood, and performance.

In modern environments, however, many people spend a significant portion of their day in artificial

lighting, which does not replicate the changes in natural light. This disconnection can lead to disruptions in circadian rhythms, resulting in issues such as **poor sleep, fatigue, reduced productivity,** and **mood disturbances.** To address these concerns, **biophilic lighting** has been developed to reconnect people with the natural environment through design, especially through the strategic use of light.

Biophilic Lighting Design and Tunable LED Technology

Biophilic lighting is a design philosophy that integrates natural light patterns into indoor spaces. Its goal is to replicate the benefits of sunlight by adjusting the **correlated color temperature (CCT)** of artificial light to mimic the natural progression of daylight. For example, the lighting can be **cool** and **blue-enriched** in the morning to promote alertness and warm in the evening to signal the body to relax and prepare for sleep.

Tunable LED fixtures play a crucial role in biophilic lighting design. These **LED lights** can adjust both their **color temperature** and **intensity** to mimic natural light changes. The **CCT** refers to the warmth or coolness of light, measured in **Kelvins (K).** In the morning, the CCT is high (around **5,000 to 6,500 K**), providing blue-enriched light that helps with mental clarity and focus. As the day progresses, the CCT gradually decreases to around **2,700 to 3,000 K** in the evening, producing warm, soothing light that encourages relaxation.

The key advantage of **tunable LED lighting** is its ability to synchronize artificial lighting with the body's circadian rhythms. As the light gradually transitions throughout the day, it helps **regulate sleep patterns, boost energy,** and **improve mood.** This alignment with natural light can significantly enhance productivity and well-being, especially in environments where exposure to natural light is limited.

In addition to tunable LEDs, **daylight sensors** and **motion detectors** can be integrated into lighting systems to optimize energy use. These sensors adjust the lighting based on the amount of available natural light and occupancy levels, ensuring that lights are only on when needed. This automation ensures that lighting is tailored to both the needs of the body and the environment, leading to energy savings and cost efficiency.

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Benefits of Biophilic Lighting Design

Biophilic lighting design offers several compelling benefits, particularly in terms of **health, productivity,** and **energy efficiency.** Some of the key advantages include:

1. Improved Productivity and Performance

The right lighting can significantly enhance **alertness, focus,** and cognitive function, leading to better **performance** at work or in educational settings. **Cool, blue-enriched light** in the morning helps stimulate the brain and improve concentration. This aligns with the body's natural response to morning sunlight, boosting mental clarity and productivity. As the day progresses, the transition to warmer tones helps maintain energy levels and reduce fatigue, especially in the afternoon when many people experience an energy dip. This alignment with natural light patterns allows for better focus, clearer thinking, and higher productivity throughout the workday.

2. Better Sleep Quality

One of the most significant benefits of biophilic lighting design is its ability to improve **sleep quality.** By following the natural circadian rhythm, lighting can promote the release of **melatonin** at the appropriate times, facilitating a smoother transition to sleep. In the evening, when the light intensity decreases and the color temperature shifts to warmer hues, it signals to the body that it is time to wind down. This helps regulate the sleep-wake cycle and improves sleep quality. Furthermore, exposure to blue light in the evening can interfere with melatonin production, making it more difficult to fall asleep. Biophilic lighting addresses this issue by minimizing blue light exposure after sunset, reducing the impact on sleep.

3. Emotional Well-being and Combating Seasonal Affective Disorder (SAD)

Biophilic lighting is particularly beneficial for individuals suffering from **SAD,** a condition caused by insufficient exposure to natural sunlight during the winter months. Light therapy, which has long been used to treat SAD, is effectively integrated into biophilic lighting systems.

By providing the right intensity and color temperature of light, biophilic lighting can help regulate serotonin levels, improving mood and reducing symptoms of depression. The ability to adjust lighting based on individual needs can also improve emotional well-being by providing the right light exposure at the right time.

4. Enhanced Comfort

Lighting plays a significant role in creating a comfortable environment. **Human-centric lighting** systems offer flexibility by allowing users to adjust light levels according to their preferences. This is particularly important in workplaces where employees have varying needs based on age, health, or personal preference. For instance, older individuals may require higher light intensity for the same level of comfort. Biophilic lighting systems can accommodate these varying needs, ensuring that each person has a comfortable and optimal lighting experience.

5. Energy Efficiency and Cost Savings

Biophilic lighting not only improves well-being but also contributes to **energy efficiency.** By using **daylight sensors** and **motion detectors**, lighting can be automatically adjusted based on the amount of natural light available and room occupancy. This reduces energy consumption and lowers electricity costs. Furthermore, **tunable LEDs** are highly energy-efficient, using less power than traditional incandescent or fluorescent lighting. The long lifespan of LEDs **(up to 50,000 hours**) also reduces maintenance and replacement costs. The overall energy savings from biophilic lighting systems can be substantial, making them a cost-effective investment in the long term.

Case Study: Biophilic Lighting Design in the Office Environment of a Tech Company

A **tech company** located in a metropolitan city faced several challenges related to employee well-being, productivity, and energy consumption. Employees worked long hours in an **open plan office**, but they reported issues such as **decreased productivity, eye strain, fatigue,** and **seasonal affective disorder (SAD)** during the winter months. The company also faced **high energy costs** due to outdated fluorescent lighting. To address these challenges, the company implemented a **biophilic lighting design** in their office space. The design included the following elements:

1. Tunable LED Fixtures

The office was fitted with **tunable LED fixtures,** which could adjust both **color temperature** and **brightness** throughout the day. These LEDs mimicked the natural progression of daylight, providing **cool, blue-enriched light** in the morning to stimulate alertness and gradually transitioning to **warmer hues** in the afternoon and evening to promote relaxation.

2. Daylight Harvesting and Sensors

Daylight sensors were integrated into the lighting system to detect the amount of natural light entering the office. The system automatically adjusted the LED fixtures to complement available daylight, reducing energy consumption. **Motion detectors** ensured that lights were only on when employees were present in the workspace.

3. Integration with the HVAC System

The lighting system was integrated with the office's HVAC system to optimize energy usage. The system adjusted both lighting and temperature based on occupancy, creating a more comfortable and energy-efficient environment.

Results and Benefits

1. Increased Employee Productivity

Employees reported feeling more **alert** and **focused** during the morning hours, and the gradual shift to warmer lighting in the afternoon helped reduce the typical **afternoon slump.** Productivity levels increased as employees felt more energized throughout the workday.

2. Improved Sleep Patterns and Well-being

The lighting system helped employees align their work environment with their **circadian rhythm**, leading to better sleep quality. The reduction in blue light exposure in the evening helped employees relax and wind down, leading to improved sleep patterns.

3. Energy Consumption Reduction

By incorporating **daylight harvesting** and motion detectors, the office reduced lighting energy consumption by **30-40%.** The **tunable LED fixtures** also contributed to long-term savings due to their energy efficiency and extended lifespan.

4. Positive Employee Feedback

Employees reported significant improvements in **mood, focus,** and **well-being.** Some employees with a history of SAD found that the dynamic lighting system improved their mood during the winter months when natural sunlight was limited.

5. Health Benefits

There was a notable decrease in employee absenteeism related to **eye strain** and **mood disorders**, leading to a more engaged and productive workforce.

Conclusion

Ultimately, the **true value** of **biophilic lighting** and **human-centric design** lies in its holistic impact on the organization. By prioritizing the health, productivity, and comfort of employees, businesses can create a work environment that fosters **creativity, collaboration,** and **innovation.**

The energy savings and maintenance reductions are important, but the **intangible returns**—improved well-being, **higher employee engagement,** and a stronger corporate culture—are what truly make biophilic design a **smart investment** for forward thinking organizations.

In a world where companies are increasingly focused on **sustainability** and **employee welfare**, biophilic lighting represents an opportunity to align with these values while simultaneously boosting the bottom line. It is not simply a lighting solution; it is an investment in the health of employees and the future of the organization.

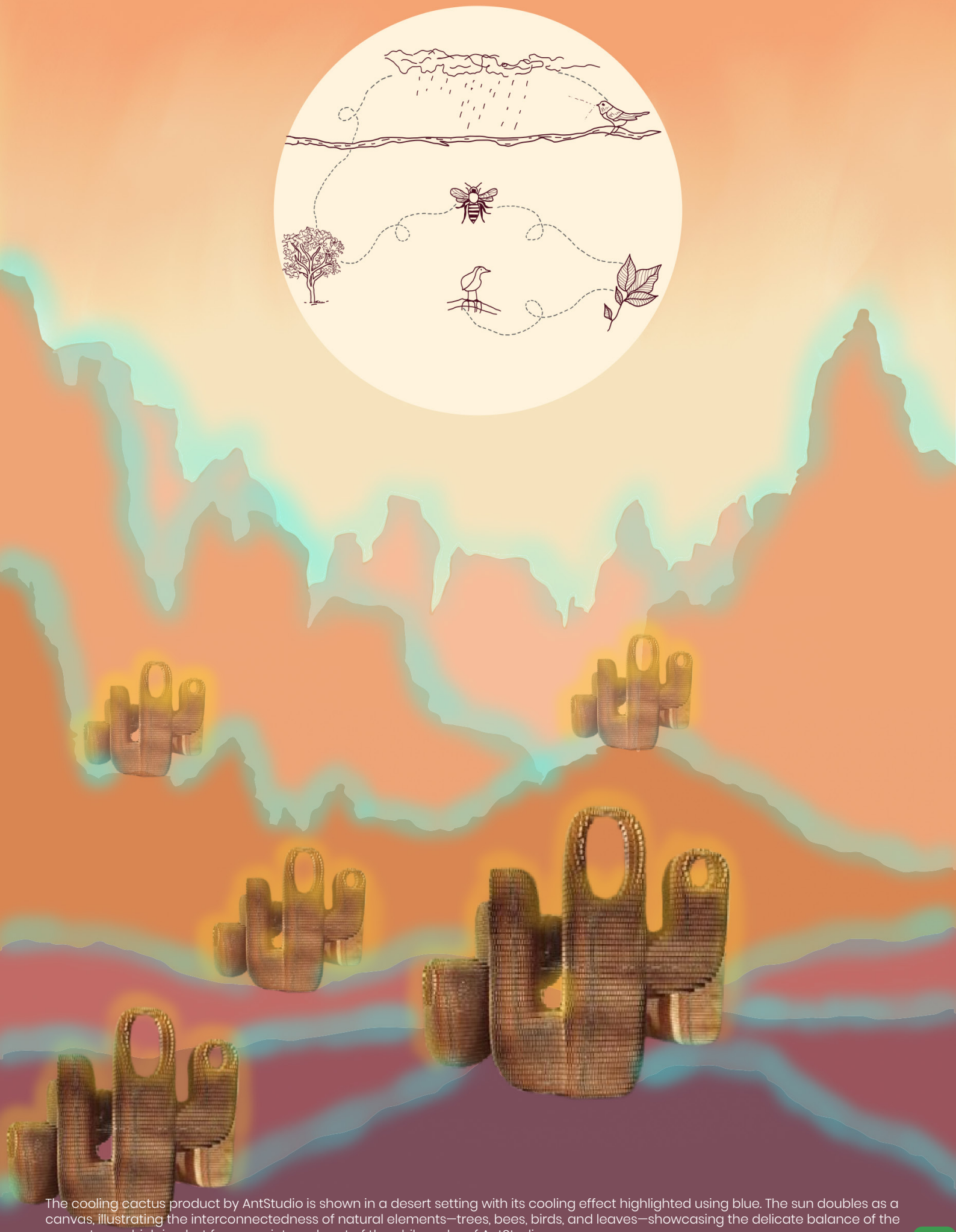
Priyanka Praful

Priyanka Praful is the Director of Design at Lumin-Essence Lighting Solutions Pvt Ltd, a turnkey lighting solutions firm.

She holds a degree in architecture from BMS College of Engineering and a Master's in Construction Economics & Management from UCL London. With over 11 years of experience spanning across architecture, interior design, project management, and lighting design,

Priyanka has successfully spear-headed a wide range of projects, including high-end residences, apartment complexes, commercial spaces, retail experience centers, F&B projects, facades, and multi-development spaces.

As a passionate advocate for the lighting design community, Priyanka serves as an active contributor and South India region lead for the 'Women in Lighting' community. Her mission is to inspire and educate young architecture students about the transformative power of lighting in design.



The cooling cactus product by AntStudio is shown in a desert setting with its cooling effect highlighted using blue. The sun doubles as a canvas, illustrating the interconnectedness of natural elements—trees, bees, birds, and leaves—showcasing the delicate balance of the ecosystem, which is what forms an integral part of the philosophy of AntStudio.

Suparna Devanathan (8th sem)

07 Terra Colonies: Executing Nature's Versatality

Interview with: Mohnish Siripurapu

Kalpa, Vol.05, 2024, pp.50-53

Abstract: The interview explores the integration of biomimicry in architecture, emphasizing nature as a guide for sustainable design. It discusses the role of terracotta in passive cooling, highlighting its hydrophilic and thermal properties as a natural alternative to mechanical cooling systems. The conversation underscores the importance of interdisciplinary collaboration, merging science, technology, and craftsmanship to translate natural efficiency into functional design. Challenges such as cost perception, scalability, and aligning natural principles with human-made materials are addressed. The discussion also reflects on the impact of digital tools, parametric design, and the evolving role of architects in creating sustainable, human-centric spaces.

Survival is a gifted skill all the species on the planet possess. Cacti, for example, is built to survive in the deserts. Drawing inspiration from the cactus, a symbol of remarkable resilience, "cooling cacti"- a cactus with terracotta instead of thorns was designed by Ant Studio, an architectural firm based in Noida, New Delhi. "Like a cactus that thrives in harsh desert conditions, our installation embodies the marriage of art and sustainability. The "cooling cacti" aims to ring the bell of Climate Change, while at the same time suggesting that the solution is rooted in our traditional systems". This installation uses the phenomenon of direct evaporative cooling to lower the temperature of the surrounding air. Water is poured over the terracotta tiles, arranged in a cactus-like shape, soaked by the porous and hydrophilic material. The water then evaporates from the surface of the tiles, taking away the latent heat and creating a cooling effect. The surface temperature is also reduced, enhancing the cooling performance.

Nature: in its complexity, in equilibrium :

Nature comes in its complex shape and form. Forms in nature are self-sufficient and stable. Larger part of these nature inspired designs comes with analysing these natural systems and integrating the principles into designs. The studio quotes- "when you notice the natural environment, you would realise that everything is linked with each other, and it is all working in a seemingly perfect balance and harmony. And yet, nothing really is perfect in nature; it's raw and inorganic. The same is true with integrating natural systems in design: it is about understanding and trying to achieve balance, while at the same time leaving room for imperfection to thrive".

Nature, along with its vast source of design inspirations and ideas, is a library of versatile materials. As nature is in equilibrium, the materials possess qualities such as unmatched strength, adaptability and embodies the ability to withstand stress and recovery. Ant studio has been particularly fascinated with terracotta. It comes from earth and is available in abundance. The designer explains- "as

per functionality, terracotta's hydrophilic nature helps manage moisture effectively, while its low emissivity ensures optimal thermal performance. Beyond functionality, it aligns with our biophilic philosophy, connecting spaces to nature. Its vast availability makes it sustainable, while its earthy aesthetics blend seamlessly into the environments we design. In every way, terracotta is a collaborator in bringing vision to life.

Sustainability, the rising need for all of us to think of every choice and the impact on society, environment and the future generators to come; it becomes extremely important to have certain ethical considerations and choices. The designer quotes- "in our projects, we ensure that every decision - whether about materials, processes or impact - is thoughtful. Locally sourced, renewable materials like terracotta reduce environmental impact and even have the potential to support local communities. Energy - efficient systems and passive design strategies help lower operational footprints, while careful site planning minimises disruptions to natural ecosystems. Sustainability is about balancing environmental, social and ethical considerations."

Design thinking: a rendezvous with trust

Design, just like other fields, intersects with ideas and theories of various fields and expertise. The larger umbrella of nature inspired designs, requires thorough, comprehensive and detailed research. This might not always be restricted to the fields in designs but often extend to various disciplines. Here comes the crucial role of the interdisciplinary collaborations and how they play a vital role in the successful implementation of such designs. To this, Ant studio quotes - "biomimicry in design sits at the intersection of nature, science, and technology, requiring insights from diverse fields. By working with diverse disciplines such as engineers, artisans, and energy consultants, we ensure every aspect of the project - from form to functionality - is well-rounded. Engineering helps translate natural principles into structural solutions, artisans bring craftsmanship aligning with our vision, while energy analysis guides the overall design to help us make informed decisions backed by data. This blend of expertise fosters innovation, solves challenges and ensures that biomimetic principles are effectively implemented." The designer, having worked in the engineering world, says that - "by binding biophilia with culling- edge technology, we are able to leverage natural processes such as shading and ventilation and mimic ones like evapotranspiration. Each design undergoes multiple iterations, balancing the artistry of nature with the precision of engineering."

Design is an extensive process. From design inspirations and ideas, to translation and fulfilling the client's requirements, design undergoes lots of changes and the designers deal with multi-faceted challenges. When it comes to nature inspired designs, the designer shares key challenges faced. He says - "one perpetual challenge we face is shifting the perspective from cost to value when discussing various ideas in a project. Often, the financial aspect overshadows discussions, with potential customers viewing it as an expense rather than an investment. Our approach has been to emphasise the long-term impact of various elements and strategies we propose, helping stakeholders see the bigger picture. For instance, we recently worked with a client sceptical about the initial investment in sustainable energy solutions. By presenting a detailed ROI (Return on Investment) analysis, including reduced energy costs and enhanced operational performance, we demonstrated how their upfront expenditure would translate into measurable gains. This expenditure reaffirmed the importance of transparent communication and data-backed insights in earning trust and building lasting relationships." He also mentioned challenges of aligning natural efficiency with human-made materials, and scaling solutions. The team approaches these hurdles through hands-on workflows and interdisciplinary brainstorming, where in every obstacle becomes an opportunity to innovate.

A future in precision: algorithmic manipulations for innovation

This age marks the beginning of the digital era. With advancement of digital tools and softwares aiding designs, the approach to nature inspired designs and parametric design are altered and influenced by them. The designer's approach to this comes from experience weighing both the pros and cons of the interventions of the digital tools. He says - "even the simplest natural processes often have hidden complexities that can be challenging to resolve manually. Addressing these issues would demand significant time and effort, often involving repetitive tasks. Digital tools and software streamline this process, automating repetitive tasks and enabling us to focus on refining designs. Parametric modelling tools allow us to replicate intricate natural patterns with precision, while simulation software evaluates performance metrics like airflow or thermal efficiency. This efficiency not only saves time but also enhances the overall design process, resulting in more refined and effective outcomes".

