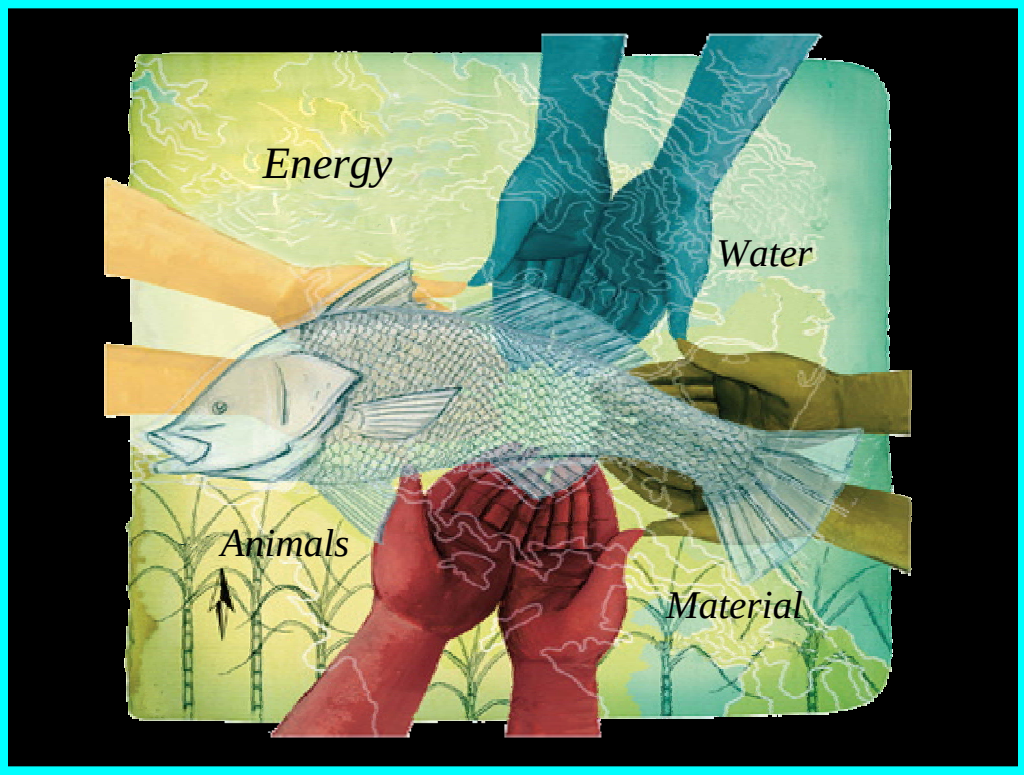
Good morning, I'm Joe Arlotto, Senior Aquatics Engineer for MWH formally an operator at Brookfield Zoo, Abq Aq and San Diego Zoo.. We are an engineering firm which specializes in all aspects of life support engineering: design, operations, retrofits, start-up, etc. I've been coming to these AALSO conferences for quite a few years now and the talks keep getting better and better. There are always good ones re: chemistry, ozone, pumps and valves, facility spotlights. And there is always at least one talk each symposium which is a little … let's say … out there. Kind of the next thing, a little vague but gets us thinking about what's next, about not just the same way we've been doing it for years, thinking outside the box, about what's possible. And this is that talk. And speaking of "OUT THERE" … I'd like to introduce Paul Cooley, MWH VP, who will get us thinking about sustainable life support design.

The world is changing. We need to look at the world differently. Thru the eyes of sustainability, carbon footprint, conservation.

