Scan, plan, print, practice, perform: A disruptive technology?

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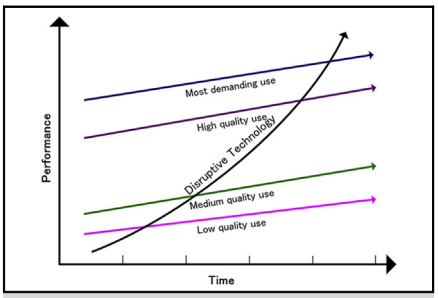

The curve of disruptive technology.

Central Message

Although the application of 3D printing to adult cardiac surgery is an intriguing concept, examination of its attributes and applicability suggests this is a limited and even potentially harmful concept.

See Article page 132.

In this issue of the *Journal*, Dr Hermsen and colleagues[1] report on 3-dimensional (3D) printing technology to visualize, plan, and rehearse myectomy in 2 patients with hypertrophic cardiomyopathy (HCM). Two provocative terms in the article serve as reflection points on the potentials and limitations of this technology in cardiothoracic surgery: interactive application and disruptive technology.

INTERACTIVE APPLICATION

The authors hypothesize that interactive models represent an advance over current use of 3D printing as an adjunct to conventional imaging. *Merriam-Webster* defines "interactive" as "mutually or reciprocally active."[2] This is indeed a tantalizing prospect. What surgeon has not rehearsed a complex case in her mind or replayed a case with less than desired outcomes, imagining the steps that might have altered results? Yet, the interactive component (manipulatable digital model) was less useful than anticipated, the surgeon rating this only 2 on a 5-point Likert scale.

The static 3D model, although potentially useful, was not interactive. Although both practice and surgical resection volumes were measured, practice volumes were not used to guide operative resection. Critically, practice resection adequacy was not tested. A truly interactive model would provide feedback in the form of predicted postmyectomy peak-derived gradients.

Finally, 3D printing places faith in anatomy, ignoring function and physiology. Models offer perfect patient-specific representation of structure only.

DISRUPTIVE TECHNOLOGY

Hermsen and colleagues[1] call 3D printing both a "solution in search of problems" and a "potentially disruptive technology." Does this study advance the applicability and disruptiveness that they suggest? Here, an examination of the term "disruptive technology" is useful. Theorized by Bower and Christensen[3] in 1995, disruptive technologies are those whose attributes differ from historical valuation, initially perform worse along important dimensions, and eventually break into established markets via rapid improvement (Figure 1). Despite concerns about cost and ability to generate true-to-life materials, the reality is that current technologic development trajectories (particularly when commercially driven) will permit rapid cost efficiencies and software/interface improvements. The question is not of physical limitations but what greater value 3D printing offers that is worthy of breakthrough. As the authors note,[1] the repertoire of cardiac operations for which 3D printing offers benefit beyond existing inanimate models is extremely limited. Bower and Christensen[3]

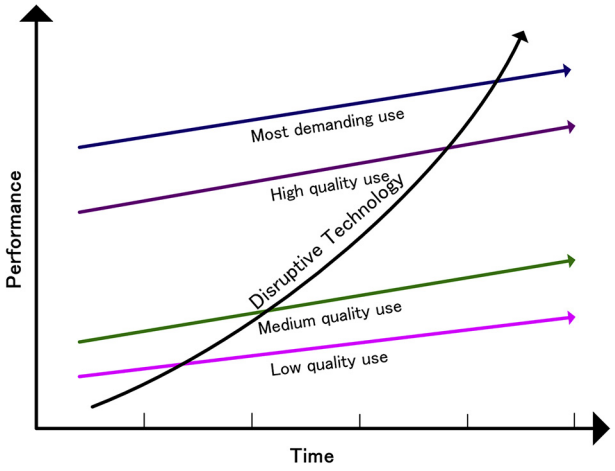

FIGURE 1. The trajectory of disruptive innovation. By Megapixie at English Wikipedia. New version by en:User:Megapixie, Public Domain, https://commons.wikimedia.org/w/index.php?curid=37670832.

stated, ''Managing the development of new technology is tightly linked to … investment processes.'' This small study, combined with limited general applicability, suggests this is and should remain a bear market.

The report[1] described only 2 patients. On the bright side, this has resulted in a ratio of 1 publication per patient (including this editorial). It is clear why HCM was chosen, with 3D printing offering more potential than for any other cardiac disease. However, suggesting disruptive potential in its zygotic stage is inaccurate. We applaud Hermsen and colleagues[1] for this step, but see dilution to low-volume surgeons with an operation as infrequent as myomectomy as potentially harmful, even with this technology. If our anatomy is not amenable to septal ablation, we will be traveling to Hartzell Schaff, MD, who has performed more than 1500 of these operations.[4] It is hard to imagine circumstances in which this model would add to that depth of experience in HCM, and harder still to envision application to other cardiac pathologies.

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