Design has consequences. it impacts how society grows and adapts to changes for years ahead. Nature inspired designs play a vital role

in shaping that future. When asked to comment on the pedagogical aspects of this discipline, the designer quotes - "The future of architecture lies in blending technology with ecological and human-centric principles. Biomimicry inspires sustainable, adaptive designs by emulating natures' strategies, while parametric design expands possibilities with precision and complexity. However, these tools enhance creativity but cannot replace the architect's role in shaping spaces with cultural sensitivity, institution, and meaning. Architectural education must adapt, balancing technical proficiency with critical thinking and contextual understanding. Ultimately, architecture must remain a human endeavour. While technology drives innovation, the architect's role in addressing emotional and cultural needs ensures spaces resonate on a deeper level. By combining technological advancements with empathy and sustainability, the discipline can shape a future where architecture is both innovative and profoundly human".

The Protagonist, after nature

Architect Mohnish Siripurapu, the founder of the studio advises young learners and architects to observe nature closely. He says it is the ultimate design manual, which offers solutions perfected over billions of years, and yet they keep evolving. From the self-cooling mechanisms of termite mounds to the structural efficiency of a honeycomb, every natural system holds a lesson in resilience efficiency and adaptability. Take time to study ecosystems, materials and processes to uncover the underlying principles that make these systems thrive. He also suggests that at the same time, it should be helpful if we master digital tools early. Parametric design software like rhino and grasshopper allow us to translate the complexity of nature into scalable, functional designs with precision. These tools enable iterative workflows, where we can tweak and test designs efficiently, avoiding the manual repetition that can stifle creativity. Simulation software helps predict performance metrics such as energy efficiency, structural stability and acoustic behaviour, ensuring our biomimetic concepts work seamlessly in real - world conditions. Ultimately, digital tools don't just simplify the process, they amplify our capacity to innovate.

Personal journey and experiences play a vital role in shaping how a designer approaches various ideas and processes. Role models, buildings and incidents shape the way we think and have a great influence on our design decisions. Similar is with "The Dumbledore" of Ant studio: Mohnish Siripurapu.

When Monish began his practice, he envisioned it as a space for unrestrained experimentation—beyond the boundaries of architecture alone. From a young age, his aptitude for math and coding set the foundation for his analytical approach, and during his bachelor's studies, he was captivated by the innovative forms emerging in the West. For him, architecture became a means to push the boundaries of imagination and craft transformative spaces. In his initial years, form-finding was at the core of his work. He relished exploring spatial experiences and challenging conventional design norms, treating architecture as a mathematical and computational puzzle. One of the first masters to profoundly influence him was Santiago Calatrava, whose work he found poetic. He admired the harmony of sculptural forms, structural ingenuity, and movement in Calatrava's projects, which resonated deeply with his architectural pursuits. His understanding of architecture expanded further with Antonio Gaudi's work. Gaudi's unique approach profoundly impacted Monish, reshaping his understanding of organic forms and the seamless integration of nature into architecture.

In 2015, he pursued a postgraduate diploma in Spain, immersing himself in the land that nurtured both Gaudi and Calatrava. This experience allowed him to explore their projects firsthand, solidifying their influence on his evolving design philosophy. Geoffrey Bawa became another defining figure in his journey. During a transformative trip to Sri Lanka, he experienced Bawa's projects, which masterfully brought nature into built environments and celebrated unbuilt spaces. The harmony of architecture and landscape, along with the beauty of in-between spaces, deeply resonated with him and reshaped his perspective on design. For Monish, Calatrava, Gaudi, and Bawa represent three architects from different generations who redefined architecture through their distinct interpretations of nature. They taught him to see beyond forms, appreciate the value of the unbuilt, and find meaning in the spaces that exist in between. These lessons continue to inspire his work, blending imagination, structure, and nature in pursuit of extraordinary architectural experiences.

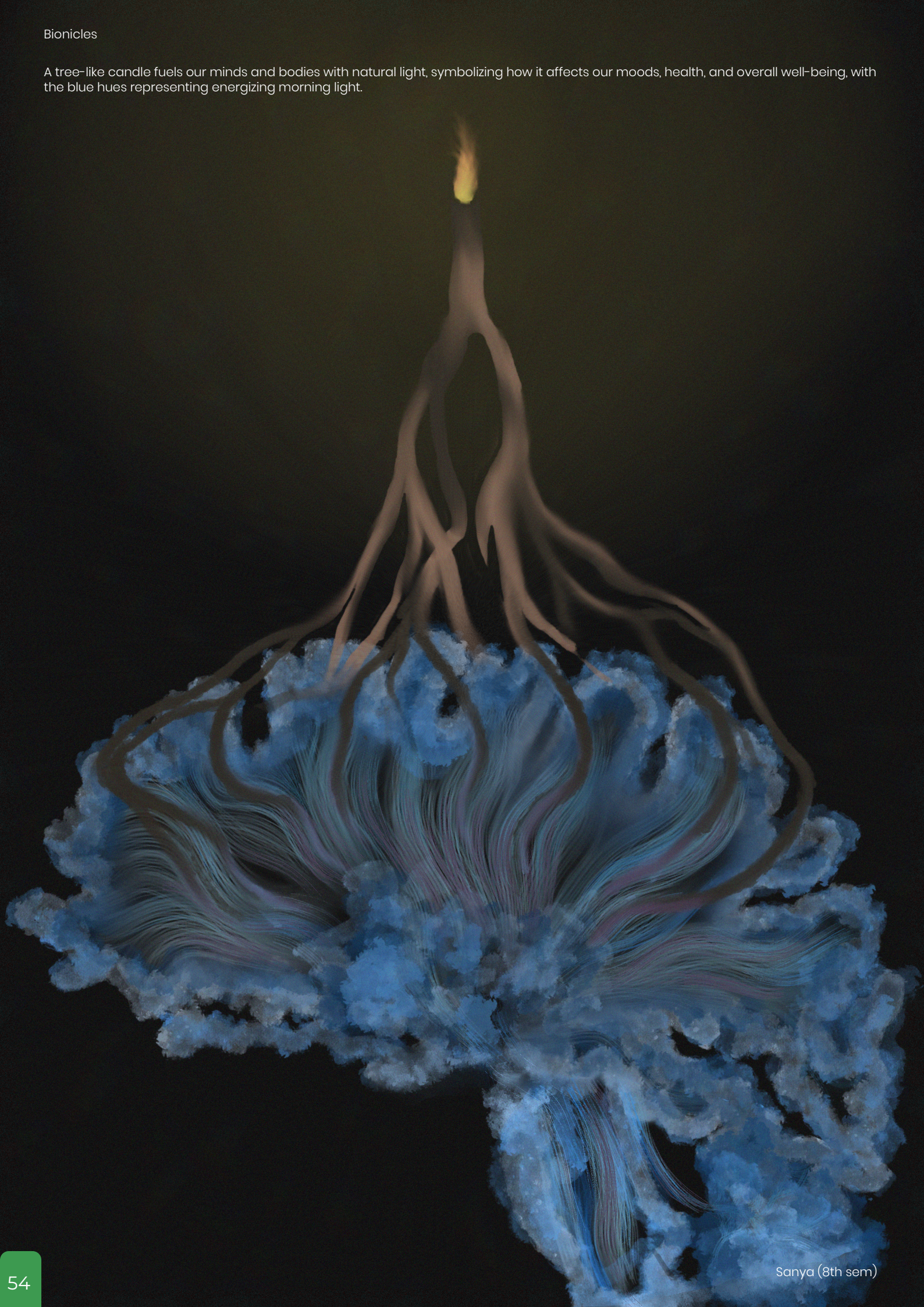
Mohnish Siripurapu

Monish Siripurapu is an Architect and 'Antrepreneur', founder of Ant Studio, an innovative architectural practice dwelling in the intersection of Art, Nature and Technology, part of AD100 2024 and carving its name with experiments in the field of sustainability and computational design technology. He is also the founder of CoolAnt, a sustainability think tank innovating Climate-Responsive Building Envelopes through nature-based energy efficient cooling solutions.

CoolAnt has received national and international recognition for its work. The startup's pitch was recently aired on season 3 of Shark Tank India. Their low-carbon cooling systems have won them the National Energy Efficiency Innovation Award (NEEIA), by the Bureau of Energy Efficiency (BEE), felicitated by President Droupadi Murmu in 2023. CoolAnt has also won the Asia Pacific Low Carbon Footprint Challenge, the Clean Energy Challenge by 'What Design Can Do', and was funded by the UN Environment Programme (UNEP).

Monish is a TEDx speaker and has also presented his work at the TMK knowledge forum at the G20 summit at Bali, Science Museum London, Google's Anthropocene, UCL Bartlett, CEDIM Mexico, IAAC Barcelona, Construction symposium Ekaterinburg in Russia etc. amongst others. His team has presented their Research in conferences like UIA Copenhagen, CATE and ENERGISE. He was a keynote speaker at the World Environment Day New Delhi, 2018 and has also lectured and exhibited his work in various IIT's and IIM's in the country. His works have been published across well renowned platforms such as History Channel, CNN, World Economic Forum, Architectural Digest, Inhabitat, and ArchDaily.

A tree-like candle fuels our minds and bodies with natural light, symbolizing how it affects our moods, health, and overall well-being, with the blue hues representing energizing morning light.



Sanya (8th sem)

08 Earth Inspires: Art of Elemental Lighting

Interview with: Shailesh Rajput

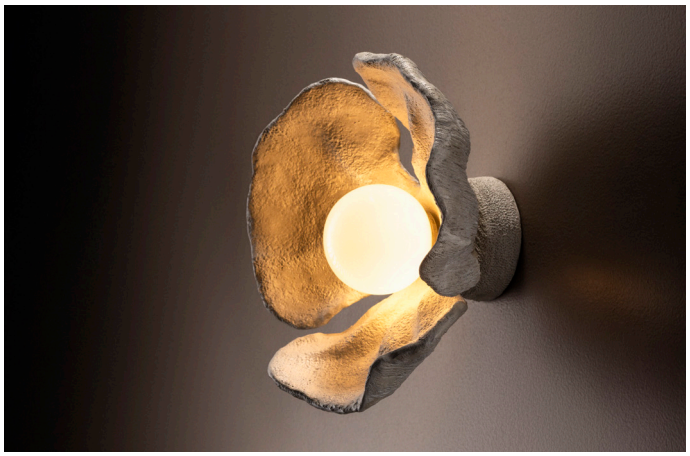
Kalpa, Vol.05, 2024, pp. 55-57

Source : Author

Shailesh Rajput studio, a product design firm based in Mumbai, redefines the field of product design through a fresh perspective. The studio explores lighting design in particular while drawing inspiration from nature and its vast spectrum of colors, textures and forms. Their meticulously crafted pieces enhance the aesthetics of a space by integrating nature and its elements. This unique approach aligns with Kalpa's commitment this season to promote the awareness of biomimicry. Team Kalpa's interview delved into the studio's philosophies, sources of inspiration and design techniques, seeking to uncover the essence of their work and what sets them apart.

Nature is man's best inspiration. Its forms, colours, textures and details carry not only an aesthetic value but also a story to tell. Shailesh Rajput Studio, a product design brand, based in Mumbai is significantly inspired by nature and is dedicated to crafting exquisite lighting products that are an elaborate description of nature.

With a philosophy strongly rooted in bio morphism the brand is an embodiment of the beauty and essence of nature.
The brand's products are as picturesque as nature itself which adds soul and meaning to every crafted piece, making them a living object and not mere products.



Source : Author

Their design thinking takes inspiration particularly from nature's aesthetics, skin textures and the overall form of an animal.



Source : Author

Nature is an endless journey in itself, and since there's a vast variety in nature just to be inspired from, their ideas are streamlined and then pondered upon using the Panch Bhutas (five elements) of nature – Earth, Water, Fire, Air and Spirit. These elements are then approached singularly depending on the choice of element.

"If the approach is water for example, then we go underwater and anything that is around water is observed and researched about.Every tiny influence in and around the region is studied which helps us assess the different aspects of the said element, which is then used in design thinking."

The brand works elaborately with textures and materials. Mother of Pearl or Nacre for example with its attractive colour and texture is used in their products which is believed to enhance the connection with nature. Another example of material and texture depiction in their products is of tree branches and twigs. Real branches and twigs are picked and cast which is then used in designing of the light fixture. This unique design style and approach is what makes their products elegant and rare.

Every design comes with its challenges, and the brand believes that the solution lies deep within the design itself; all it takes is some digging in:the problem and its design solution.


Source : Author

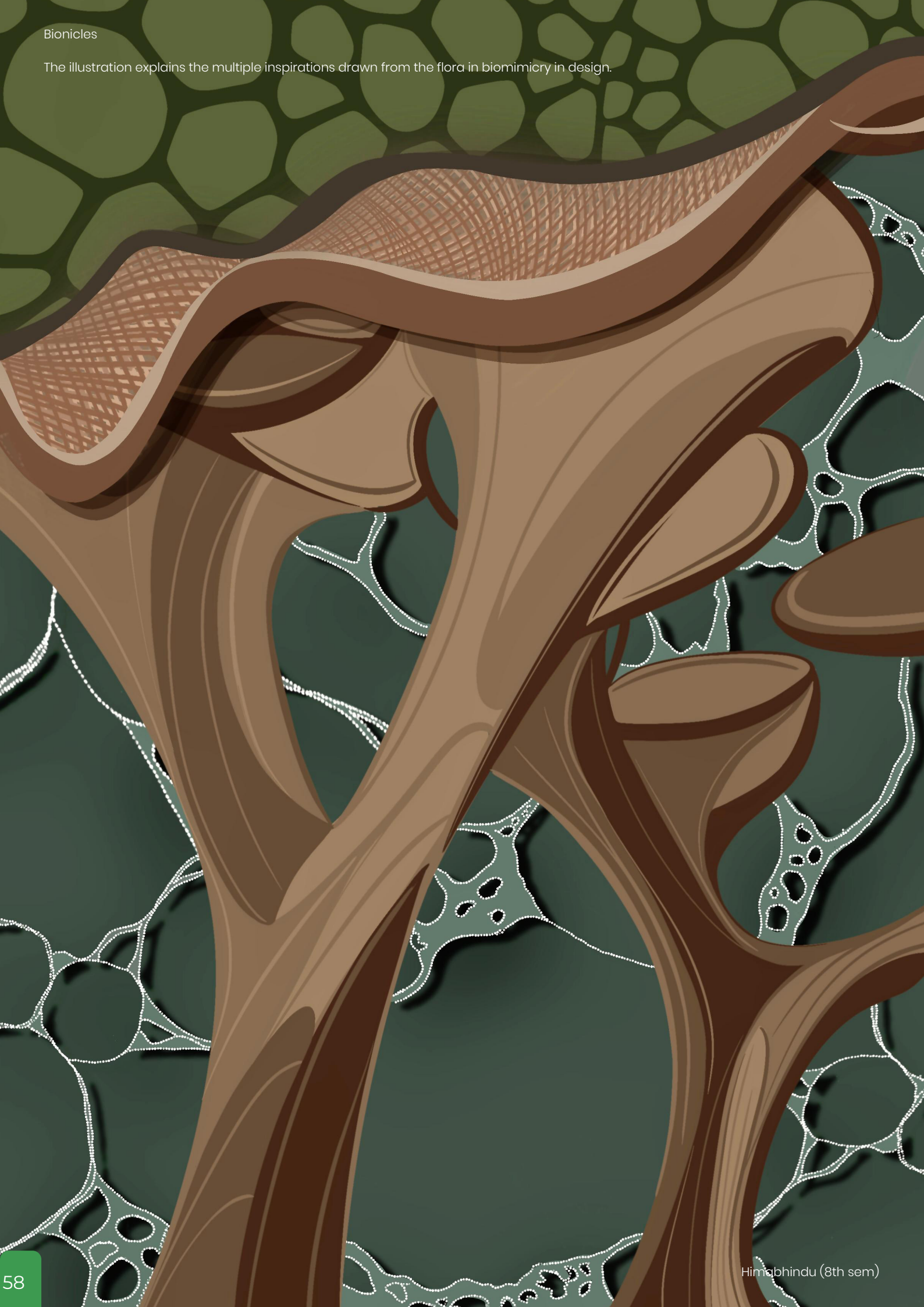
Hence, all one needs to do is to "look at nature, look into nature and then portray nature". One's inspiration, concept, approach, challenge and solution, all lie in nature alone, one needs to delve into it.

Shailesh Rajput

Shailesh Rajput Studio is a product design brand that prides itself on creating handcrafted high-end lifestyle products inspired by Nature.
This Mumbai based Studio of the duo Shailesh and Mansi believes in the merit and beauty of hand crafted products and advocate the same through all their designs.
Our philosophy is to create objects that have life not just lifeless products.
We are not a trend driven practice as the trends live short, our effort is to create timeless pieces that has an emotion. The function we try to cater to is the emotional need of the being, we believe that the function of the light is not just help you see things but to elevate the experiential factor also. Thus we try to create sculptural light that has life and 'Life always is a blend of beauty and function.'

Bionicles

The illustration explains the multiple inspirations drawn from the flora in biomimicry in design.



Himabhindu (8th sem)

09

Biomimicry: Bridging Nature and Innovation

ARTICLE by: Geetanjali D , Rajat N Joshi

Kalpa, Vol.05, 2024, pp.59- 62

Abstract : Biomimicry is an innovative approach the draws inspiration from nature's principles and processes to help humanity develop sustainable and efficient designs. Biomimicry focuses on learning from nature rather than exploiting it. Its core principles involve viewing nature as a model, measure and mentor.
The article delves into biomimicry which was taken up as an elective by the 7th semester students that reflected these principles. It explores the principles and purpose of biomimicry altogether. The course involved combining theoretical learning with practical application. Each student's creativity was encouraged and explored via case studies and design projects. Students uncovered notable examples of biomimicry as case studies including, the kingfisher inspired Shinkansen train, Velcro modeled based on burdock seeds and many more.
One of the highlights of the course was an aromatic diffuser inspired by the functioning of a dandelion that inspired students to design their own biomimetic projects. Students eventually designed quite intriguing projects themselves that encompassed all of their learning, principles, research and
understanding about the field. As the course progressed, students also explored how biomimicry can influence architecture and urban planning while understanding the various challenges it poses. Despite its challenges biomimicry holds promise for addressing global environmental concerns and the article summarizes how students arrived at this exact conclusion.

