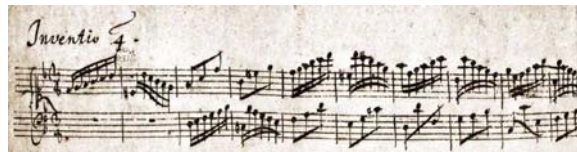


The first article - “[Convergent Medical Technology: Part I - What is it?](#)” – in this three-part series on [convergent medical technologies](#) (CMT), defined *what* CMT is ... and what it isn't. This second article presents some reasons *why* CMT is important and *why* there will be a crescendo of such applications flowing forth. The third and last part in the series – later this week - will address some implications of this technology convergence and *how* it will impact medicine and healthcare. But first: a musical interlude ...

### **Polyphony, counterpoint and the Renaissance**

During the late Medieval and early Renaissance periods, Western music – in step with widespread cultural flowering in general – experimented with new and innovative forms of music. [Polyphony](#) – that is, music in which two or more independent melodic voices are brought together in one musical expression – was the most significant of such advances. While monophonic music - such as medieval chants - can be beautifully haunting, the breadth and depth of artistic expression under a monophonic regime is decidedly limited. With a polyphonic texture there are no limits from which we have been not by note led to the entire spectrum of musical expression from Johan Sebastian Bach to Snoop Dog.

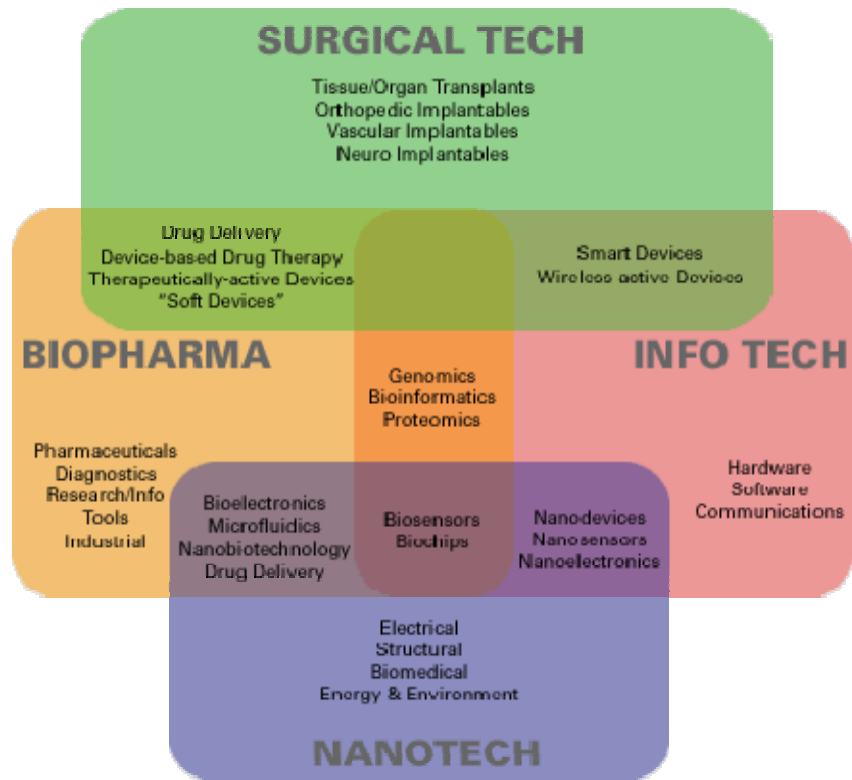
[Counterpoint](#) –a further advance in polyphony – developed during the later Renaissance and early Baroque periods and was raised to its height of intricate artistry with Bach's two- and three-part inventions. The picture below depicts the first nine measures of Bach's two-part invention No. 4 (in d minor); a link to download the corresponding audio (.mp3 format) can be found at the end of this posting.



Even to the untrained eye, one can see that the lower staff (played by the left hand) trails by exactly two measures the upper staff (played by the right hand). When the two separate musical streams are combined (starting in the 3<sup>rd</sup> measure) an entirely new piece of music enabling both greater intensity and subtlety of expression arises. Once the basic technique of combining two separate voices was discovered and mastered music was never to be the same.

### **Definition of Convergent Medical Technologies**

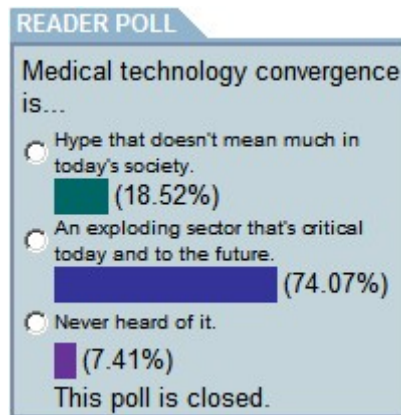
Despite the multitude of melodies, the musical metaphor is clear. As defined in the first [part](#) of this series, convergent medical technologies (CMT) can be defined in terms of combining of technologies from two different sectors. A drug-device combination or a device – IT combination resulting in a smart device would be examples of convergent medical technologies. CMT was also defined as a “diagnosis of exclusion” whereby a convergent technology was defined as not being a “pure” device, “pure” drug and so forth. The diagram below illustrates that definition.



As noted, convergent medical technologies are differentiated from combination medical products (an FDA term) which can refer to combinations arising from different sectors but is more generally – and passively – defined as combinations of any sort of therapeutic such as with two complementary drug therapies in a cocktail.

