When Worlds Collide

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We might be talking about the old sci-fi thriller or perhaps the on-going media clash (convergence) between television and computers. The colliding worlds could be any of a dozen confrontations within the worlds of technology, culture or ideology. But our topic is not a big battle of planets, countries, societies or any titans. In fact, it's the impending clash within the ***Brave New Nanoworld***. Then again, the nanoworld is constantly colliding with our macro-world as it strives to become the darling technology universe of the 21st century. Microelectromechanical systems (MEMS) devices constructed with semiconductor processes have taken on the big machines made piece-meal by humans. Nanotechnology can now build gears, wheels and tiny mirrors the size of microbes. MEMS can move, "hear", "see" and control the surrounding space. One example of advanced MEMS is the Texas Instruments chip for digital projectors. This optical MEMS device has over a million micro-mirrors. That's more moving parts than anything yet manufactured in our big world - even more than a Boeing 777. So let's zoom down over the *nanoscape* for a brief flyby.

We've been hearing about nanostructures, especially those based on carbon atoms combined to form tubes, fibers, ropes and *buckeyballs*, all on an atomic scale where the micron is a very long yardstick. The figure below shows some of the nanocarbon structures. Several advanced research labs, including IBM's, have recently announced *nanotube transistors* where carbon replaces silicon. And perhaps a move to carbon, or C-based computers makes sense. The human brain is a carbon-based thinking "machine" that evolved over millions of years. So maybe the colliding worlds are really those of silicon vs. carbon, or electronics vs. biotech, or electrons vs. photons vs. ions. There are certainly plenty of competing dreams, concepts, sciences and technologies. But there are two tiny worlds that are on a collision course to make the tiniest self-activating structures possessing sensing and logic.

Nanoscience has made major strides in crafting ever-shrinking "engineered" structures. Thanks to atomic microscopes and manipulators we can even built these things by moving one atom at a time. Some may recall that IBM constructed their logo in atoms - a remarkable feat considering the miniscule size of atoms. It would take 250 million hydrogen atoms placed in a row to make a one-inch line.

Today, MEMS nanostructures are made by mostly "mechanical" methods. We add material by deposition and remove it by etching using semiconductor machinery. This may be high tech from an engineering view, but it's crude on a molecule scale. But there is another nanoworld science with much more experience and success in constructing tiny objects. It's chemistry! Chemists, whether known as material scientists, molecular biologists or genetic engineers, also appear headed toward *man-crafting* tiny structures with life-like characteristics. Chemists, especially in the fields of organic and biochemistry, have been slowly succeeding in the nanoworld using mostly molecular methods. Some assembly required, but no etching and hacking, thank you! The atoms and molecules are transported, combined and rearranged under their own power by simply permitting the laws of chemistry to rule. Complex structures are made at the rate of millions of molecules per second in chemical reactors. Chemistry is a massively parallel process and scales very, very well! And while nano-engineers are shrinking their creations to squeeze into the molecular world, the chemists are upward bound, building and manipulating larger and larger molecules, even DNA. The DNA molecule is the most complex nano-structure known and its script may contain the equivalent of 1 million pages of "words". So will these two worlds collide – nano-machinists vs. chemists as the first group sharpen their "nano-tweezers" and the chemists bulk up? And what is the final goal. When we extrapolate these technology trends forward, we get tiny machines that move, sense, think and someday make more machines. Is this not the definition of "life"?

In a future not too far, the nano-technologists are about to create a man-made structure that meets all the requirements of a life form. Starting with earthly soil, the teams are about to create ***nano-life***. Soil was selected as starting material based on an early reference stating that the first human was created from this element-rich medium. But just as the experiment begins a voice booms down, *"Hey down there, use your own soil"*.