Nature, with its vast diversity and complexity, has spent billions of years refining its designs through the process of evolution. The practice of biomimicry harnesses these natural strategies, adapting them to solve human challenges. In essence, biomimicry is an approach to innovation that seeks sustainable solutions by emulating nature's time-tested patterns and strategies. The term comes from the Greek words "bios," meaning life, and "mimesis," meaning to imitate. Biomimicry isn't just about copying nature's forms but understanding and applying the underlying principles and processes to human designs.
The 7th-semester elective course on biomimicry delved deep into this concept, offering a blend of theory and hands-on activities. The class allowed us to explore the principles of biomimicry, analyze case studies, and even create our own product designs inspired by natural organisms. Further explorations included the foundational ideas of biomimicry, examining examples of its application, and sharing insights from our classroom activities, including the design of an aromatic diffuser inspired by the dandelion.

The Core Principles of Biomimicry

Biomimicry is grounded in three main principles:
1. Nature as Model: This involves studying and emulating natural forms, processes, and ecosystems to solve human problems. Instead of reinventing the wheel, we look at how nature has already addressed similar issues.
2. Nature as Measure: Biomimicry evaluates human designs based on nature's principles of sustainability. By adhering to life's principles, we can create products, processes, and systems that are more efficient and resilient.

3. Nature as Mentor: Rather than exploiting nature, biomimicry encourages us to respect and learn from it. It shifts our approach from what we can extract from the natural world to what we can learn from it.

Biomimicry in Action: Case Studies

The course introduced a few important examples to highlight some well-known innovations in this discipline.
1. The Shinkansen Bullet Train (Japan): The engineers behind Japan's Shinkansen Bullet Train faced a significant challenge: the train generated a loud boom when it exited tunnels, due to air pressure changes. The lead engineer, a birdwatcher, noticed that the kingfisher bird could dive into water with barely a splash. He modeled the train's nose after the kingfisher's beak, resulting in a quieter, more aerodynamic train that consumed less energy.
2. Velcro: One of the most famous examples of biomimicry, Velcro was inspired by burdock seeds that stick to animal fur. In 1941, Swiss engineer George de Mestral observed how these seeds clung to his dog's fur during a walk. By mimicking the tiny hooks found on the seeds, he invented Velcro, a fastener used worldwide.
3. The Lotus Effect: The lotus plant's leaves are known for their self-cleaning properties, thanks to microscopic structures that repel water and dirt. This phenomenon inspired the creation of self-cleaning surfaces, such as paints and glass coatings, reducing the need for chemical cleaning agents.
These case studies illustrate how biomimicry can lead to innovative solutions that are efficient, sustainable, and environmentally friendly.

Exploring Biomimicry in Design Thinking

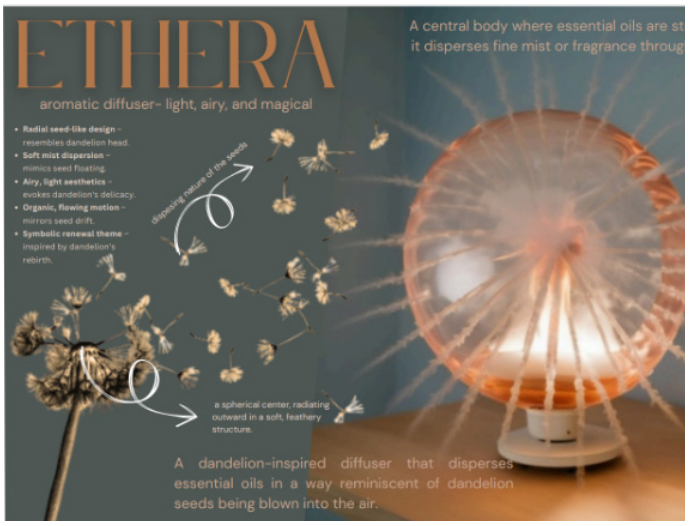
The course included an investigation into case studies on products or systems inspired by specific plants or animals. Each group was assigned an organism, and the challenge was to understand its unique characteristics and think of a practical application. Let us demonstrate examples below:

The Aromatic Diffuser Inspired by the Dandelion

One of the products designed during the course was an aromatic diffuser inspired by the dandelion: known for its ability to disperse seeds efficiently over a wide area, became a source of inspiration. The design process unfolded through:
Observation:
The dandelion's spherical seed head is made up of numerous tiny seeds attached to fine, hair-like structures called pappi. These pappi act like tiny parachutes, allowing the seeds to be carried by

Biomimetic Application:

Inspired by this dispersal mechanism, the diffuser was designed to replicate the way dandelions release their seeds. The diffuser's structure mimics the spherical shape of the dandelion seed head. The aromatic oil is stored in a central reservoir, and the fragrance is dispersed through thin, hair-like structures radiating outward. As air passes through, it picks up the scent and disperses it into the surrounding environment, much like how the wind carries dandelion seeds. This design not only enhances the diffusion process but also creates a visually striking product that embodies the elegance of nature.



Source : Author

Outcome:

The final product was a minimalist yet efficient diffuser that required no electricity. It used the natural airflow in the room to spread the aroma, making it an eco-friendly and sustainable choice for home fragrance.

Source : Author

The Adaptive Fabric Inspired by Octopus Skin

Observation:
An innovative product developed during the course is a dynamic, color-changing fabric inspired by the camouflage abilities of the day to mimic an octopus. These cephalopods can adjust their skin color and texture instantly, responding to different lighting conditions and surroundings to blend seamlessly.
Octopuses possess specialized skin cells called chromatophores that expand and contract to reveal various colors. Beneath these are light-reflecting iridophores and leucophores, allowing further color and light manipulation to match the environment throughout the day. Additionally,
small, muscle-controlled projections called papillae let octopuses alter their skin texture, changing from smooth to textured in one-fifth of a second to enhance their camouflage.

Biomimetic Application:

The adaptive fabric uses responsive pigments and light-sensitive cells within its fibers to alter color based on sunlight wavelengths, mimicking octopus skin. It also includes muscle-like units that inflate or deflate to change texture, imitating the octopus's papillae.
Research at Shanghai Jiao Tong University (SJTU) has been instrumental in advancing this concept, focusing on cephalopod-inspired camouflage materials. SJTU's team has developed synthetic chromatophores using thermochromic and photochromic materials which are embedded with nanoparticles that can reflect different wavelengths of light based on the environment, controlled by microfluidics and electroactive polymers to achieve color changes with minimal power. Embedded nanoparticles allow these cells to reflect specific light wavelengths, creating adaptable, thin, flexible fabrics.

Outcome:

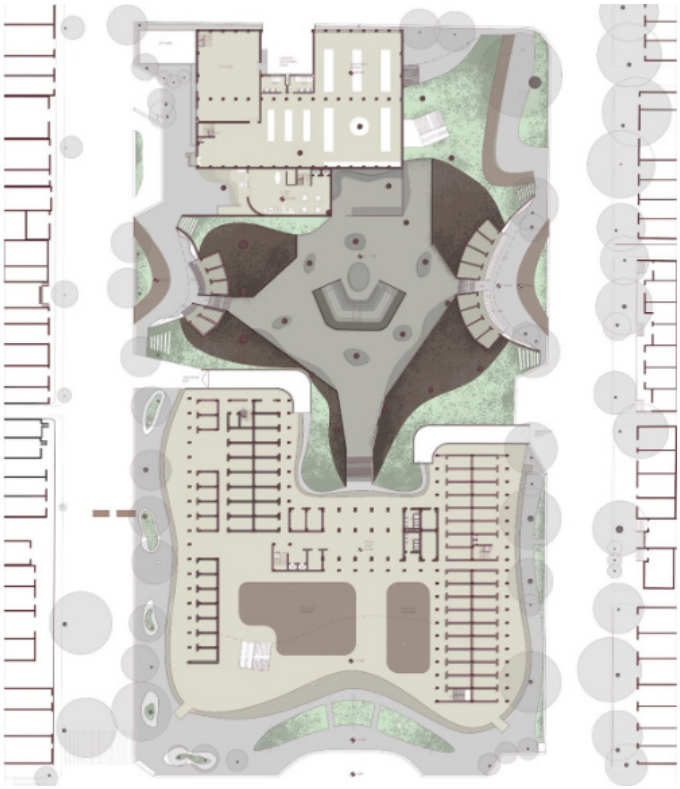
The final product is ideal for fashion, outdoor gear, and interiors, and outdoor pavilion structures responding naturally to changing light and requiring only sunlight and low electrical input for color and texture changes, making it a sustainable innovation.This innovative fabric requires minimal power, relying primarily on sunlight and subtle electrical stimulation.

Source : Author

Exploring Other Designs: Animal and Plant Inspirations

In addition to the aromatic diffuser, students created several other innovative designs inspired by different plants and animals:
1. The Kingfisher-Inspired Diving Suit
Taking inspiration from the kingfisher's streamlined beak, a diving suit was designed to reduce drag and enhance underwater speed. The suit featured a sleek, hydrodynamic design that mimicked the kingfisher's body, minimizing resistance as the diver moved through water. This design aimed to improve efficiency and speed for competitive swimming and underwater exploration.
2. The Gecko-Inspired Climbing Gear
Geckos can effortlessly scale vertical surfaces thanks to millions of microscopic hair-like structures called setae on their feet. These setae create *Van der Waals forces (1),* allowing geckos to adhere to surfaces without any adhesive substances. A group of students used this principle to design climbing gloves that mimicked the gecko's foot. The gloves had a textured surface with synthetic setae, enabling climbers to grip surfaces without relying on traditional equipment like hooks and ropes.

3. The Termite-Inspired Ventilation System
Termite mounds in African savannas are known for their efficient natural ventilation systems. Despite the external temperature fluctuations, the internal temperature of the mounds remains constant. This is achieved through a network of tunnels that regulate airflow. Inspired by this, a team of students designed a passive ventilation system for buildings. The system used a network of air channels, similar to termite mounds, to naturally regulate indoor temperatures, reducing the need for air conditioning and lowering energy consumption.
Nature's Wisdom in Architecture and Urban Design
The course further explored how biomimicry can influence architecture and urban planning. Buildings and cities can be designed to be more efficient, sustainable, and in harmony with their surroundings by emulating natural ecosystems.
For instance, in our own marketplace redevelopment project, we applied the concept of a layered urban ecosystem. By drawing inspiration from natural ecosystems, we created a multi-level design that accommodates various activities while maintaining a porous, breathable environment at the ground level. This approach reflects the way a forest functions, with different layers of vegetation, each fulfilling a unique ecological role.



Source : Author

Challenges and Future of Biomimicry

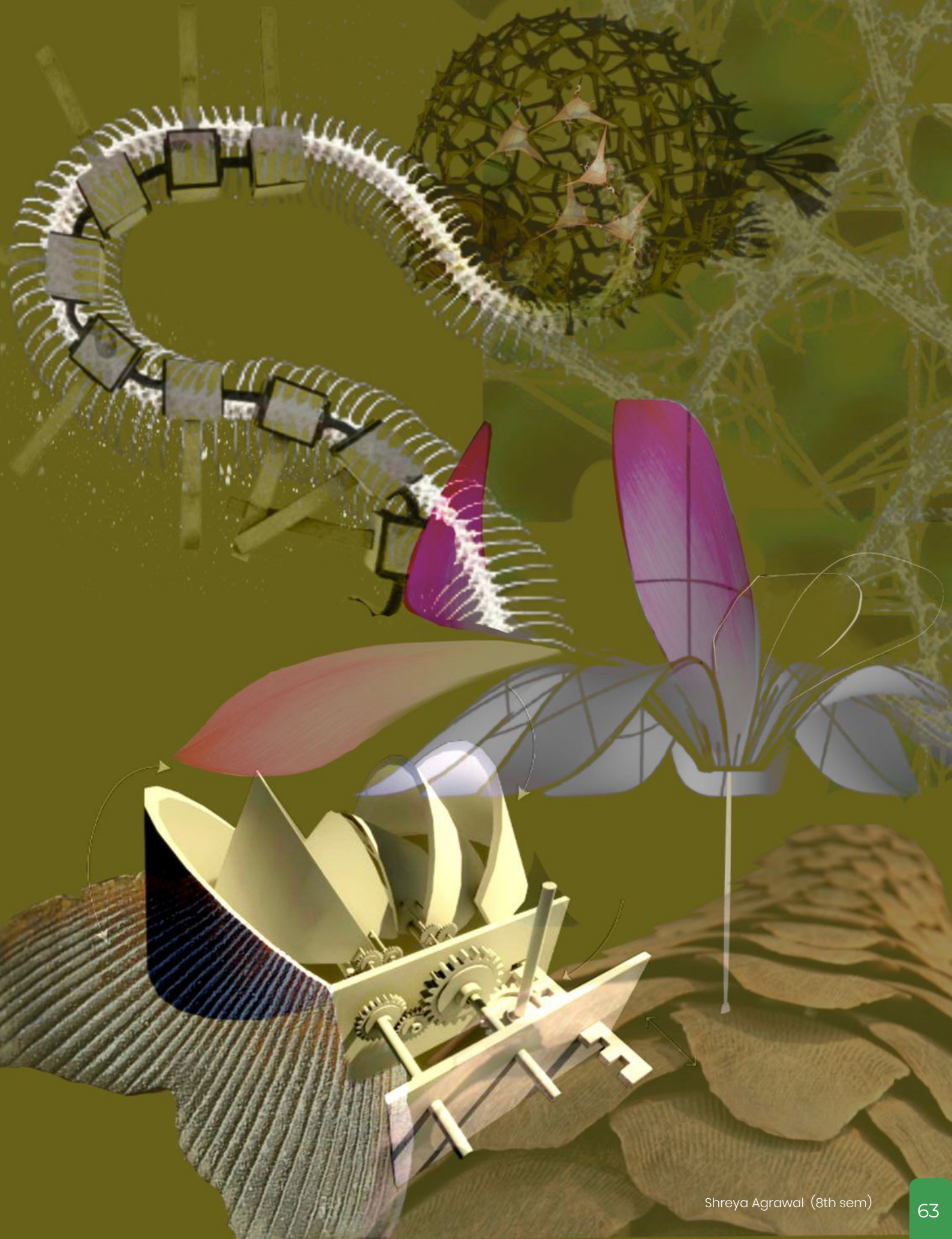
While biomimicry offers immense potential, it also faces certain challenges:
1. Understanding Nature's Complex Systems:
Nature's designs are often the result of millions of years of evolution, making them incredibly complex. Deciphering these intricate systems requires extensive research and a deep understanding of biological processes.
2. Translating Biological Principles to Human Design:
Adapting natural principles to human-made products is not always straightforward. It requires interdisciplinary collaboration between biologists, engineers, designers, and architects.
3. Balancing Aesthetics and Functionality:
While nature-inspired designs can be aesthetically pleasing, they must also meet functional and practical requirements. Achieving this balance can be challenging but is essential for the success of biomimetic products. Despite these challenges, the future of biomimicry is promising. As we face growing environmental concerns, there is an increasing need for sustainable and resilient solutions. Biomimicry offers a pathway to create designs that not only meet human needs but also work in harmony with the natural world.

The elective course gave us a unique opportunity to explore the intersection of nature, design, and technology. Through studying natural organisms and their adaptive strategies, we learned how to develop innovative solutions to real-world problems. The process of observing, analyzing, and applying nature's principles taught us to appreciate the elegance and efficiency of the natural world.

The design of an aromatic diffuser inspired by the dandelion was just one example of how we can harness nature's genius. It demonstrated that even the simplest natural mechanisms could inspire practical and sustainable designs. From diving suits inspired by kingfishers to climbing gloves modeled after gecko feet, our projects showed how biomimicry could lead to innovative, eco-friendly products. As we continue to face global challenges such as climate change, resource depletion, and environmental degradation, biomimicry provides a hopeful vision for the future. By learning from and emulating nature, we can create a world that is not only more.

1. The key mechanism behind a gecko's ability to stick to surfaces, where tiny hair-like structures on their feet called setae create extremely close contact with a surface

the illustration portrays the elements of nature which inspire mechanisms and models that can be integrated into the built environment. it creates a dialogue between movement, material and the resilience that link nature and design.



Shreya Agrawal (8th sem)

10 Nature's Imprint: Students exploration in Biomimicry

Interview with: Prof. Shashank Satish

Kalpa, Vol.05, 2024, pp.64-72

Abstract : In this interview with professor Shashank Satish from Wadiyar Centre for Architecture (WCFA) Mysore, we discuss teaching biomimicry in design through a structured, inquiry-driven methodology. He explains the approach taken by students and various resources that help during the process. Students focus on sustainability and functionality with the priority given to these two aspects. He also discusses how it bridges the gap of theoretical and practical knowledge, thus giving students a researched understanding of biomimicry to suit innovative design solutions that counteract ecological principles and contemporary architectural challenges.

This interview with Professor Shashank Satish from Wadiyar Centre For Architecture (WCFA), Mysore highlights his innovative pedagogy in the elective course of bio-inspired design. He elaborates on a structured approach that guides students through the exploration of bio-inspired concepts, emphasizing practical applications and sustainability. The course uses resources like Janine Benyus' works and asknature.org to guide students in exploring natural mechanisms for sustainable design solutions.

Focusing on hands-on learning, students create dynamic prototypes, integrating nature-inspired mechanisms into architectural projects and products. Examples include facades inspired by the Venus flower basket, adaptable designs based on snake skeletons, and air-filtration systems modeled after the Titan Arum. The course fosters experiential learning, aligns with sustainability goals, and inspires both students and faculty to explore the potential of biomimicry in architecture.

Q1: Reflecting on the structured exercises employed in your elective, could you provide a detailed explanation of your teaching approach and its intended outcomes?

The students are given a structured lens through which they explore literature and then use specific keywords to find examples of bio-inspired design from around the world. These examples could be recent or older ideas, but the focus is on viewing them through these lenses. This happens in the first month of the semester. Since this elective is primarily for students in their 7th semester, I provide an option for them to incorporate their own designs into the coursework.