**Are convergent medical technologies important?**

To some extent the readers of my column (and blog) have answered this question. In an article last year “[Tech Convergence a Key Theme at Orthopedics Conference in Chicago](#)” Midwestbusiness.com ran an accompanying user surveying polling whether people felt CMT was important or not. The poll results are quite interesting; here are the results:



Nearly 75% of you agreed with the statement that “medical technology convergence is an exploding sector that’s critical today and to the future.” That statement is supported by the facts if we look, for example, at the remarkable market entry and penetration of drug-eluting stents (DES) over the past few years. [Drug-eluting stents](#) are the prototypical convergent medical technology as they combine a [restenosis-inhibiting drug](#) with a mechanical device (the stent) that keeps the blood vessel open after an [angioplasty](#) procedure. Another article from last year “[Drug-Eluting Stent Market: \\$5 Billion Turning on a Dime](#)” discussed some of the rapid shifts that have occurred in the stent market of which perhaps the most remarkable has been the growth of DES from virtually zero in the U.S. to nearly \$5B in the space of three years. In general, then, what has led to the rise of CMT?

### **Factors behind the growth of convergent medical technologies**

As discussed in a previous posting: “[A Time to Make Friends: More Partnerships in Biotech, Med Tech](#)” there are six basic drivers of growth in CMT. Like any “mega-trend” there are often multiple factors (a “triple-storm” like phenomenon) that coalesce to make conditions ripe for market take-off. For CMT, these include:

1. Advances in [minimally invasive surgery](#) (MIS)
2. Miniaturization of electronics
3. Closing the loop between [diagnostics, therapeutics](#) – also known as [theranostics](#).
4. The rise of [personalized medicine](#) including [pharmacogenomics](#).
5. Increasing demand for convenience
6. Growing importance of [safety](#)

Minimally invasive surgical techniques (such as the catheter techniques that have enabled drug-eluting stents and stenting more generally) make it possible to implant devices in patients with less risk. As it becomes easier and more accepted for patients to have these devices implanted, new markets, new capabilities and new indications arise for biotech/IT/device combinations of a nearly infinite variety. The miniaturization of electronics which has enabled other areas of technology convergence such as cell phones and the like also enable such implanted devices to have increased capabilities – thus enabling the field of “[smart devices](#).” The “bionic man” is becoming a reality – see for example, Dr. Frank Johnson’s recent book “[The Bionic Human: Health Promotion for People with Implanted Prosthetic Devices](#)” - and CMT is a major part of this.

The growth of personalized medicine goes hand-in-hand with the convergent medical technologies. As written about in the article “[Personalized Medicine and Technology Convergence: Decisive Trends](#),” personalized medicine, by definition, includes not only a therapeutic component but also a corresponding diagnostic aspect. To “personalize” a medical treatment for a particular patient requires a more personalized and specific diagnosis which has led to the growing field of [pharmacogenomics](#) and a tighter link (a “closing of the loop” as it were) between diagnostics and therapeutics which has led to the concept of [theranostics](#). A

second angle to personalized medicine is not just a higher degree of specificity from the genomic perspective (e.g. pharmacogenomics) but also a finer-tuned personalization and specificity from an *anatomic* perspective. The example of drug-eluting stents is certainly illustrative as the powerfully toxic drugs such as paclitaxel and rapamycin used in such stents could not at all be administered systemically at the therapeutically relevant doses. Putting them directly on a stent at the localized site for their action is what makes the entire thing work. That's the power of drug-device combinations. A previous posting "[The Diabetes Divide: Is Diabetes a Surgical or Medical Disease](#)," discusses how drug-device combinations may be potentially used in the future to both connect insulin delivery levels with physiologically relevant portal vein glucose levels as well as more optimally deliver insulin to relevant target tissues such as the liver.

The demand for convenience – the now-classic and well-known characteristic of aging baby boomers – is not an insignificant factor behind the development of CMT. The rise of theranostics – the closer link between diagnostics and therapeutics – is as much a new technological paradigm as well as a payment of homage to the increasing demand for rapid information delivery and convenience by our society. The world of waiting a week for your “test results” is rapidly coming to a close and the theranostics revolution as enabled by CMT that brings together more closely diagnostic and therapeutic technologies.

Finally, the growing importance of safety further drives the development of convergent medical technologies. As outlined in another article - "[Drug /Device Safety Debate to Yield Big Changes, Grow More Controversial](#)," safety is an increasingly important consideration for medicine. A number of trends – including greater efficacy of medicine, the coming of age of the baby boomers, the rise of chronic diseases, more aggressive disease prevention and the rise of quality-of-life treatments – have given safety a much greater significance than what might have been in the past. Pharmacogenomics, the greater specificity and localization of treatments and the infiltration of devices with smart, safety-enhancing features are all trends in CMT that enable greater safety.

### **The outlook for convergent medical technologies**

In the third part of this series, we will highlight some of the ways in which CMT is changing healthcare and medicine. Suffice to say that the field is growing and like the catalyst that polyphony and counterpoint were as integral to the cultural revolution of the Renaissance, there will be no limit to the flourishing of new applications (and benefit to patients) that will result from convergent medical technologies.

To listen to the Bach d-minor invention, click [here](#) (it'll take a few moments to download). It's played a bit fast for my tastes but perhaps that's because I'm certainly not virtuoso enough to do that. In any case, enjoy!

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