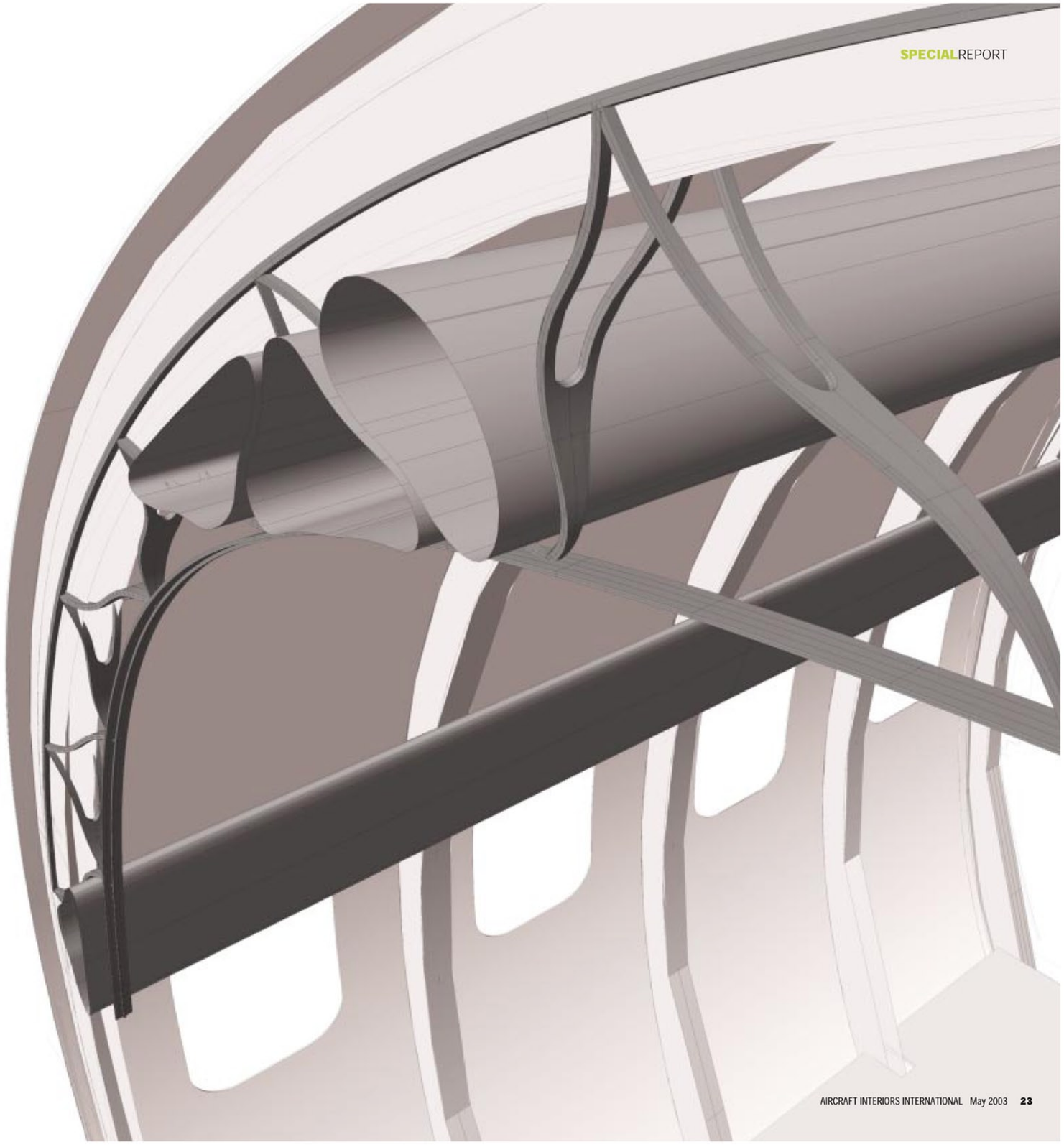
Bob Swain Aircraft Intelligence Inc, USA

natural order

THOSE IN SEARCH OF INNOVATION NEED TO OPEN THEIR MINDS TO NEW METHODS OF TEAM BUILDING, PROCESS MANAGEMENT AND THE WONDERFUL EXAMPLES OF NATURE

Airline travel and innovation are topics that enjoy broad discourse and equally broad meanings. To dramatically improve the passenger's experience during airline travel, we must move beyond the theatrical ambience of design, and transform it so that the passenger is drawn into a truly enjoyable experience. Consider the places we choose in life that transcend our daily existence, such as a spa, a restaurant or a resort. In this context, it becomes clear that breakthrough innovations could redefine the air travel experience. With this greater goal in mind, Aircraft Intelligence applies process, team-building and industrial research to rapidly deliver functional innovations.