At the end of the semester, they are required to design something. This criterion is clearly communicated before they select this elective over others, such as architectural journalism. I emphasize that this elective will have a design component and won't be purely theoretical. Once this expectation is set, during the first week and month, I ask them to identify different questions they're curious about. Until that point, I hold off on introducing them to Janine Benyus' work.

Q2: After students identify their questions, how do you guide them in refining and exploring these ideas further within the framework of the elective?

Once they come forward with at least three questions, I sit with them to discuss and break down these questions. After this, I introduce them to Janine Benyus' work. They use resources like asknature.org to explore how their questions are addressed in the natural world and develop ideas for their designs. Since this elective is in their 7th semester, they also have the option to align this work with their architectural design projects, which

often emphasize sustainability.
A significant portion of students—approximately 50-70% each semester—integrate their work in this elective with their architectural design projects. The AD (Architectural Design) faculty have responded positively, noting that the biomimicry details students create align well with sustainability criteria. For students who struggle to identify a passion project, I suggest working with the building's skin as a design problem. They explore mechanisms and processes from nature, using resources like asknature.org to emulate designs that meet their specific project requirements.

Q3: Could you elaborate on the progression of the semester and the phases that structure the learning process for students?

The last three months lead to the final prototype design. By the semester's end, students present dynamic prototypes inspired by natural processes. These prototypes need to demonstrate dynamism and explain the underlying process inspired by nature. Typically, these designs do not mimic nature visually but instead adapt natural mechanisms to specific design challenges, such as facade design, skylights, or biophilic products.
Some students even design products unrelated to their architectural projects, like pavilions or other prototypes. The methodology emphasizes exploring mechanisms rather than visual biomorphism. For example, some students design facades inspired by dynamic natural processes, while others create product designs that function independently of architectural applications.

Q4: Could you share a few notable student projects or outcomes, highlighting how students applied biomimicry principles to their designs?

Certainly. Here are a few examples:
***Facade Design Inspired by a Venus Flower Basket**: One student designed a prototype inspired by this underwater organism, which expands, contracts, and purifies water. The facade design aligns with their AD project, and the student also created a video or GIF as part of their final submission.*
***Dynamic Facade Using Silver Ant and Mimosa Pudica Mechanisms:** Another student fused mechanisms from the silver ant and Mimosa Pudica plant to create a facade that dynamically manages radiation and building cooling.*
***Air Filtering Inspired by Titan Arum**: A student explored the air-capturing and filtering capabilities of Titan Arum to create a detailed model for sustainable building design, incorporating layers for glazing and air filtration.*
***Origami Facade Design:** Inspired by the interlocking mechanisms of a powerful fish, one student developed a facade with dynamic, expandable, and contractible features.*
***Pavilion Design Inspired by a Snake's Spine:** Using the skeletal system of a snake, a student designed a pavilion that adapts and deploys into various forms.*

Q5: Could you tell us about the specific tools, resources, or methodologies that you incorporate into this elective to enhance the students' learning experience and support their design explorations?

The primary resource I recommend is Janine Benyus' website, asknature.org. While I don't focus heavily on theoretical tools like climate analysis (as students learn these in their AD studio), I complement their existing knowledge. Additionally, we invite experts like Prashant Dhawan, co-founder of Biomimicry India, for guest lectures. He shares insights into biomimicry practices in India, providing valuable exposure.
Each year, I update the resources with relevant readings, such as "Biomimicry in Architecture," and introduce students to works from institutions like MIT Media Lab, Michael Pollan's and Janine Benyus' works remain consistent foundational resources.

Q6: How does this elective impact students' conceptual understanding and practical approaches to their design processes, particularly in terms of integrating biomimicry principles into their designs?

The elective aims to instill a hands-on, experiential approach to learning. Students not only conceptualize ideas but also work on physical prototypes, diving into the physics, dynamics, and materiality of their designs. This process encourages

them to integrate biomimicry principles into their sustainability strategies in AD studio projects. While it's too early to measure real-world applications, the elective sows seeds for a deeper appreciation of nature's mechanisms.

In the first class, I challenge students to reflect on questions like, "What do you take for granted?" and "What does nature do best?" This shifts their perspective, encouraging them to observe everyday natural phenomena closely. For instance, an early assignment involves visiting the Mysore zoo to study a species, its behaviors, and environment, fostering a deeper understanding of biomimicry concepts.

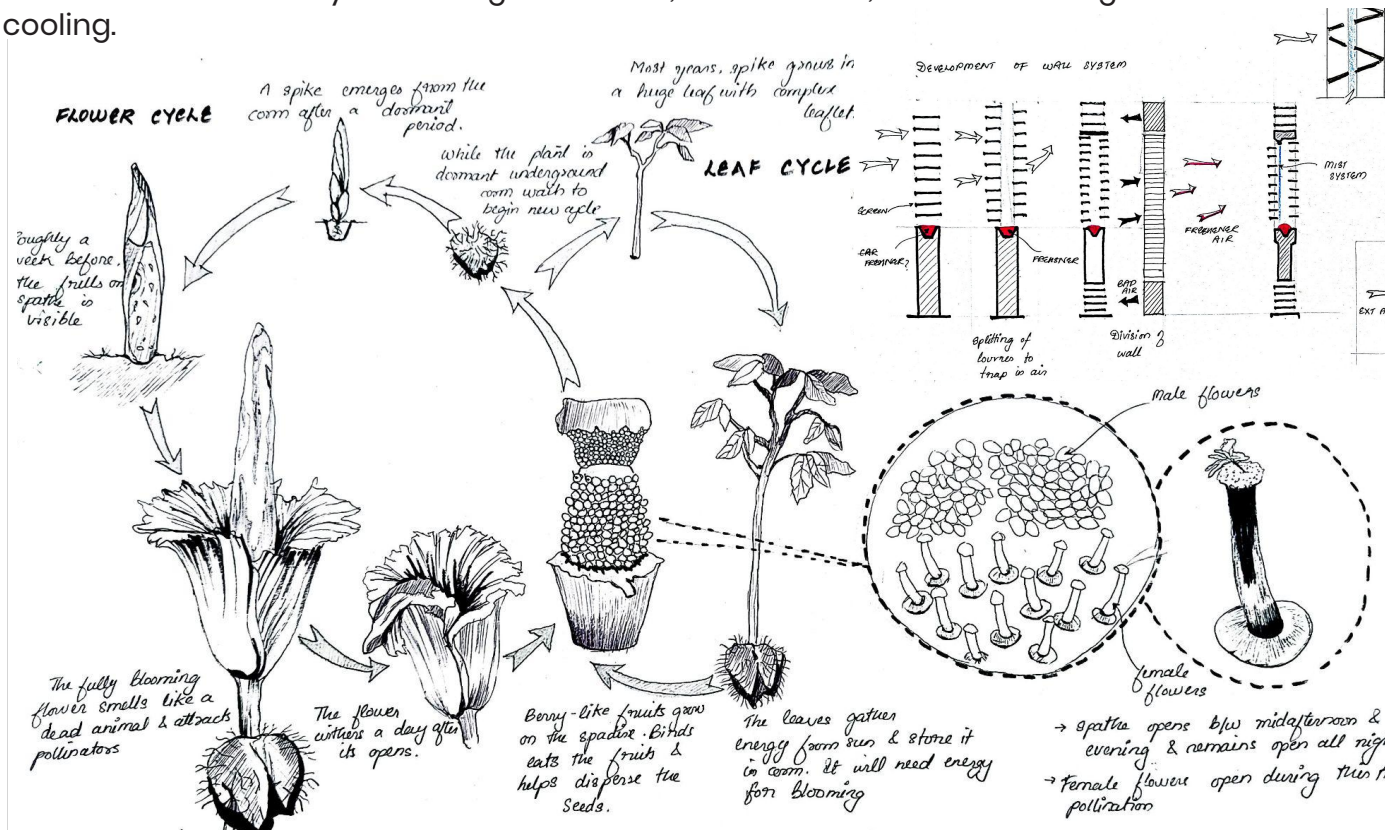
Q7: How do students respond to the integration of biomimicry principles into their work, and how do they perceive the connection between these ideas and their broader academic endeavors?

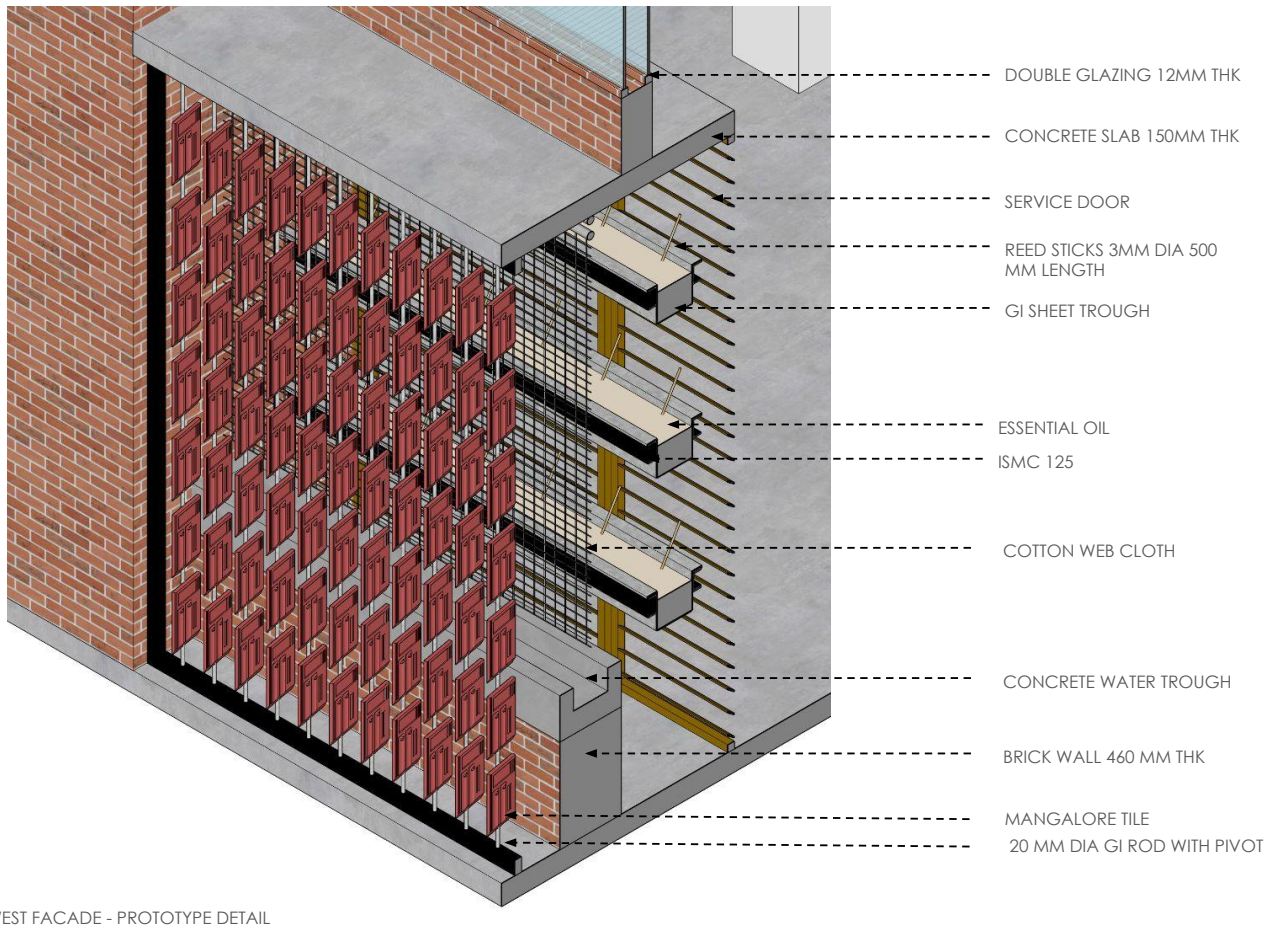
Absolutely. Many students and faculty in the AD studio are enthusiastic about how this elective complements their sustainability projects. It's rewarding to see students excited about translating these concepts into tangible designs, and it's a testament to the elective's success in bridging theoretical knowledge and practical application.

1. Titan Arum

Student Name: HariPrasad

Titan Arum examines the plant's bloom cycle, odor release, and structure, applying its principles to a breathable facade system using reed sticks, essential oils, and water troughs for ventilation and cooling.



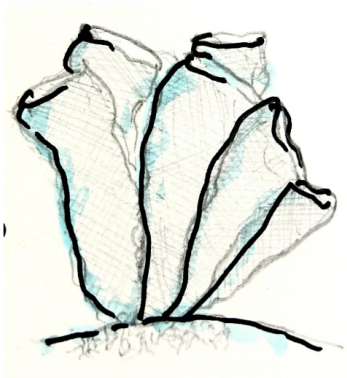


WEST FACADE - PROTOTYPE DETAIL

2. Venus Flower Basket

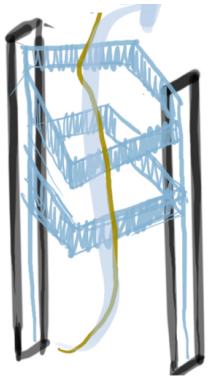
Student Name: Ruchi

Venus Flower Basket studies the deep-sea sponge's air and water channeling properties, translating them into a dynamic facade system with movable lattices and membranes for controlled light and airflow.

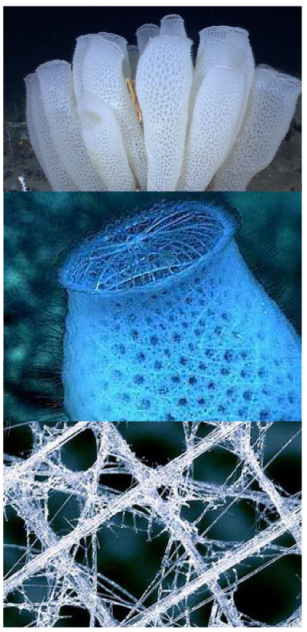


VIEW OF THE ORGANISM

CHANNELLING OF WATER

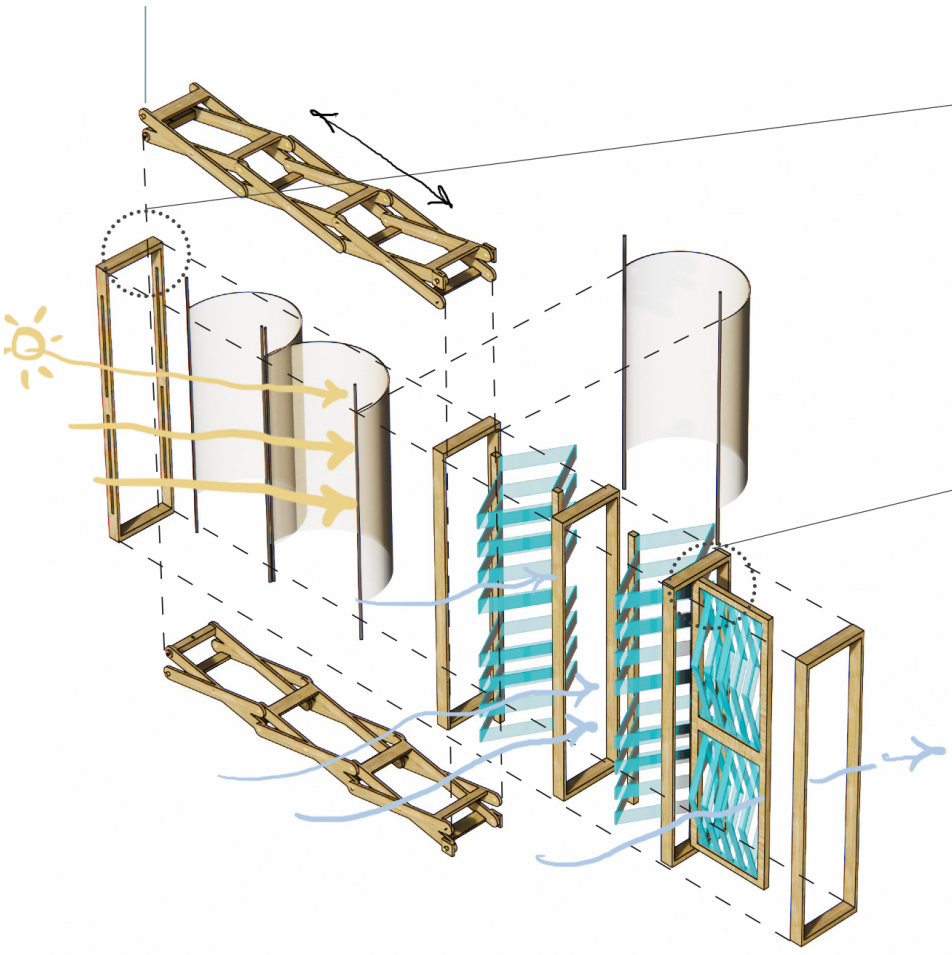


CHANNELLING OF AIR

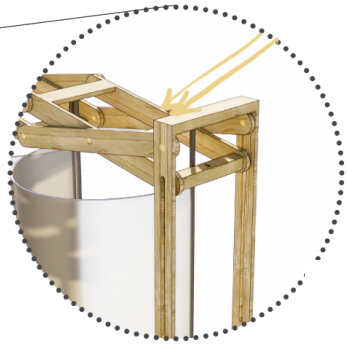


LATTICE MOVING IN A FRAME ATTACHED WITHA TRANSLUCENT MEMBRANE TO ALLOW LIGHT. AS IT MOVES / EXPANDS, IT ALLOWS MORE LIGHT AND AS IT CLOSES IT OPENS UP THE VENTILATION UNITS WHICH SUCK IN AIR DUE TO THE VOID CREATED. THERE ARE ALSO FIXED UNITS FOR CONSTANT AIR FLOW.

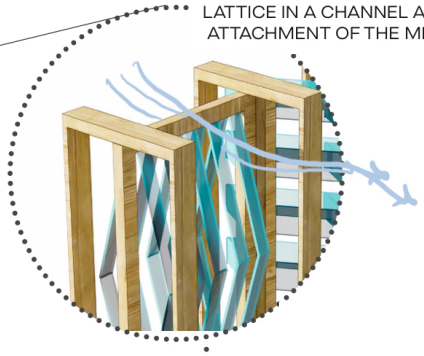
CONCEPTUAL SECTION THROUGH THE MEMBRANE.



EXPLODED ISOMETRIC VIEW OF THE MODULE



DETAIL SHOWING THE MOVEMENT OF LATTICE IN A CHANNEL AND THE ATTACHMENT OF THE MEMBRANE.



