Part 1. Molecular Ergonomics "Your knee bone's connected to your chromosome!"

For those who think they have missed the birth of a new science, fear not, you haven't nor are you likely to hear the term again. It is a one off event to bring focus to some basic concepts of biochemistry in an ergonomic perspective. Ergonomics' serves beings with chromosomes, which script our destiny based on our history and so ergonomic practice must work within the confines that they create!

There is no physical activity that does not alter physiology, no Biomechanics without Biochemistry. Biomechanics provides the potential to change position or location. It uses a lot of energy and is always at odds with an organism's biochemistry that strives to conserve energy and maintain stasis as a dynamic equilibrium at the "Molecular" level. Ergo, Ergonomics impacts molecules. This equilibrium must be maintained in each and every tissue cell. Therefore posture and movement strategies (ergonomics) must maintain cellular biochemistry within the acceptable boundaries that ensure the organism's survival.

The energy costs of movement must be justified in terms of the "viability of that species" on the basis of additional access to food and the enhancement of procreation. If it didn't there would be not point to evolution beyond plants or trees. Leaving theories of evolution behind: in a nutshell the ability to move evolved because the benefits of doing so outweighed any disadvantage. The way and the extent we use computers today is now reversing that evolutionary principle. Evolved over eons and honed by the extinction of those for whom change "didn't take" one aspect of our "design success" was the development of a control mechanism. This is a feedback system that monitors the activity of the entire body though not individual muscles or cells, which is why the problems that we cal RSI can occur.

Computer work has resulted in us working for hours at a time with a resting heart rate even when extensively use our small muscles. Nature never anticipated this posture, or work habit, but then there are no zeros in nature, so she never saw binary coming! Therefore she only saw fit to evolve a single centralized sensor system for the detection of "out of boundary" conditions for our biochemistry with the objective of ensuring that we do not stray too far or for too long outside of a biochemically manageable zone.

If our biochemistry were locked into a closed loop system it would inevitably result in our demise. This is a sobering thought and as all brewers yeast cells know, after being supplied with sugar and oxygen in a nutrient rich though closed environment, while proliferation is rapid early on, once the nutrients run out and alcohol, their metabolic byproduct, builds up (thankfully) the end is inevitable. Ultimately any closed ecosystem collapses due to a lack of nutrients and the toxicity of metabolic byproducts. Cut off circulation to a limb extremity and you are creating the exact same closed loop system.

Computers have put "the design of man" at odds with man's design. That is to say that just because we can sit at computers for hours and hours does not mean with have the physical makeup or endurance to do so. This is because the detection of out of boundary

conditions relies upon this centralized sensing system so remote "closed systems" can occur unbeknown to the body.

Apartment dwellers that do not have their own thermostat will know exactly what this means. When there is one thermostat for the entire building it is assumed that activity and needs of all apartments are the same. Consequently if Apartment 4A is working out while the rest of the building is watching TV then 4A produces more, localized, heat. The building heating system however is oblivious to this and, even though the heat produced in 4A travels through the walls and down the corridors, 4A's activity impact is so small it is "diluted out" by the temperature in the rest of the building and so the thermostat does not detect so react to it. Meanwhile 4A could be in a state of collapse through heatstroke.

If everyone in the building worked out at the same time then the heat produced would likely have an impact on the building's temperature sensor, which would then cut back on the boiler, turn on the AC, whatever.

Now imagine for a moment that the building is hermetically sealed and all air, food and water going in and waste going out is regulated by one set of sensors in the reception area. If 4A is now exercising in isolation oxygen levels will fall and concentrations of waste increase locally in 4A but because the sensors in reception have not detected it 4A has become an isolated closed loop system.

Only if all apartments start to workout will there be sufficient impact on the "building sensor" to create a feedback response that increases the oxygen supply, food supply and waste removal.

