

Force Cancelling and the Ethics of Spatial Design

Wonhee Lee (Wuanny)

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33672811

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I contend that force cancelling should not remain a secondary technique used merely to make small speakers louder, but must be redefined as a foundational design principle capable of fundamentally expanding the limits of structurally constrained loudspeaker design. Force cancelling is a structural method for eliminating the unwanted vibration that occurs when a speaker reproduces sound. In a conventional loudspeaker, the driver moves back and forth to displace air, and the reactive force generated by this motion causes the entire cabinet to vibrate. This vibration degrades sonic accuracy and transmits unnecessary energy into surrounding structures. Force cancelling addresses this by placing an identical driver on the opposite side of the enclosure. When both drivers move simultaneously in opposing directions, the forces they generate cancel each other out. As a result, the speaker body remains largely still while sound is produced.

This structure can be understood intuitively. If only one hand is moved side to side, the entire body sways with it. However, if both hands move at the same speed and distance in opposite directions, the body remains comparatively still. The opposing forces neutralise one another. A force cancelling loudspeaker operates on the same principle. No matter how high the playback level, the unwanted vibration of the cabinet is dramatically reduced.

Yet this structure has clear disadvantages. It requires an additional driver, increasing both cost and physical volume. Internal air pressure within the enclosure also rises, reducing the excursion range of each driver. To achieve the same output level, more electrical power is therefore required. For these reasons, force cancelling has remained a difficult choice within an industry shaped by efficiency, cost reduction, and compactness. As a result, the technology is typically deployed only in situations where a small enclosure must produce a relatively large sound, such as portable Bluetooth speakers or compact subwoofers. In these contexts, force cancelling functions as a compensatory tool, a way of temporarily overcoming spatial limitation. It is treated as a pragmatic compromise. I believe this usage severely underestimates the potential of the structure. This logic can be seen in products such as the iMac's internal speaker system or the Devialet Phantom, where force cancelling is employed to extract unexpected loudness from compact, sealed forms, yet remains framed as a technical solution to size rather than a principle that reshapes what a loudspeaker can be.

Force cancelling is not simply a technique for miniaturisation. It is a bridge that allows sound to coexist with form without conflict. When placed at the centre of design, it enables loudspeakers to exist within shapes and structures that would otherwise be acoustically hostile. The speaker no longer needs to conform to the familiar box-like form dictated by internal volume and mechanical stability. It can adopt unconventional geometries, integrate into architectural elements, or inhabit illusionistic and constrained structures while remaining sonically viable. In this sense, force cancelling does not force the speaker to submit to form. It mediates between sound and structural limitation.

This position therefore proposes a redefinition of force cancelling not as an auxiliary efficiency device, but as the foundation for a new relationship between sound and design. It is not merely a technical preference, but an ethical stance that rejects the assumption that external form must always suppress acoustic possibility. I believe that a

loudspeaker need not exist only by the permission of its internal structure. Instead, even within constraint, it can become a quiet agent capable of rewriting the rules that shape it.

Force cancelling structures carry clear disadvantages. As discussed in the previous section, while this approach allows the internal volume of a cabinet to be reduced, it requires an additional identical driver and demands greater electrical power to compensate for increased internal air pressure. Structurally, it is an elegant solution, yet from an industrial perspective it collides with the realities of cost and efficiency. Within an audio industry shaped by mass production, cost reduction, and energy optimisation, force cancelling remains a difficult choice. Even when adopted, it is rarely treated as a core structural logic, but rather as a supplementary device used to temporarily resolve a specific problem. Moreover, force cancelling is often combined with digital signal processing, allowing the acoustic behaviour of a simplified enclosure to be corrected in software. While this enables physical constraints to be



Internal structure image of Bang & Olufsen Beosound Balance (Force Cancelling)

bypassed, it introduces a new layer of labour. Tuning such systems requires significant time and expertise. Driver behaviour, cabinet geometry, porting, and internal resonance must be repeatedly adjusted before a coherent sound emerges. This process may be viable within small scale or experimental contexts, but it becomes costly and impractical within large scale production systems. Judged purely through the lens of sonic efficiency, force cancelling often appears economically irrational. As a result, the conditions under which force cancelling is selected are

Force Cancelling and the Ethics of Spatial Design

strikingly specific. It is employed precisely at moments when sound and vibration themselves become problematic. Like all designed objects, loudspeakers are expected to conform to space. They must occupy permitted positions, minimise disturbance, and remain physically and socially unobtrusive. Small size, low vibration, and acoustic restraint become prerequisites. Within such environments, force cancelling becomes essential.