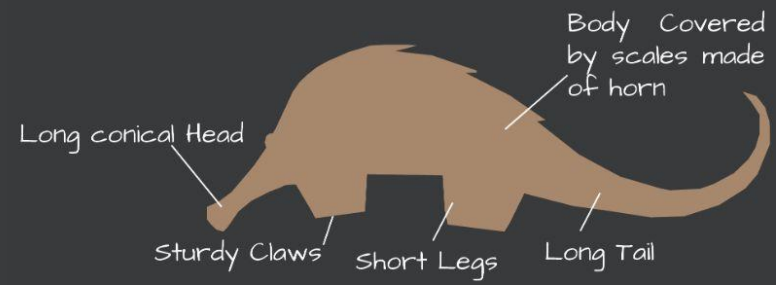
DETAIL SHOWING THE PRIMARY AND SECONDARY FRAME OF THE WIND LATTICE.

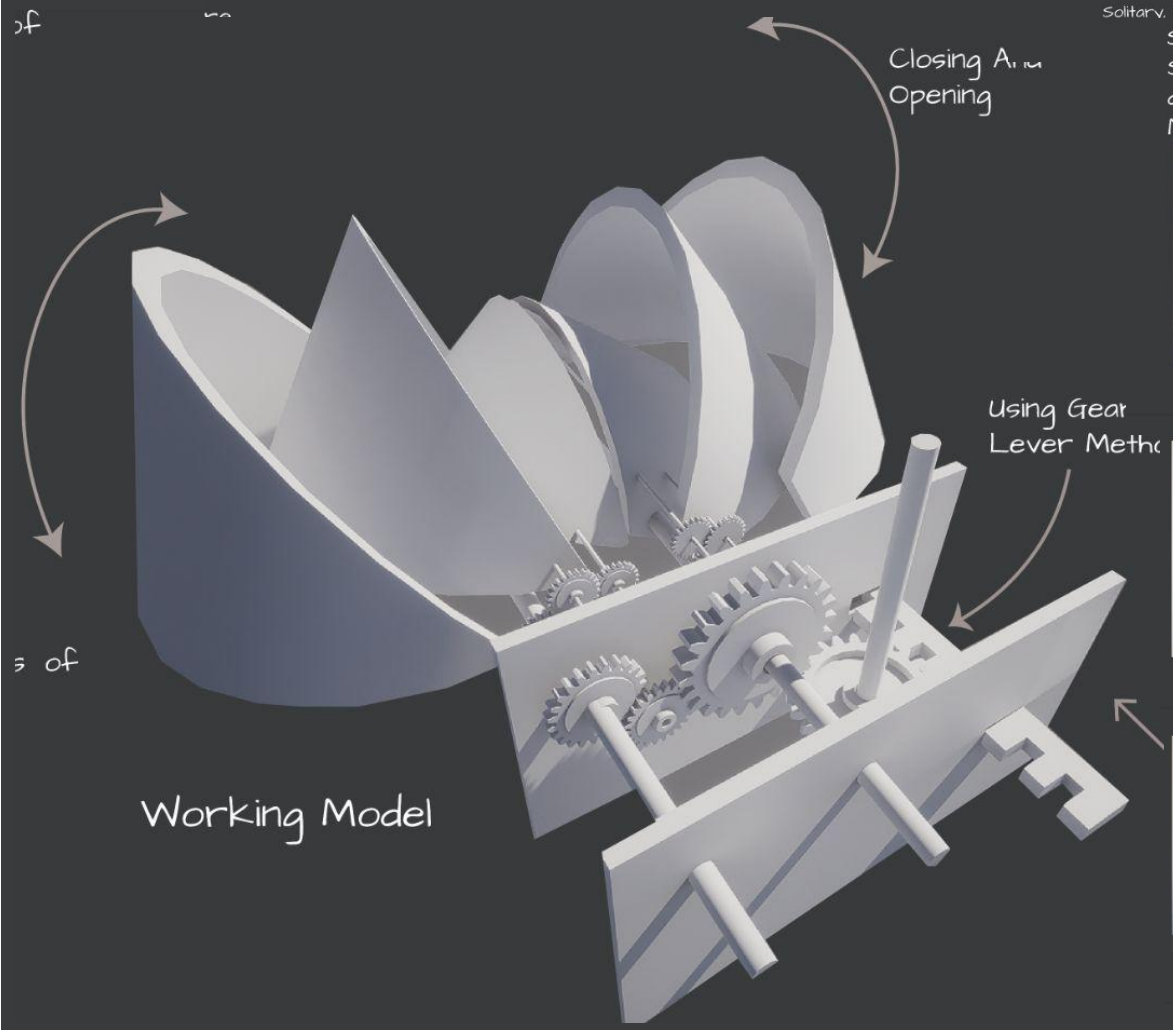
THESE LATTICES FORM MODULES OF A SKIN WHICH RESPONDS LIGHT AND WIND, BY ALTERNATIVELY CONTROLLING THE AMOU ENTERING IN.

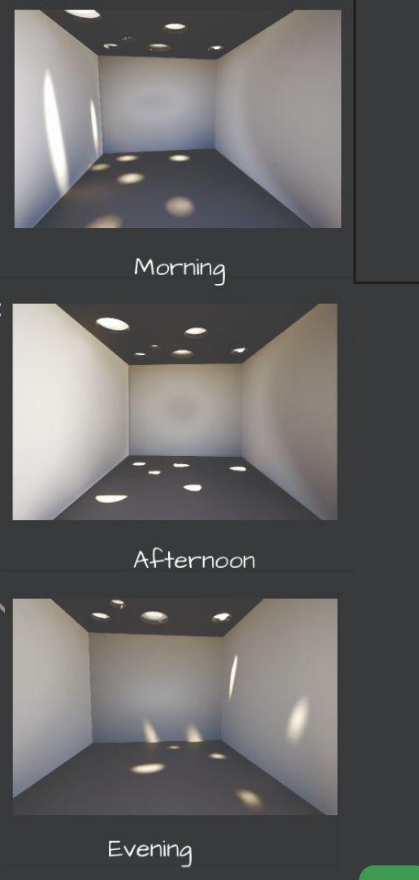
3. Pangolin

Student Name: Ujwal K

This design mimics the pangolin's protective scales, using a gear and lever mechanism to regulate openings for light and ventilation. Inspired by its adaptive behavior, the model adjusts sunlight patterns throughout the day, enhancing sustainability and efficiency in architecture.



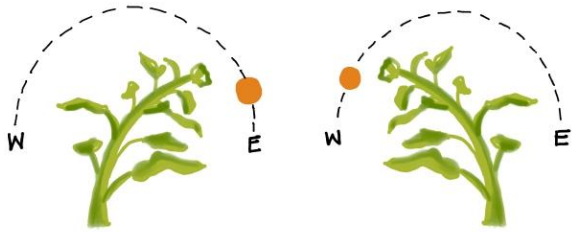


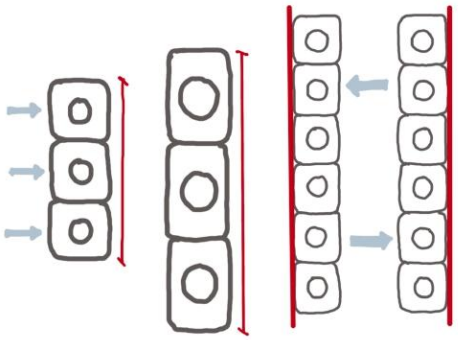


4. Sunflower

Student Name: Seeka J

Inspired by the sunflower's heliotropism, this modular kinetic facade adjusts sunlight and ventilation using folding aluminum panels. The panels dynamically open and close, enhancing passive cooling and energy efficiency.



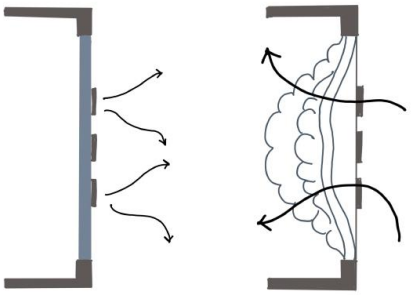


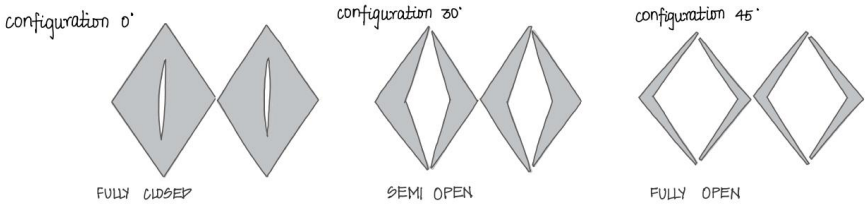
Movement of water reduces tugor pressure

The bending of the stem towards the sun is because of

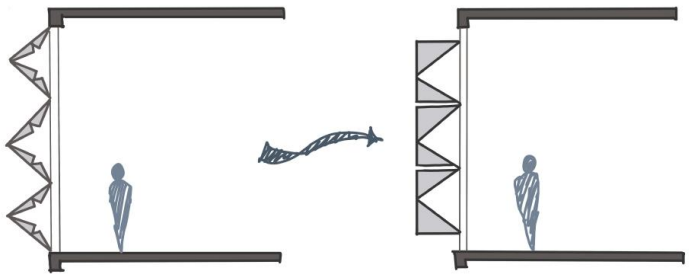
- TUGOR PRESSURE
- RESULTANT ELONGATION

↝ Applying external pressure to adapt a surface modularity





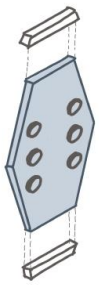
↝ control sunlight and enable natural ventilation



SCHEMATIC DIAGRAM SHOWING FACADE IN MOTION

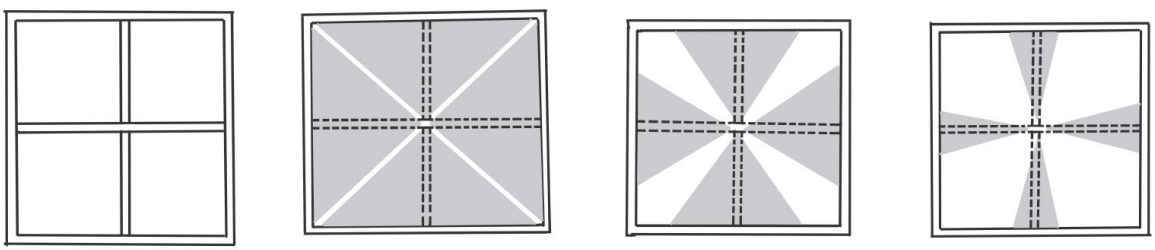
↝ The proposed kinetic facade is a modular system made of pre-fabricated modules with alluminium sheet for base frame.

↝ The mountain fold of the plates cuts direct sunlight



SINGLE MODULE OF THE FACADE

WORKING MECHANISM OF SINGULAR UNIT :

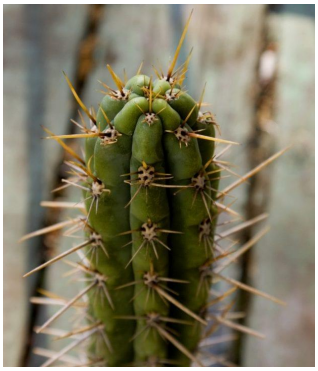


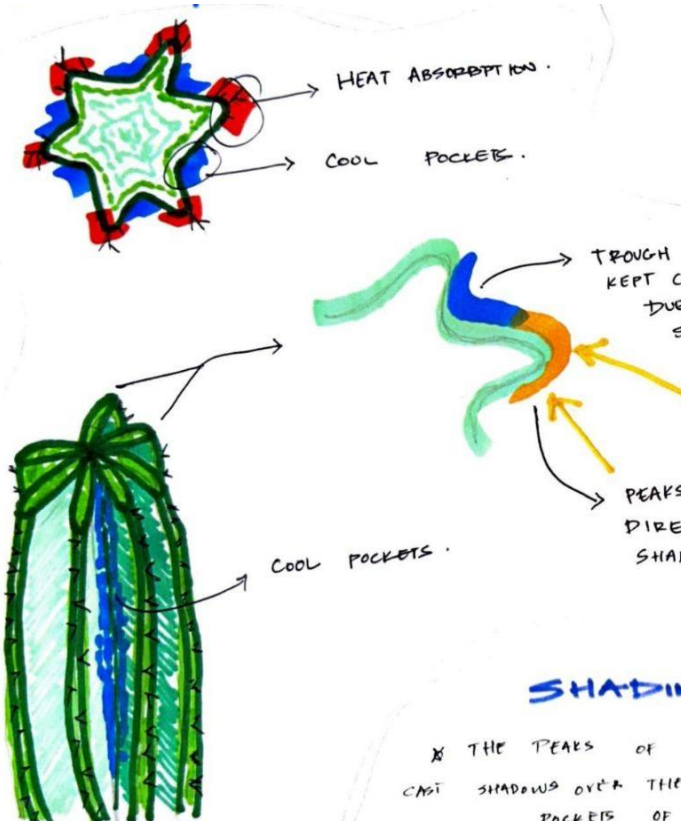
FRAMEWORK | FULLY CLOSED | SEMI CLOSED | FULLY OPEN

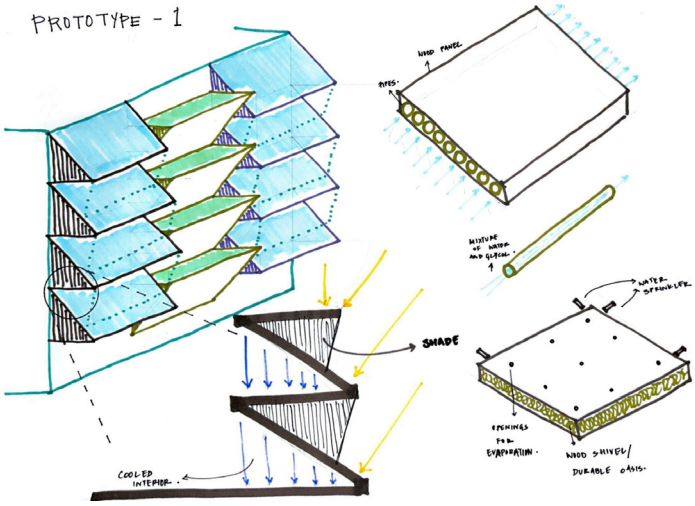
5. Cactus

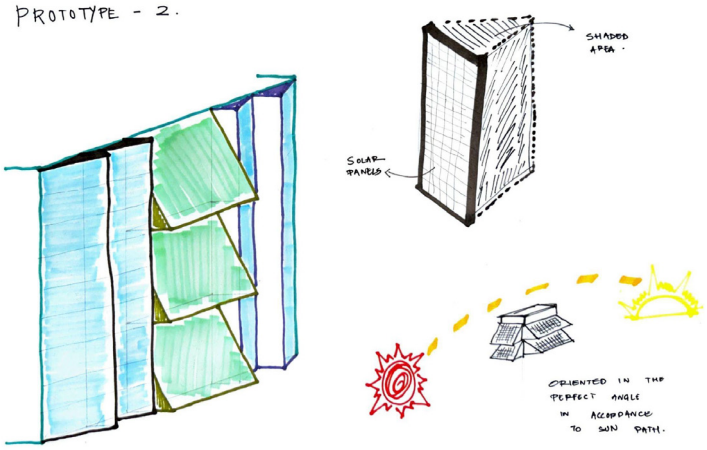
Student Name: Raheesh M

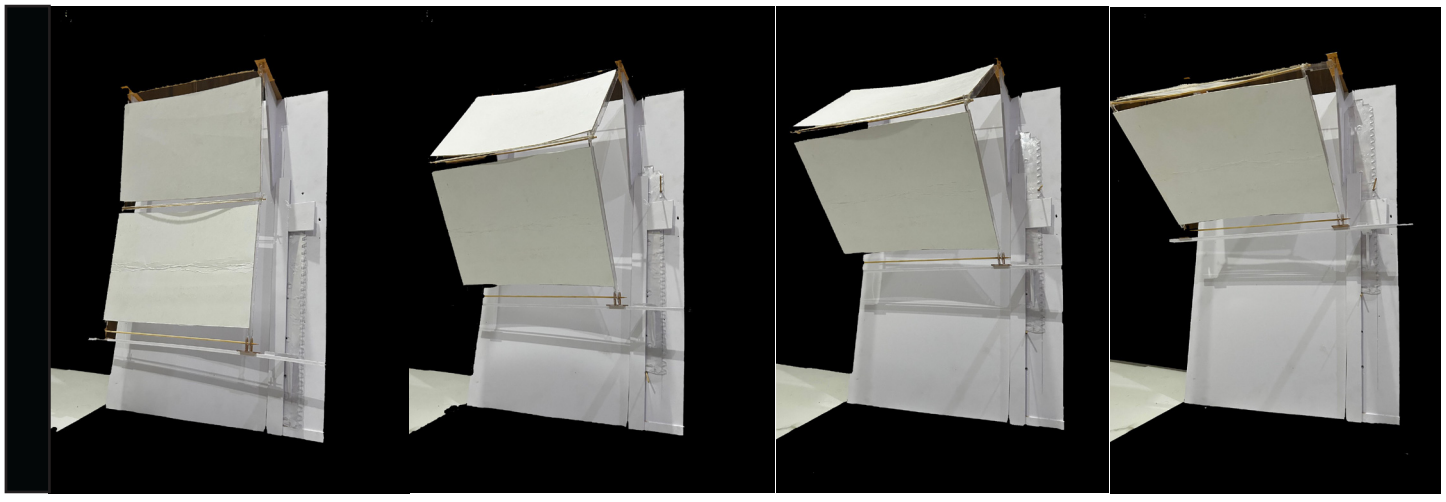
This design takes inspiration from the ribbed structure of cacti, where peaks provide shade to troughs, reducing heat absorption and keeping the plant cooler. The architectural model mimics this by incorporating angled panels or layered facades that create self-