Despite the obvious holes in that analogy the principle is the same for the body. The body's oxygen sensor, located in the brain, cannot detect the localized oxygen depletion in the small muscles of the fingers etc, even when they are working at 100% of capacity or are near exhaustion. Their activity is not of significant magnitude to alter oxygen levels in the main blood vessels to the brain sufficient to precipitate a sensor response. Only when the larger muscles of the body are involved are blood oxygen levels sufficiently impacted so aerating all body tissues. Breathing and heart rate increase when we walk or move around, peaking when we run or do heavy exercise. Those who cannot see the value of, or are sometimes delinquent in following break protocols, including just getting up and moving around periodically, might like to review their own strategies.

Increasing blood circulation to deliver more oxygen automatically increases nutrient delivery and waste product removal because the body moves materials in and out by osmosis. Osmosis is the movement of molecules from a high concentration to a low concentration (down a concentration gradient) across a cell membrane. So if you have a high concentration of toxins in your tissue cells and a slow, resting, circulation, toxin levels in the blood increase until the blood reaches the same concentration as the tissues so osmosis stops or the blood becomes saturated and cannot carry anymore and so any

toxins in tissue cells further downstream do not diffuse (the process of osmosis) into the blood.

One last building analogy to explain this point! We have a long street with apartment buildings on either side. We'll call it Lunar Blvd; it is part of the first moon-based community so buildings require regular delivers of bottled oxygen as well as having to bag their garbage for collection. Oxygen delivery and garbage pick up are on the same truck because the quantum of building activity is that one bag of garbage is produced for every bottle of oxygen that is consumed. The truck starts at one end of the street delivering oxygen and picking up garbage at each building. If the truck becomes full of garbage before it reaches the end of the street then garbage from the buildings further down the street does not get collected. We also know, because of the quantum nature of activity, that if the truck gets full of garbage then it has also run out of oxygen and so buildings down stream have to wait for the next truck for both delivery and collection. But when the next truck arrives it starts at the same end of the street as before servicing the same buildings that filled the first truck. So if they have put more garbage out once again this truck can become spent before it reaches those buildings that could not be serviced by the last truck. Unfortunately Lunar Blvd does not have a phone system and so occupants at the end of the Blvd cannot call to order more trucks. They are scheduled centrally on the basis of the entire moon colonies oxygen consumption and not just Lunar Blvd's.

This is how "closed loop" systems are created in the body and why damage can occur in deep tissues that do not have an adequate blood supply. The deficiency is created simply because, relative to the rest of the body, working our hands while our body is at "respiratory rest" means those muscles that are active use up all their available oxygen and produce too much waste for blood flow that is available. The sinister aspect to this decline is that once we get into this spiral, metaphorically speaking, the garbage gets piled so high on the streets that it blocks them (tissues become damaged) so that trucks (blood supply) can no longer get through!

Once tissues reach a critically low oxygen level they switch to an internal last ditch "energy generator" known as the Lactic Acid Cycle (LAC). LAC is the only way that cells can make energy in the absence of oxygen and it is a process that can only be sustained for a few minutes. It is oxygen levels in individual cells that precipitate its occurrence and so in the same tissue some cells can be working aerobically, some anaerobically (under LAC) and some cycling between the two. We know when LAC has been invoked to an excessive extent in the legs as the toxins it produces cause the Charlie Horse reflex. LAC toxins also produce the burning sensations felt during a heart attack. Most muscles do not demonstrate a Charlie Horse reflex so cells in the vicinity of any extended oxygen depletion become "pickled" in their own waste. This needn't be a large number involved at one time and any damage thereby is as a result of its cumulative effect. Pickling best describes the effective outcome of immersing living tissues into a weak acid and is why muscles loose elasticity and function and pickled cells begin to form regions of dead scar like tissue. The only clue we are likely to get when this occurs is an ache in those muscles affected, a point we will come to in part two.

Tom Large
President & CEO
Designer Appliances Inc