Systemic optimization: Process and team building are key to rapid innovation. Too often the design process consists of interconnecting highly individual solutions and a secondary attempt to integrate the suboptimized parts. Systemic optimization considers overall issues and continually refines integrated solutions through an interactive process of examination. This in turn leads to simpler, dependable, lightweight designs. The challenge is how to deal with a broad scope of interactive design options: the number of combinations can be staggering. We encourage ideas from diverse sources, catalog them, allow associations to cluster,



AFTER OBSERVING AIR MOVEMENT OVER SAND DUNES AND CLOUD FORMATIONS, WE APPLIED SYSTEMIC OPTIMIZATION TO VARIOUS DUCT FORMS

and then orchestrate selective evolution. Unused discoveries are documented for potential future solutions – all ideas are stored and cataloged. In documenting the chaotic process, we create a broader resource for future solutions.

In addition to evolution, we take inspiration from nature by studying plants and animals. We observe the subtle effects of nature, and through biomimicry, our best ideas form. We pick three fundamentals to study and evaluate: shape, material and structure. We explore each of these elements in sequences dictated by genetic algorithms – achieving effective solutions to our functional goal. The result is a system-wide optimization in a much shorter period of time than linear methods.

The interior of an aircraft, even if not structural, has to be perfectly integrated with this flying object, which has its own economic balance in terms of the use of resources and the sustainability of the solutions adopted. This is something of a challenge: life is transported to a hostile environment at -50°C with very low external atmospheric pressure. When we are in an aircraft (for anywhere between 1-20 hours), we are living in hostile conditions. It is like having a home in the desert or at the North Pole: technology is used to ensure satisfactory conditions for life in a hostile environment (sustainable development). In order to be efficient and sustainable, the design process cannot be a process of linear redesign, merely the sum of a number of separate operations. One cannot separately redevelop the air-conditioning, lighting, ventilation, oxygen, and depressurisation safety systems. Each of these systems represents a single component of the more extensive aircraft system. Therefore, focusing attention on a single functional area could introduce solutions that are unsustainable for the entire system (excessive weight or bulk). The evolutionary design process takes a spiral path, in which materials, forms and structure interact to evolve to a specific integrated solution under the driving force of a target function and the constraints of the specific scenario. The material that is chosen (it could be one of the components of a composite structure) is part of the process linked to one or more functions so that not just one solution, but rather a whole series of design ideas, are combined. In design, it is wrong to be obsessed with a single idea and develop it obstinately; this would be a linear process.

Team building: Innovation grows from the integration of people, process and technology. As a company that relies on global cooperation, Aircraft Intelligence appreciates and values the benefits derived from cultural differences and diverse points of view. Also, cross-disciplinary team contributions bring unique educational and professional experiences to the development in the course of innovation.

As a juror of the *Domus* BBJ design competition in June 2000, I observed the benefits of such an approach at first hand: the European tradition of design integrity and permanence; the manufacturing excellence and interest in perfection of the Asian cultures; the effects of America's entrepreneurial approach and tradition of focused innovation. Bringing this diversity together makes for extraordinary teams, resulting in effective solutions that work in worldwide, global economies.

In addition to diverse backgrounds and cross-discipline, we believe that the core team must be small: 5 to 12 members with seven being the optimal. Face-to-face meetings are used to brainstorm and establish a clear vision for the process and team cohesiveness. Between meetings, individuals continue the process in a virtual team environment.

The established team uses appropriate scalable tools, and outsources elements of the process to an ever-growing group of virtual resources. Our strongest tool is a visual knowledge base – a picture is worth a thousand words – to communicate quickly and effectively, across languages. Effective virtual team collaboration requires easy-to-use technologies for fluid communication and focused analysis.

Breakthrough solutions: In a recent project, Aircraft Intelligence assembled an international team to dramatically improve the environmental quality, space allocation and passenger comfort of BBJ interiors, while at the same time advancing layout flexibility, reducing weight, and speeding installation. In a three-month timeframe our small team achieved the following selected results:

Noise Attenuation: Two primary sources of aircraft noise are: environmental control systems (ECS) and boundary noise. After observing air movement over sand dunes and cloud formations, we applied systemic optimization to various duct forms, quickly arriving at a design for lower air noise. By mimicking the forms found in nature within the ducts themselves and then placing the air exits in low velocity sections – the goal was met. Further optimization resulted in five-meter duct sections with all the required functional characteristics.

In searching for lightweight structures to support ducts and panels, a boundary noise solution evolved. A space frame was transformed into a composite spring truss, passively reducing vibration transfer between fuselage and the interior.