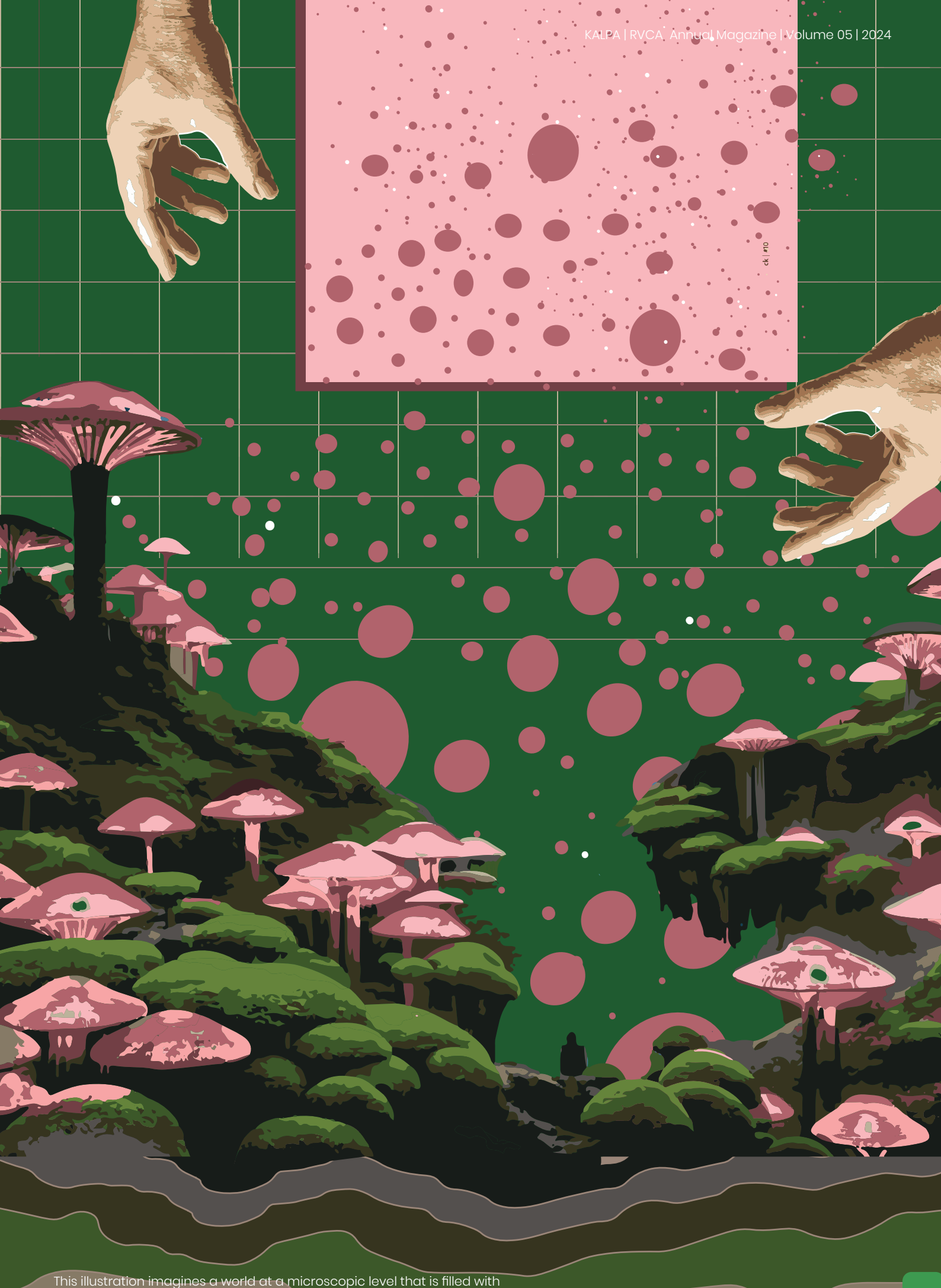




Shashank Satish

Shashank works at the intersection of Art-Science, Phenomenology, and Curation. He founded Holy Cow! Studio in Bangalore, where he engages in diverse graphic design projects, art grants, and creative collaborations. His work has been showcased at notable events such as the India Foundation for the Arts' Project 560 (2015), Serendipity Arts Festival (2016), and Walk-in Studios (2019). Shashank has also curated Indian and international artists and architects in exhibitions including Designuru (2016), Festival of Stories (2016), Rangoli Metro Art Centre (2017), and Chennai Photo Biennale (2019).

As the Principal Investigator of the Experiential Cognition Lab, established in 2017, Shashank explores the human experience between art and cognitive science. In 2019, he collaborated with scientists from the National Centre for Biological Sciences, Bengaluru, producing installations for the 'Lab Cultures' Art-Science exhibition. His podcast, 'Anubhava,' features conversations on Experience and Consciousness with leading thinkers and practitioners. With a background in architecture and a master's in Experimental Media Arts, his transdisciplinary research influences his teaching and artistic practice. He currently serves as a faculty member at the Wadiyar Centre for Architecture in Mysuru



This illustration imagines a world at a microscopic level that is filled with budding mushrooms in a cool environment.

Rahul H Nayak (8th sem)

11 Introducing Mushcool Panels

ARTICLE by: Team Arctic Air

Kalpa, Vol.05, 2024, pp.74-76

ABSTRACT: Today, the relentless surge of industrialization and urbanization across the globe, is accelerating climate change that brings humanity down to a critical juncture, one where sustainability seems to be the lone ray of hope. Without a doubt, the built environment and the materials employed play a huge role and thus a set of innovative students from RV College of Architecture, set out to foster sustainable solutions.

Solar Decathlon, a nationwide competition organized by The Indo-U.S. Science and Technology Forum (IUSSTF), the Alliance for an Energy Efficient Economy (AEEE), and The Indian Institute for Human Settlements (IIHS) is a challenge proposed to undergraduate and postgraduate students of India to explore net zero building concepts of which Residential Cooling Retrofit is a new sect that the students took part in. The participants are invited to propose real time projects with the aim of retrofitting a sustainable solution for the existing cooling systems.

As the Earth groans beneath the weight of climate change, our world stands at a precipice, a crossroad where sustainability is no longer a choice, but a necessity. In this moment of ecological urgency, a group of visionary students has embarked on a journey to transform bio-waste into a beacon of hope—the Mushcool panel. A harmonious blend of architecture, engineering, and design, this innovative solution seeks to redefine the very fabric of our interiors.

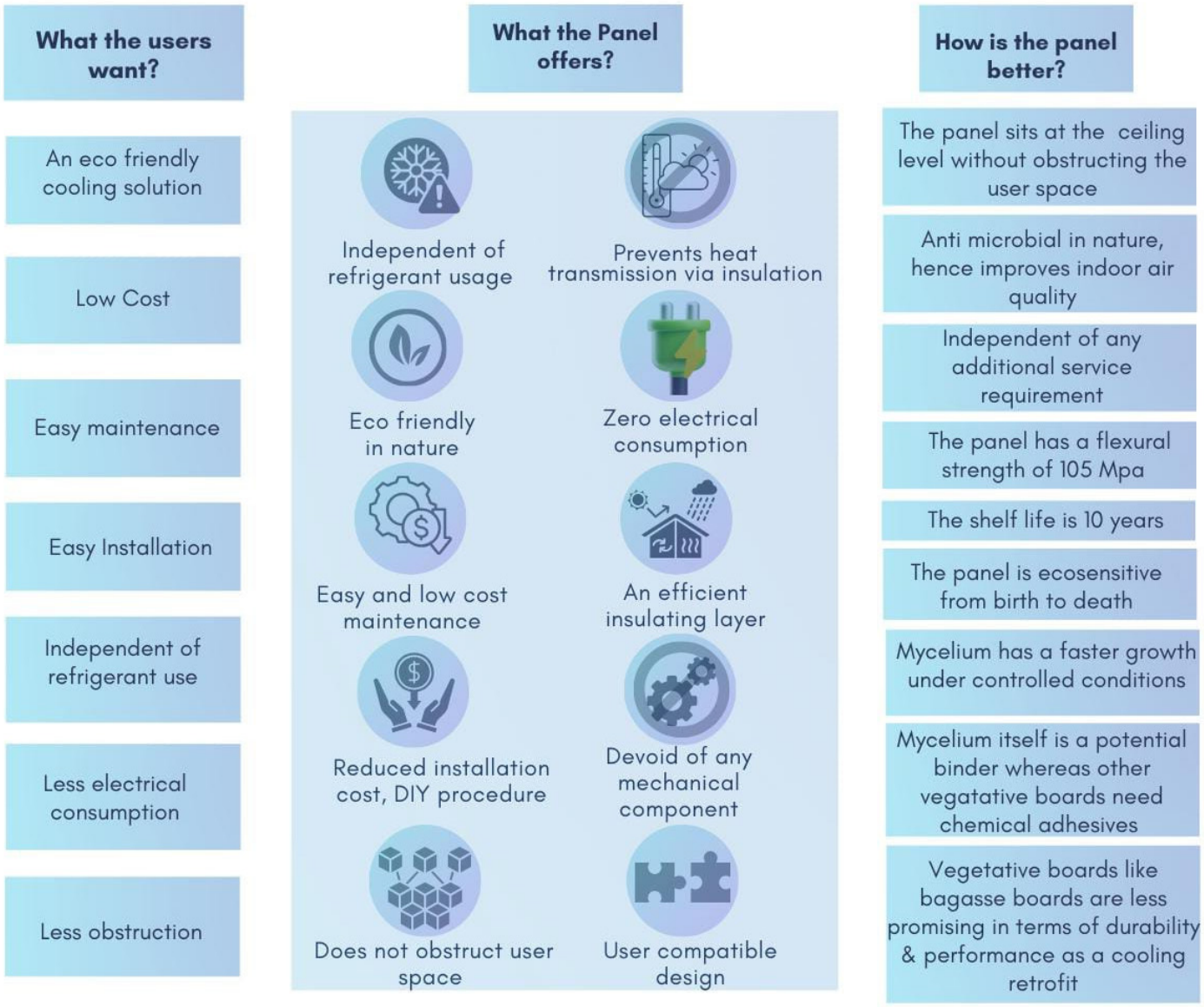
In today's world, where environmental concerns are paramount, the construction industry is under increasing pressure to adopt sustainable practices. One sect that has significant potential for improvement is energy consumption, particularly in relation to cooling systems. Traditional cooling methods often rely on harmful refrigerants and consume substantial amounts of energy. However, a new wave of innovative solutions is emerging that offers a rather sustainable and efficient approach.

This product is one such innovation that promises to revolutionize the cooling landscape. While the word "mushroom" conjures images of delectable vegetarian dishes, it's easy to overlook its potential as a revolutionary building material.

While mycelium has gained recognition as a sustainable packaging and construction material, its application as a natural cooling retrofit offers an intriguing prospect. Born from the humble oyster mushroom, sugarcane bagasse, and sawdust, the mycelium panel is a testament to the power of nature's ingenuity.

The panel is also a testament to human ingenuity which offers a modular design that seamlessly integrates into existing structures, providing homeowners with a practical and accessible solution. Its remarkable ability to significantly reduce daytime heat gain offers a tangible respite from the scorching sun, creating a cooler and more comfortable living environment.

Beyond its functional benefits, the mycelium panel drives for a positive change:
This product provides a comprehensive solution that addresses multiple environmental concerns. By significantly reducing overall heat in the affected space, it helps to lower energy consumption and reduce the carbon footprint of buildings. Additionally, its ease of maintenance and biodegradable nature contribute to a more sustainable and environmentally friendly product lifecycle.



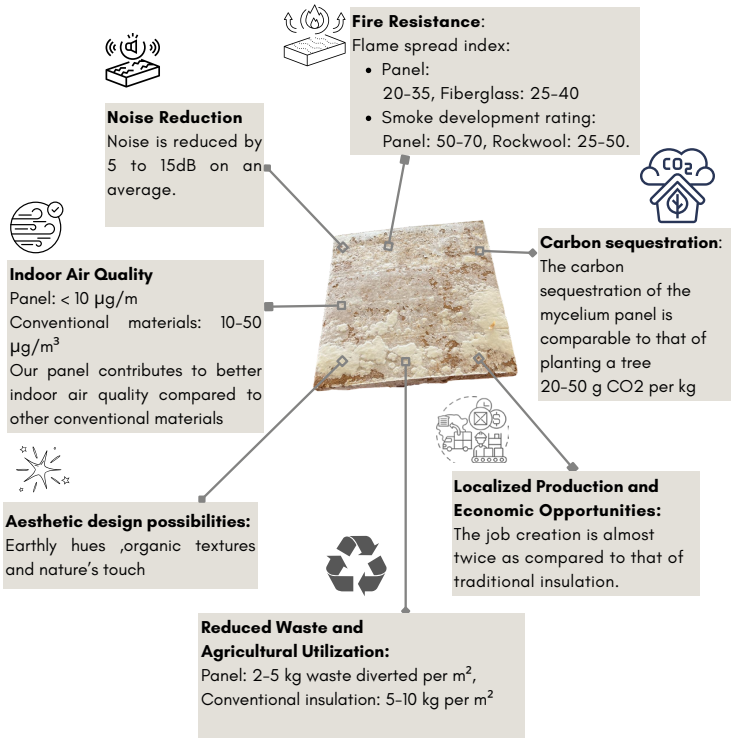
Source :Team Archtic Air SDI report

The benefits of this product extend beyond energy efficiency. Its ability to create a healthier indoor environment can enhance the well-being of occupants. Moreover, by reducing the need for harmful refrigerants, it helps in protecting the ozone layer and mitigating climate change.

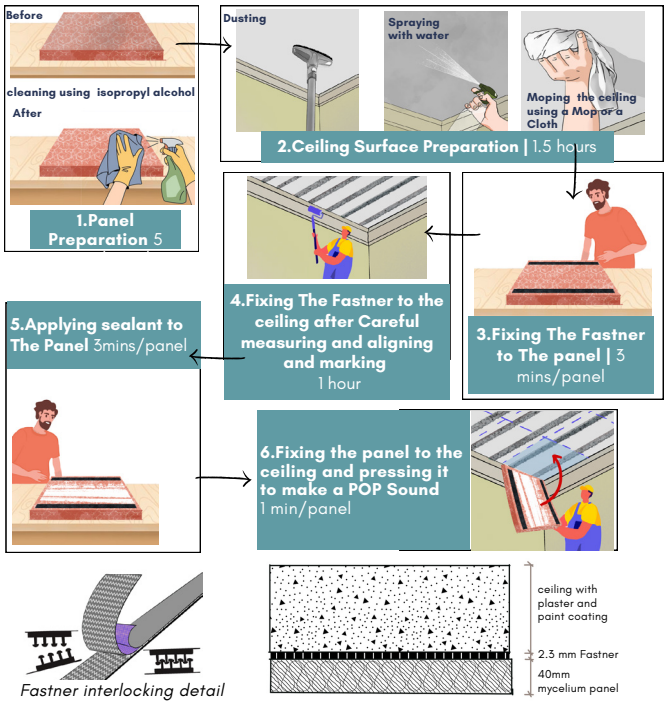
The synergy created by this product is evident in its appeal to various stakeholders in the construction industry. Designers and engineers can leverage its capabilities to create more sustainable and energy-efficient buildings.

For end consumers, it offers a comfortable and environmentally responsible living or working space. As for governments seeking to promote a greener future, it aligns with their sustainability goals and contributes to a sustainable society.

As we navigate the complexities of our modern world, this product stands as a testament to the power of human innovation when guided by a commitment to sustainability. It is a gentle reminder that progress and harmony can coexist, that the pursuit of a greener future is not merely a noble aspiration but a tangible reality within our reach.



Installation guide with operation technique and approximate time required for D.I.Y installation(for 10ft x1 0ft)



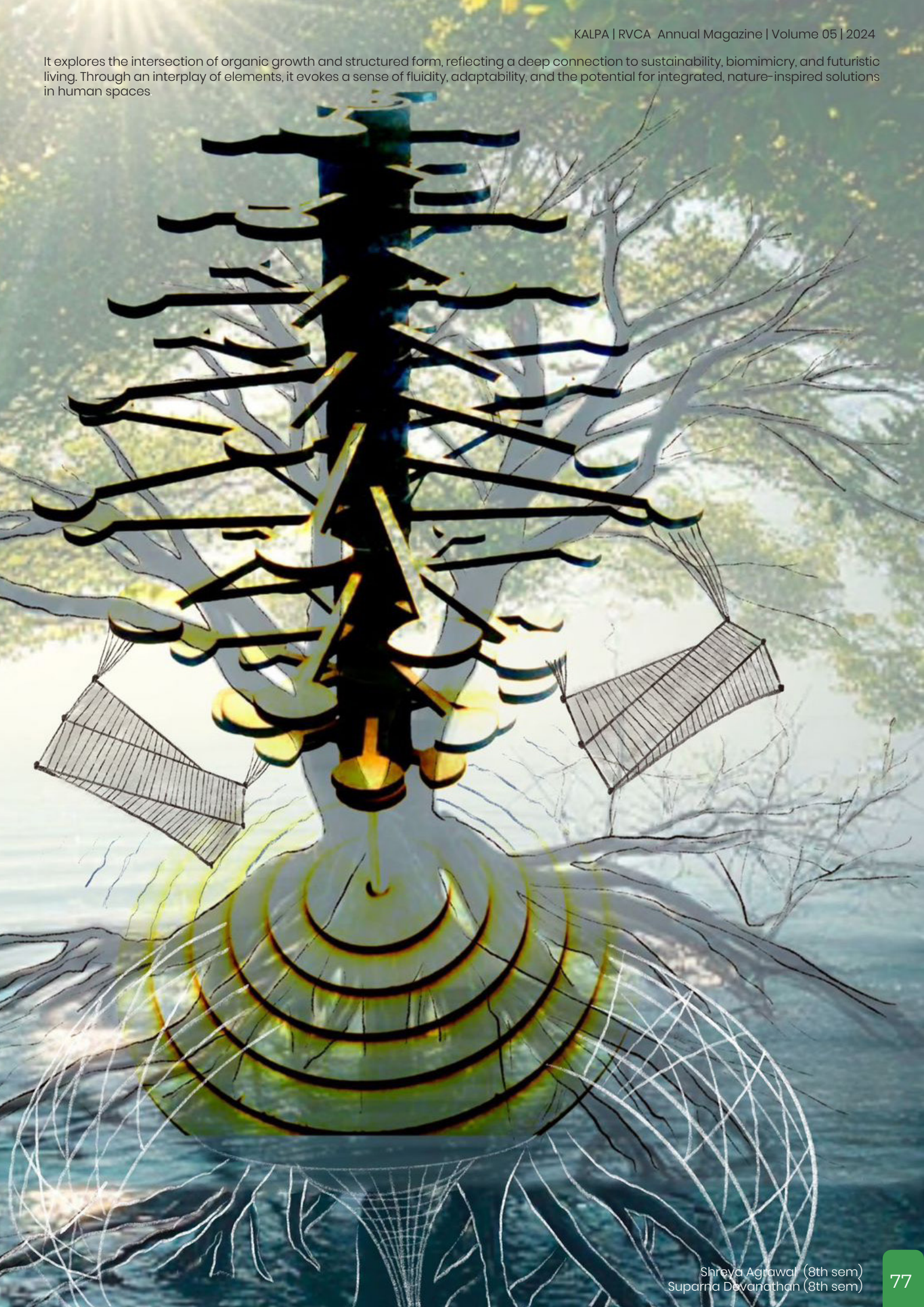
Source :Team Archtic Air SDI report

Team Archtic Air

Faculty Lead : Prof. Anuradha Dinesha
Faculty Advisor: , Prof. Anupriya Saxena, Prof. Mayank Singh, Prof. Gowtham Nandakumar

Team Members : Likith R, Megha Roy,Richitha A, Kashish Singh, Sanjana Mahendrakar, Anirban Gupta, Shruthi B K, Varungouda Patil, Tummala Pranesh, Hima Priya K N, Yashaswini M R, Kritin Hegde,Aayush Singh

It explores the intersection of organic growth and structured form, reflecting a deep connection to sustainability, biomimicry, and futuristic living. Through an interplay of elements, it evokes a sense of fluidity, adaptability, and the potential for integrated, nature-inspired solutions in human spaces



Shreya Agrawal (8th sem)
Suparna Devanathan (8th sem)

12 Fractal Dimensions: Phyllotaxis in Design Evolution

Students work Biomimcry Elective

Kalpa, Vol.05, 2024, pp.78-84

Abstract: This segment explores the learning methodologies and the application of nature-inspired design by students of RV College of Architecture under the guidance of Seema Anand, Co-founder of Biomimicry India. Through a process of observation and experimentation, students engage with biomimicry principles to explore various strategies aimed at enhancing structural systems, passive cooling and heating mechanisms, architectural elements, material innovation, and sustainable construction approaches.