In densely populated housing, particularly within apartment based living, sensitivity toward vibration and inter floor noise has intensified. Here, the suppression of unwanted resonance is no longer a technical preference but a social necessity. It directly shapes relationships between neighbours, notions of privacy, and the quality of everyday life. Sound becomes problematic not by nature, but through the structures that refuse to host it. The moments in which force cancelling becomes viable are therefore those in which sound is already framed as an intrusion. This reveals a deeper condition: the disturbance is not sound itself, but the spatial and design systems that are unable to accommodate it.

I believe that this technology should not be confined to a role of limitation, correction, or support, but placed at the centre of design as a core principle capable of fundamentally expanding its structural boundaries. As discussed earlier, force cancelling structures undeniably carry disadvantages. They require additional drivers, greater power, and more complex processes of design and tuning. Yet when weighed against their potential, these costs become acceptable. They are the price of enabling a new relationship between form and sound. In this sense, force cancelling offers the rare possibility of capturing two aims at once: design freedom and acoustic integrity.

By employing force cancelling, unwanted vibration within a loudspeaker can be almost entirely eliminated. This allows intended sound to be delivered with far greater precision, free from mechanical interference or structural resonance. When combined with digital signal processing, this advantage is amplified further. Sound is no longer bound by the shape of the cabinet or the constraints of its internal architecture. Instead, designers can begin with form itself, imagining a structure with force cancelling in mind, and subsequently shape the sound to inhabit that form. The traditional hierarchy is reversed. Rather than sacrificing form in order to preserve sound, sound is recalibrated to live within form.

This marks a departure from the long standing convention in loudspeaker design in which shape must always yield to acoustic necessity. Volume, proportion, and geometry have historically been dictated by the needs of sound reproduction. Force cancelling loosens this bond. It allows the enclosure to become smaller while remaining structurally stable, reducing the influence of physical constraints. The designer can determine both shape and scale according to intention, then refine the sonic behaviour through calibration. What was once an unavoidable box becomes a field of possibility.

This freedom is not absolute, and it remains bounded by the conditions under which force cancelling can operate. Yet even within those limits, a wide spectrum of previously unthinkable forms becomes viable. Illusionistic structures, unconventional geometries, placements that blur the boundary between object and architecture, and designs once dismissed as acoustically impossible can now be explored. When this technology

becomes central rather than auxiliary, the loudspeaker ceases to be a container for sound. It becomes a site where sound and form are conceived together.

Such a shift moves beyond the idea of simply creating "a speaker that fits a space." It opens the possibility for the speaker to become a defining presence within that space. One can imagine loudspeakers that dissolve into any interior, as well as others that exist only for a specific place, inseparable from its character. Without sacrificing either sonic quality or visual intent, design is liberated. The loudspeaker is no longer merely a functional machine. It becomes an experiential object, capable of prompting the question: is this really a speaker? It is this transformation that makes force cancelling worthy of redefinition as a foundational principle of design.