Microclimate: Observing the Radiolarian, a tiny sea creature, we considered detailing airflow on a micro level for precise control. Micro-electro mechanical devices and smart wire could offer precision airflow management. With a temperature differential in each zone and proper controls, an individual's comfort could be greatly improved. Phase change materials provided another alternative. Silica-rich stone has historically been used by many cultures to balance temperature extremes. From this inspiration we considered the effects of 'Nano Silica', and studied thermoactive fillers in fibers and foams. Engineered

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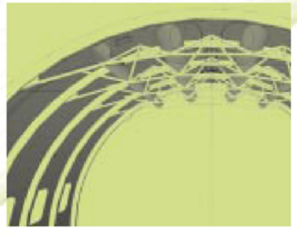

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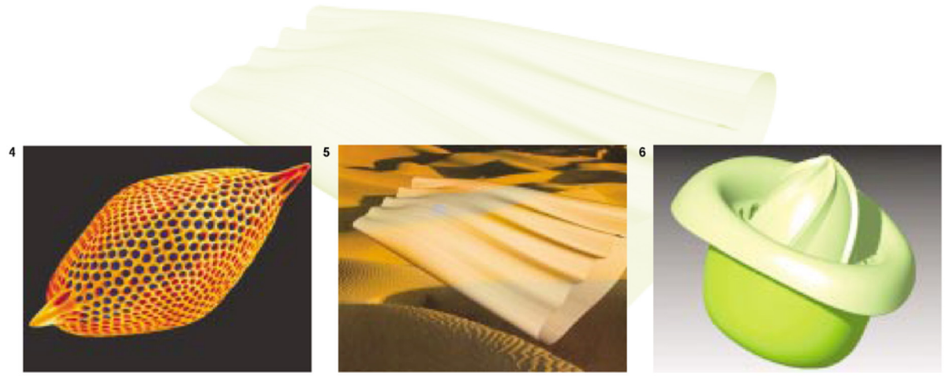
1. An early concept model of an extruded and thermoformed air duct
2. A suspension truss with air duct and panel support designed with flexibility in mind
3. A promising solution for improving noise attenuation and available overhead space



4. The sophisticated structure of the radiolarian, a microscopic sea creature, provides many design opportunities
5. The form of this air duct was inspired by the flow of air over sand dunes
6. A spill-free and perfect-pour kitchen utensil, a new approach to an everyday item

fabrics, liners and insulators using these 'smart' materials can significantly affect climate balance in extreme high-altitude conditions. Microzones can then be created through flexible duct distribution, smart materials and smart controls. Temperature and humidity control, done systemically, can improve passenger comfort while eliminating many drawbacks of current approaches that involve cost, weight, and mechanical complexity.

Lighting: Architecture uses the fundamentals of reflected and/or ducted day lighting, and reflective radiant films have recently been adapted to this purpose. We integrated radiant mirror film into a system. This product is thinner than a sheet of paper and boasts 99 per cent reflectivity. The resulting system is lightweight, reduces wiring, transformers, replacement bulbs, and mechanical complexity. Maintenance is greatly simplified. At night, point source LEDs illuminate from several easily serviced locations.

Flexible solutions: The armadillo is a hard shell and soft body in one 'system'. Our process resulted in panel systems that are lighter in weight, flexible in design, and lower in cost. We adapted materials and processes from automotive and boat manufacturing to aviation requirements for weight, fire, strength, and resiliency, while serving aesthetic demands. Two methods provided excellent potential: continuous process manufacturing and thermoforming. In both areas, we identified manufacturing methods that by contemporary standards are considered basic, but could be adapted for both signature interiors in commercial aircraft and individualized interiors for completion centers.

Transforming travel: In this example, technical expertise combined with a sound design process and the input of an international team created rapidly evolved integrated solutions for noise attenuation, microclimate, flexible systems and lighting. For the end user, these innovations improve passenger comfort, allow greater flexibility in design solutions, maximize interior space, and with weight reductions improve range. For the industry, passenger satisfaction is obviously beneficial. In addition, weight reduction and improved aircraft performance, reduced installation times, improved maintenance efficiency and simplified manufacturing are benefits of this approach.

The team building and design process described has been effectively applied to a variety of industrial design projects in transportation as well as other industries. They can even be applied to the design of services. The keys are to build a small cross-disciplinary team, to draw in additional talent as needed, to follow the systemic optimization process, and to have creative fun. END

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BOB SWAIN

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Photo: Clive Nichols

What is your definition of perfect design?
Balance and beauty, where the whole experience with a design is one of joy!

Is the term 'innovation' overused?
Yes, but what is the right word to describe a very real need for the creative transformation of the customer experience in an industry that has spent much reasonable, needed and valued time in developing the machine, but little developing the experience?

When did you last feel at one with nature?
Very recently, snow-shoeing with a friend in the Pacific-Cascade wilderness, completely free of other people and the mechanized world.

Do the marvels of natural design hint at a higher intelligence?
Yes, such exquisite and evolved solutions so superbly integrated can be nothing else.

What do you do to put you in a more creative mood?
Solitude: "Only the person who is relaxed can create, and to that mind ideas flow like lightning." – *Cicero*

What are your hobbies?
Experiencing the wilderness by exploring: hiking, kayaking, mountaineering – travel!

What is your favourite animal?
The eagle: fluid and gifted in its element (in the air) and clumsy when not (on the ground), most alive when fully in its passion – a wonderful symbol of powerful natural movement and freedom.