The exploration of natural systems allows students to gain insights into how biological forms, patterns, and processes can inform design decisions that are more adaptive and resource-efficient. A deeper understanding of ecological interdependence is fostered, encouraging a design approach that aligns with nature's inherent wisdom. The emphasis is placed on studying and applying biomimetic concepts across various scales, from urban planning and architecture to interior and landscape design.

For the past seven years, I have been conducting a Biomimicry Elective at RV College of Architecture, Bangalore. This elective introduces students to nature's principles, biomimicry methodology, and case studies through experiential and game-based learning, making complex concepts engaging and accessible.

A key focus of the course is to train students to become keen observers of nature, understanding its deep wisdom and applying it to human challenges. They explore how artists draw inspiration from nature to create biomimetic art, broadening their perspective on the intersection of design, sustainability, and natural systems. As part of the learning process, students undertake a group project where they study nature's strategies and translate them into solutions for pressing issues in the built environment.

Through a mix of hands-on activities, interactive discussions, and collaborative exercises, students not only reconnect with nature but also develop a sense of humility about its problem-solving abilities. The emphasis is on learning from nature rather than just extracting from it, shifting their approach to design towards regenerative and sustainable solutions.

By the end of the elective, students develop both a scientific and artistic understanding of biomimicry, enabling them to integrate these insights into their design thinking. More importantly, the course helps them move beyond conventional sustainability approaches, encouraging them to view nature as a mentor that offers invaluable lessons for creating resilient, future-ready architecture.

Through a mix of hands-on activities, interactive

1. Phyllotactic

Chumki, Hari Kiran, Manasa,Navya Ub, Alisha

Phyllotaxis- refers to the arrangement of leaves on a plant stem. Phyllotactic spirals form a distinctive class of patterns in nature.

PHYLLOTAXIS

SPIRAL

YOUNG LEAVES
- Divergence angle = 137.5° (Golden Angle)

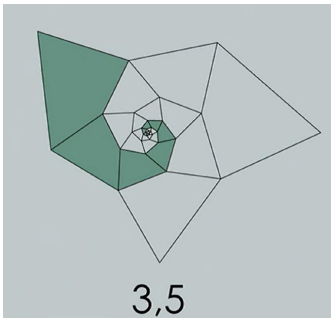
DEVELOPED LEAVES
- Sequence of Fibonacci fractions, such as 1/3, 2/5, 3/8, 5/13

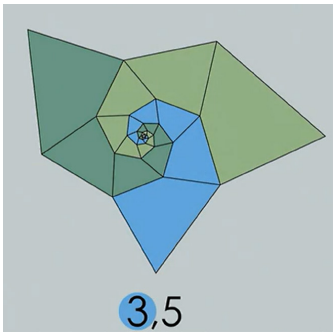
NON-SPIRAL
- Divergence angle = fraction of 360°
- Ex: distichy, decussate and whorled phyllotaxis

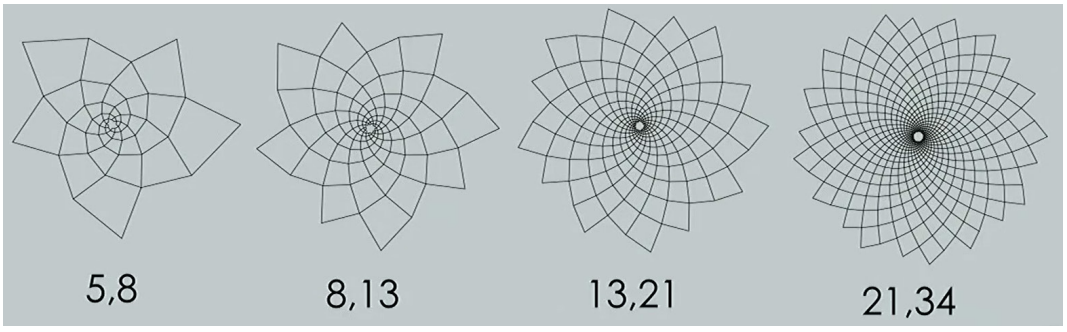
Phyllotactic arrangement of leaves

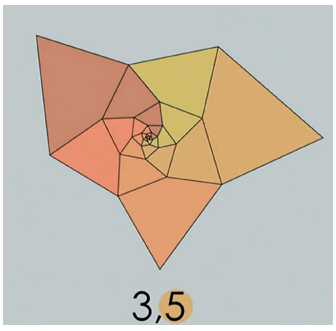
Spiral Phyllotactic Arrangements

The rotational angle from leaf to leaf in a repeating spiral can be represented by a fraction of a full rotation around the stem. The numerator and denominator normally consist of a Fibonacci number and its second successor. Ex: In sunflowers and pear, it is 3/8, and in willow and almond the angle is 5/13.

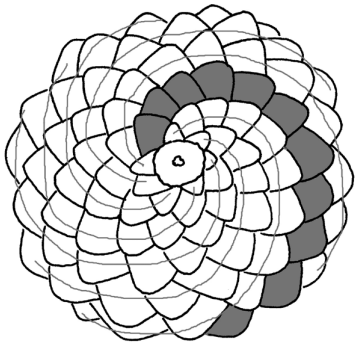


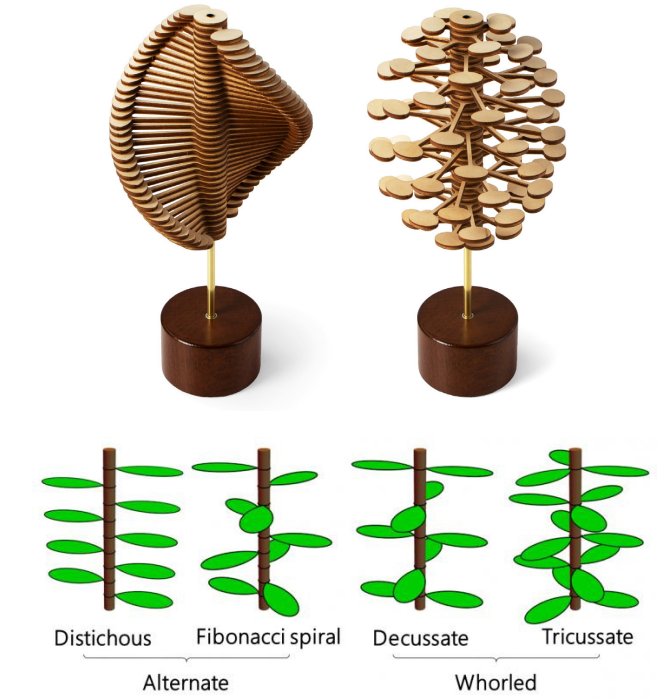






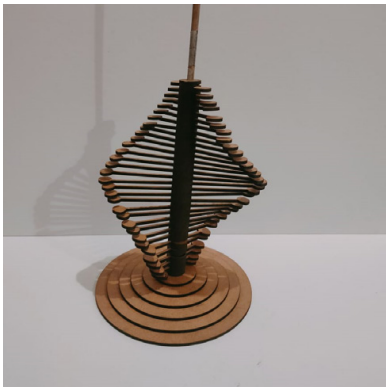
Edmark studied the connection between math and the natural world to create the Helicone. Specifically, he translated numerical, nature-based concepts like Fibonacci Numbers and the Golden Ratio into a plaything that shapeshifts into two natural forms right before your eyes. Edmark opted to craft the Helicone out of wood. In addition to giving the piece a rustic look and feel fit for a pinecone. Through the use of internal stops, each arm is constrained to rotate a maximum of 68.75° (1/2 the Golden Angle) relative to its neighboring layer.

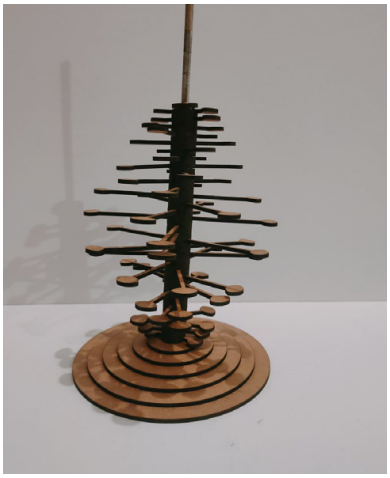


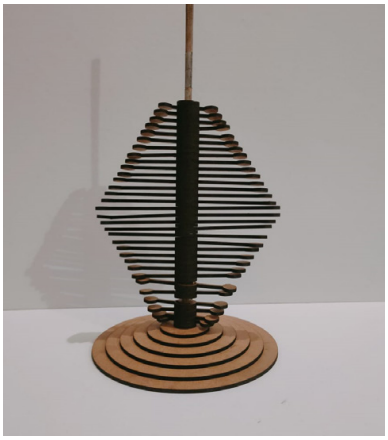


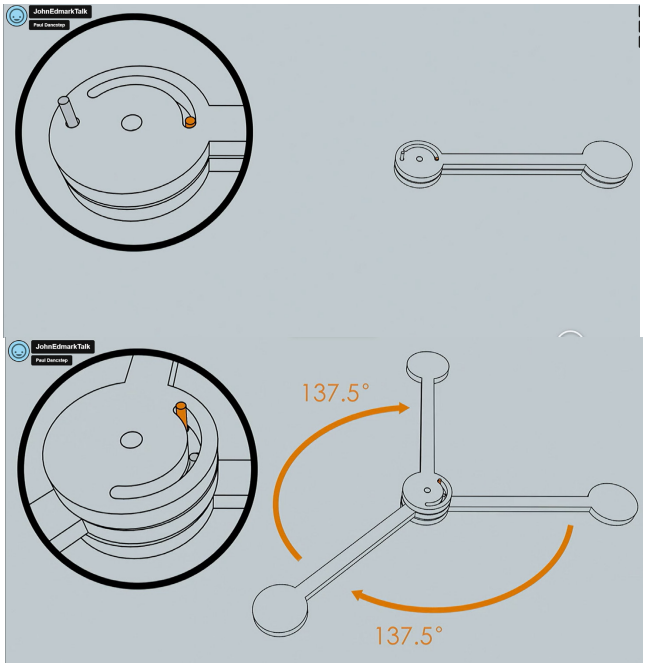
Different types of phyllotactic arrangement of leaves

Helicone - Process and model photos









Principle of how the model works

Application

Arrangement of leaves on the pinecone are arranged in sucha way that each one recieves equal amount of sunlight and hence this apporoach can be used for a building where green terraces are rotated at that angle to recieve maximum sunlight

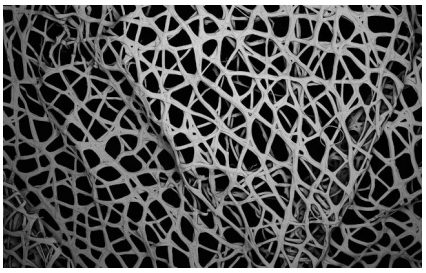
2. Silk Pavilion

Haashim Maricar, Likhith Rajesh, Sasikumar, Snehith Poojary, Tummala Pranesh

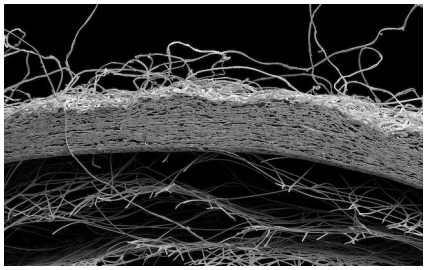
The Silk Pavilion explores relationships between digital and biological construction, proposing methods that unite the biologically spun and the robotically woven. Inspired by the silkworm's ability to generate a three-dimensional cocoon out of a single silk thread.

Constructed over three weeks with a flock of 6,500 live silkworms assisted by a robotic arm. Each silkworm spun a single silk thread filament that is about 1km long.

The silkworm is the larva (the active immature form of an insect) or caterpillar of the Bombyx mori moth. Silk has been made for at least 5000 years in China. Themoth is important because it makes silk. It is entirely dependent on humans, and it no longer lives in the wild. Silkworms eat mulberry leaves, and are native to Northern China.

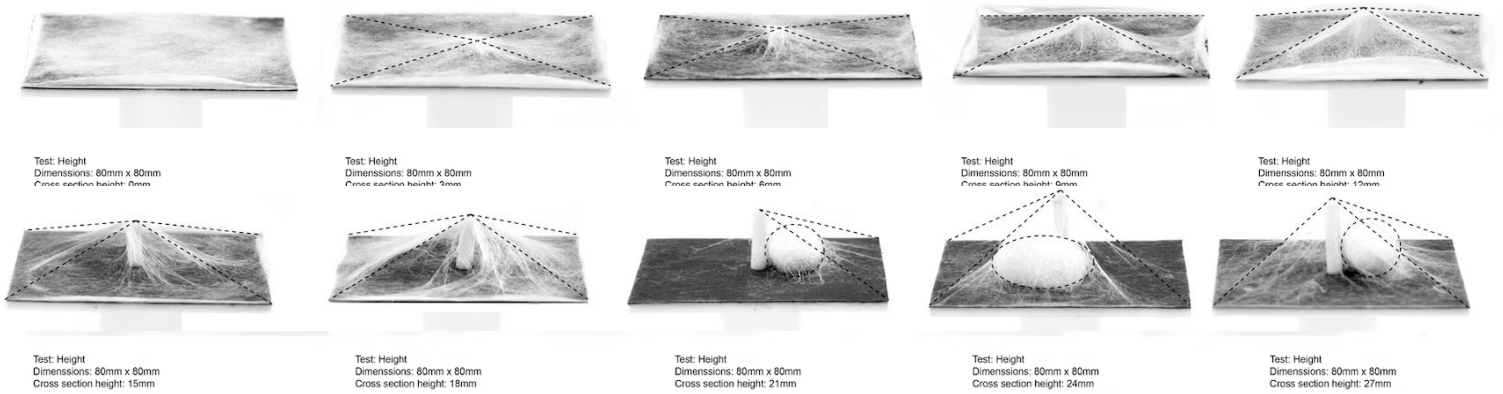


Intricate fiber layering created by the spinning



Section view of a silk cocoon

Silkworm templated response to height



Silk pavilion Model

PROTOTYPE I

PROTOTYPE II

3. Retaining Wall

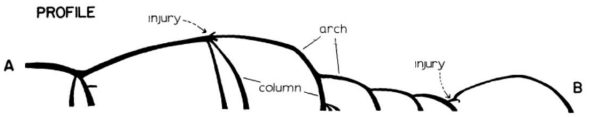
The red mangrove (Rhizophora mangle) is a coastal tree that grows in shallow estuaries throughout tropical regions. They grow in regions where storms and high winds are common and they are continually subjected to water currents and tidal forces. At the same time, they grow in waterlogged and shallow silt that is continually moving and so they are unable to anchor themselves using their roots the way trees growing on land can.

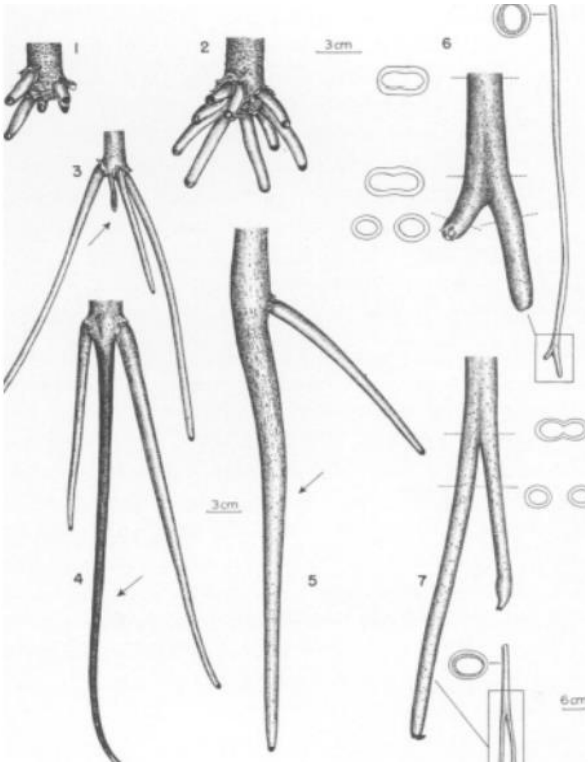
Soil pressure Some retaining walls, like brick walls, can't withstand severe soil pressure. This can lead to brick breakage or foundation failure.

Temperature and pressure Retaining walls can develop vertical fissures in the poured concrete due to severe pressure or drastic temperature changes.