I want to actively employ this structure to demonstrate that a loudspeaker does not have to be defined solely as an efficient, compact machine. Loudspeakers have long existed under an unspoken rule that they must "look like speakers." Even when their forms deviate slightly, they are still read as nothing more than "unusually shaped speakers." They remain variations of the same box. At the same time, loudspeakers are expected to integrate every electronic element into a single body. Amplifiers, power supplies, processing units, and drivers are gathered into one closed

object, because this is considered efficient. Integration is treated as completeness. Efficiency becomes a virtue, and form is disciplined by it. I do not wish to remain within the boundaries produced by this logic. As argued earlier, once force cancelling becomes central, a loudspeaker no longer needs to submit to the demands of internal volume and structural constraint. Yet we continue to reproduce the same assumptions: that a speaker must look a certain way, that it must contain everything within itself, that it must behave as a closed machine. These assumptions lock the loudspeaker into a narrow identity. They frame it as a self contained device whose purpose is purely functional. I seek to unsettle this framework. Why must a speaker be whole in one body. Why must sound always be enclosed. These are not merely questions of form. They are questions about how we understand objects, technology, and their place within space.

My intention is to escape the idea of the loudspeaker as a finished machine and instead explore how far its form can be extended. I aim to propose structures in which electronic components do not have to collapse into a single enclosure, in which function does not dictate shape, and in which sound no longer serves as an excuse for form. Rather than treating the speaker as a box that contains sound, I propose to imagine it as an open system in which sound and structure can be separated, redistributed, and recomposed. A loudspeaker does not need to hide everything inside itself. It can disperse across space, merge with architecture, or exist as a form whose presence is itself experiential. This ambition is not simply to create a new type of product. It is to question how we have come to understand the loudspeaker as an object. Until now, it has largely been framed either as an efficient machine or as a structure in which every element is subordinated to sonic performance. I argue that it does not have to remain within this role. A loudspeaker can form new relationships with space, form, and perception. It can afford

excess. It can be inefficient. It can be unnecessary in ways that are meaningful.

Ultimately, I seek to allow the loudspeaker to become something that can be wasted. In a world governed by optimisation, calculation, and restraint, I aim to imagine a speaker that exists even when it does not need to. One that privileges experience over function, presence over necessity. In doing so, the loudspeaker gains the possibility of becoming an artwork. It is no longer a device that must hide, but an object that can speak spatially. At that moment, force cancelling ceases to be a technical feature. It becomes a structural tool for altering the ethics of design itself.

In the end, what I want to say is that this work is not about making a speaker with better performance. It is not a technical race to make sound louder or more accurate. It is an attempt to rethink how we live with sound. Until now, sound has always been treated as something that must be controlled. Design has developed in ways that hide it, soften it, and push it back. Walls became thicker, surfaces absorbed more, and machines were asked to be quieter. Through this process, sound was slowly learned as a “problem,” and speakers became devices that had to manage that problem carefully. But I do not believe sound itself is the problem. The problem lies in structures that are designed in ways that cannot accept sound, and in the attitudes that treat those structures as natural.

Force cancelling is a rare structural tool that can disturb this assumption. It is not a technology that suppresses sound or hides it. Instead, it allows sound to exist without colliding with structure. Rather than keeping the old order in which “sound must give way,” it suggests that “structure can change.” In this sense, force cancelling is not a tool for control, but a trigger that invites design to reshape itself. This is not only a technical matter. It is an ethical one. It asks what kinds of senses we allow, what we choose to protect, and what we decide to exclude. It asks what design is really for.

This position is not about taste or style. It is about attitude. It concerns what kind of environments we build and what kinds of experiences we allow within them. In a world where sound is always framed as disturbance, we have learned to value silence, restraint, and efficiency. Yet this order has also narrowed our range of experience. As long as design only works to hide sound, we cannot imagine other ways of living with it. I want to create a small crack in this fixed order. I want to imagine a moment in which a speaker is no longer an apologetic machine, but an object that can claim its presence within space.

However, such an ethical shift cannot remain abstract. It must be tested within a real place, a concrete scene, a specific environment. In spaces where sound is most easily seen as a problem, where structure is quick to reject it, how might this position take form. Where is force cancelling most needed. And in that place, what might a speaker become.

In the next section, I will set a place where these questions can be made clear. This place will not be a neutral background, but a site where sound and structure, control and allowance, directly collide. Within it, this ethical position will move from idea to form. I now want to explore how this principle can produce real tension and possibility within the world.

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