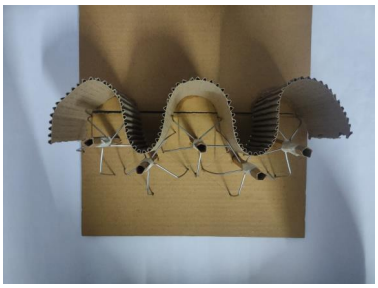
Water Retaining walls that are not properly maintained can allow water to seep in and contaminate the soil. This can negatively impact the health of plants and animals in the area.

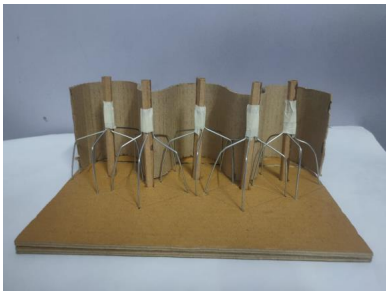
Aerial roots - emerges from the single stem, multiple branching radially.
secondary aerial roots - always dichotomous (branches in twos)
Subterranean roots- relatively thicker, mo branching from aerial roots

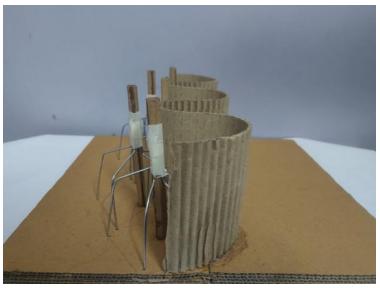


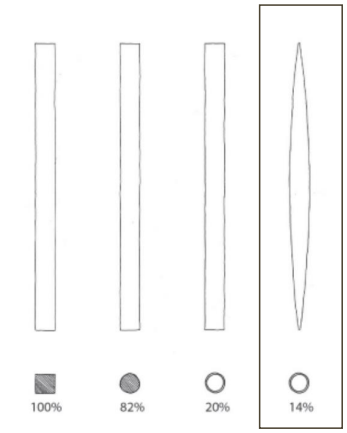


Creating: retaining wall scheme inspired from the roots of red mangrove trees









Efficiency in cross section

4. Frisky Mesh

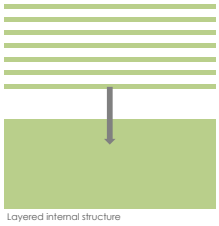
Aniruddh Muvva, Dhanyashree M , Janvi Singhania,
Kulsum Fatima

Venus Flower Basket :
Marine structure found underwater,100 to 300 mm tall,Also known as glass sponge.

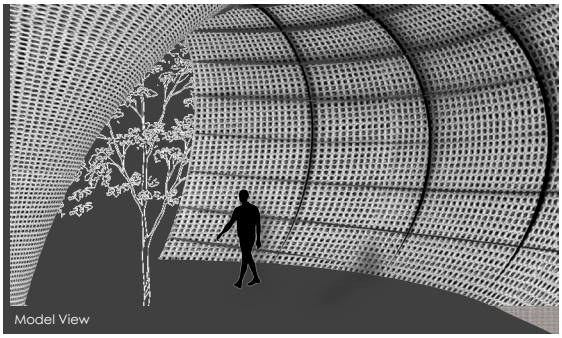
Venus flower basket or 'Glass sponge'

Two separate but overlapping lattices make up the main frame.These lattices can still move relative to one another, the skeleton can be flexible while it's growing. The squares of the lattice are reinforced by struts that run vertically, horizontally, and diagonally.

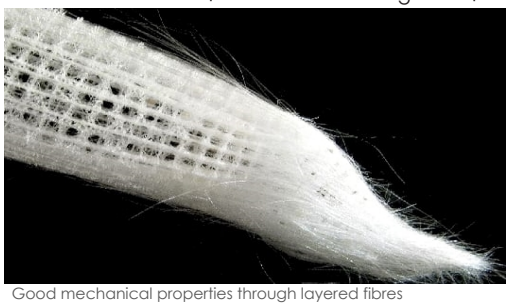
The sponge's glass skeleton is made up of spicules, tubule structures of concentric layers of amorphous hydrated silica separated by thin organic layers. But these thin organic layers go a long way to impart the spicules with considerable toughness. Silica layers are made up of colloidal spheres of silica about 50 to 200 nm in diameter, which are in turn made up of smaller spheres about 2.8 nanometers in diameter.



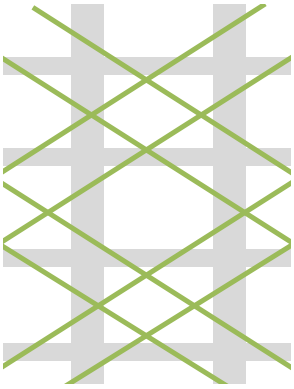
Layered internal structure



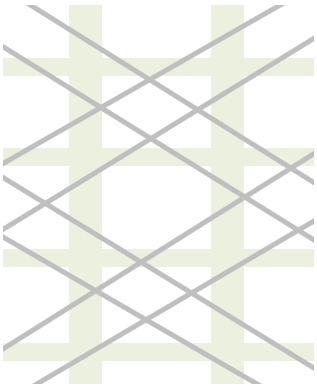
Model View



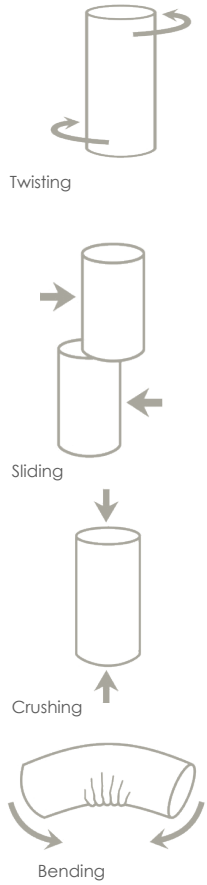
Good mechanical properties through layered fibres



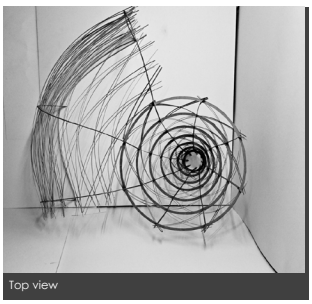
Lattice 1



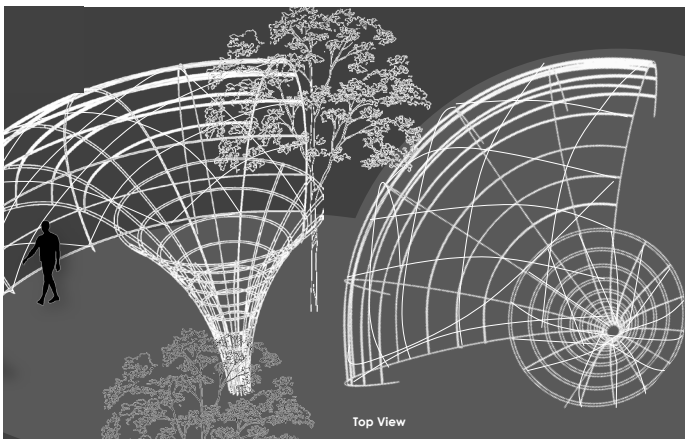
Lattice 2



Model view



Top view

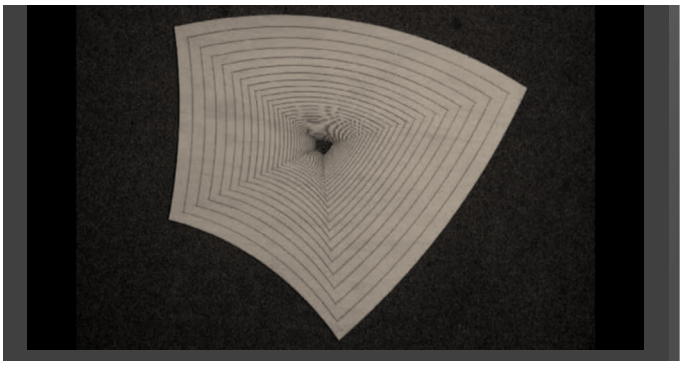


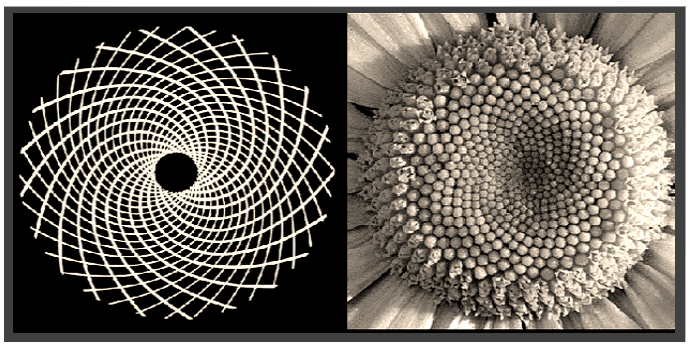
Top View

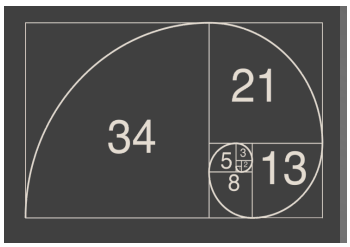
5. Golden Glow

Aniruddh Muvva, Dhanyashree M , Janvi Singhania,
Kulsum Fatima

The nesting principle was used to design this light fixture that can be viewed as a spiral when stood under it. A complicated pattern such as
the spiral can be broken down to simple fractals as seen in the drawings.It has been installed in a double height space such as in the well of a spiral staircase.The extent of the spiral chandelier in plan is 2 m x 1.5 m x 4 m

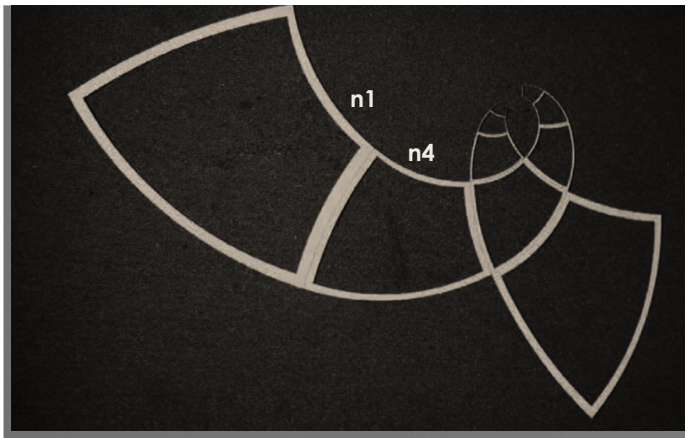




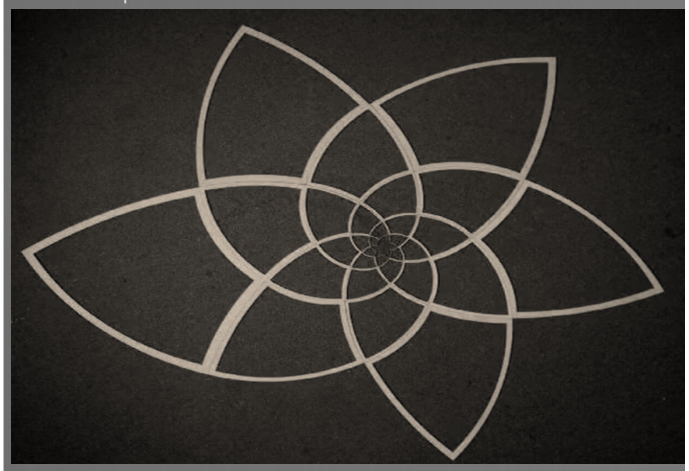


FIBONACCI SERIES
The Fibonacci sequence starts like this: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55 and so on forever. Each number is the sum of the two numbers that precede it.
It's a simple pattern, but it appears to be a kind of built-in numbering system to the cosmos

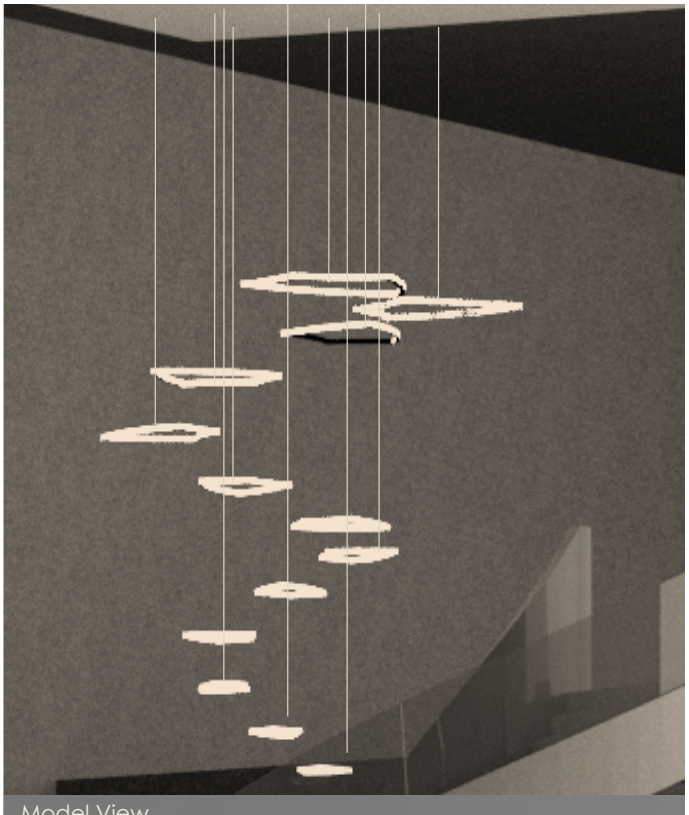
n =	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
x_n =	0	1	1	2	3	5	8	13	21	34	55	89	144	233	377	...



Possible patterns


Fibonacci Spiral

NESTING FRAMES
SPIRAL TILING
All of these frames are cut from a single piece of wood. They are similar, and logarithmically scaled. Their shape was designed to allow them to be combined to form a spiral tiling

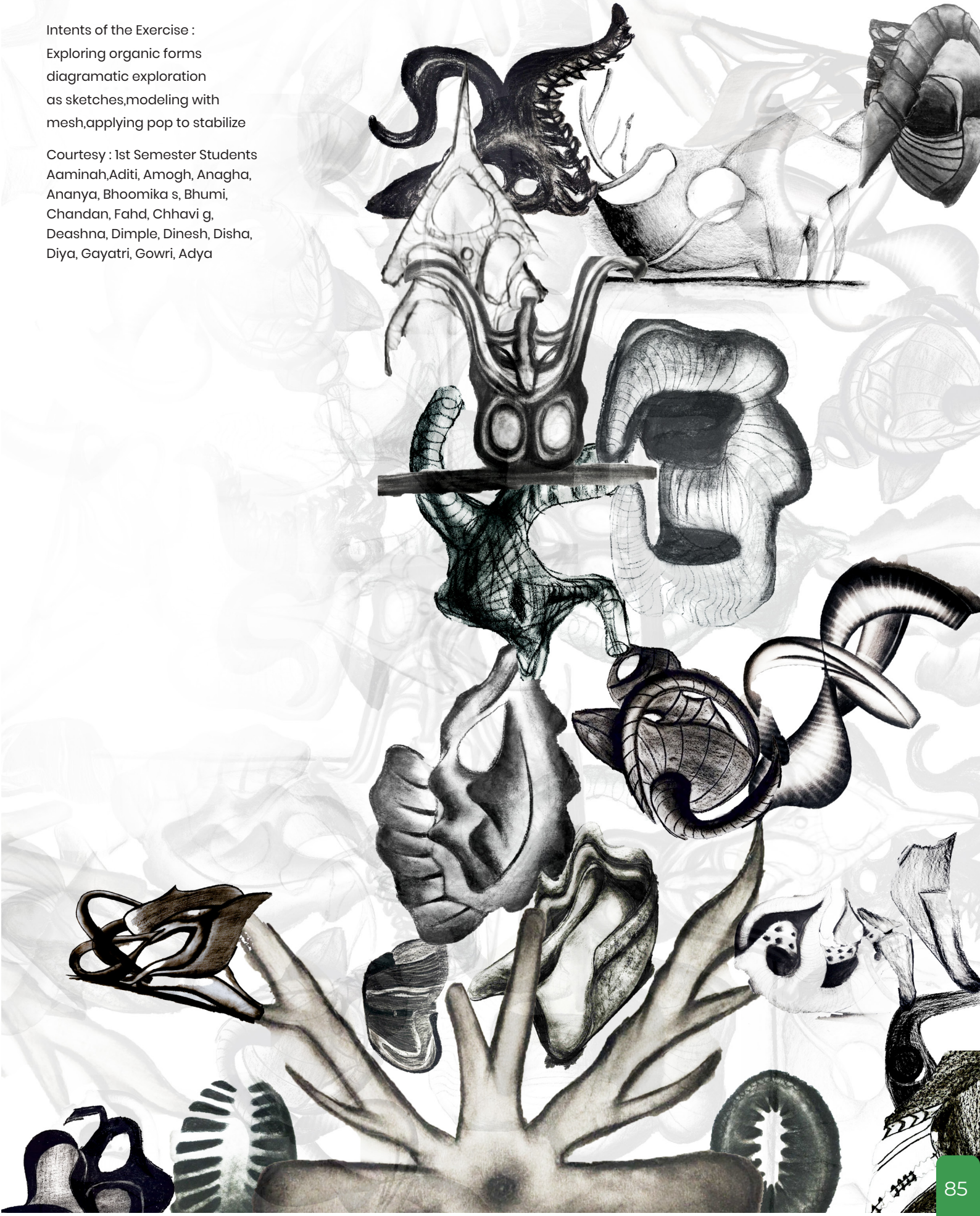

Model View

Modelling Forms of Nature: A Charcoal Rendition

Studio Faculty : Dr. MS Amaranath, Ravikumar Kashi, Prof. Hiranmayi Shankavaram

Intents of the Exercise :
Exploring organic forms
diagramatic exploration
as sketches,modeling with
mesh,applying pop to stabilize

Courtesy : 1st Semester Students
Aaminah,Aditi, Amogh, Anagha,
Ananya, Bhoomika s, Bhumi,
Chandan, Fahd, Chhavi g,
Deashna, Dimple, Dinesh, Disha,
Diya, Gayatri, Gowri, Adya



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Finding humility and responsibility

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Nature and Innovation

Section 3- Nature's Womb

Creativity and Learning

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