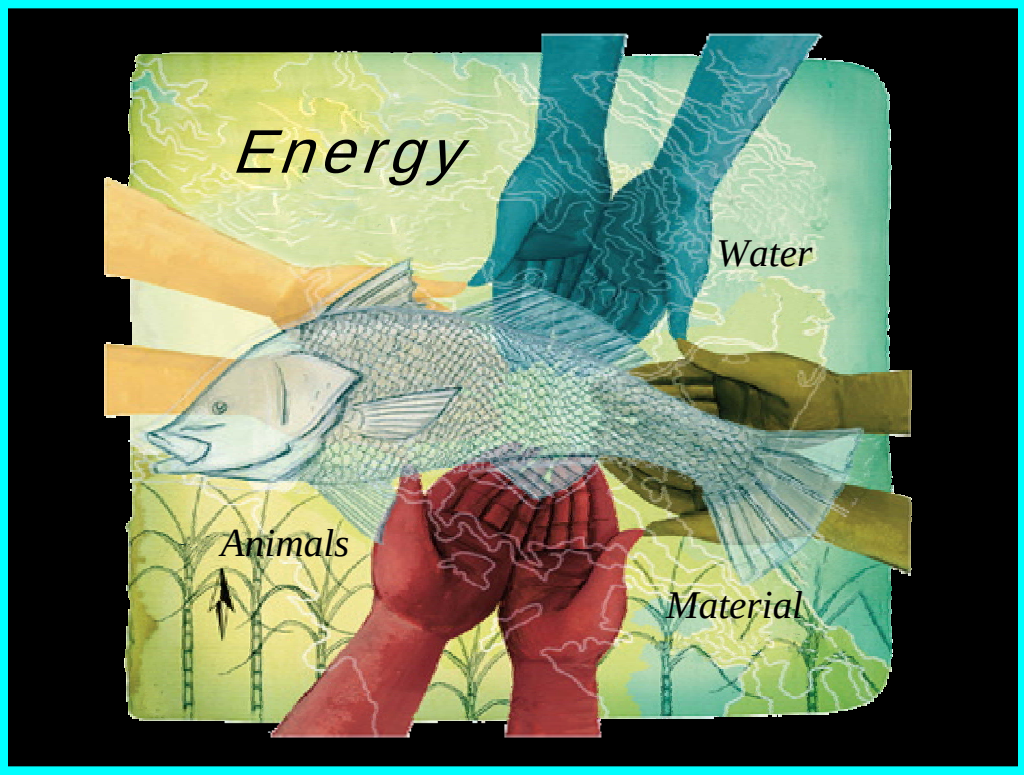
It is accelerating. Technology continues to accelerate. Water treatment technologies is acceletating. Wastewater treatment technology is accelerating. Life support system designs need to keep up with that acceleration.. Or we will be…

left behind.



There are four basic aspects of sustainability for Life Support Systems that I want to talk about today.

I. **Energy**
II. **Water**
III. **Materials**
IV. **Animals**

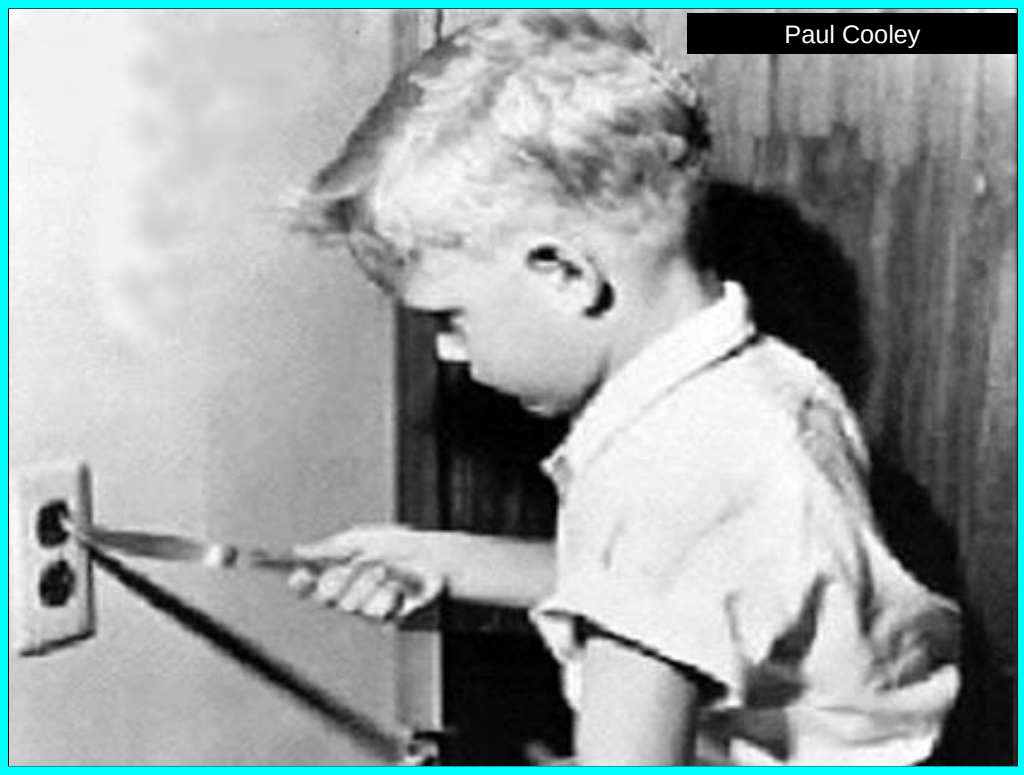


Let’s start with Energy.

Aquariums consume lots of energy - about 60 kw/year/sqft

Pumping, cooling, heating, treating - big power consumers.

With the cost of energy increasing it is obvious ……

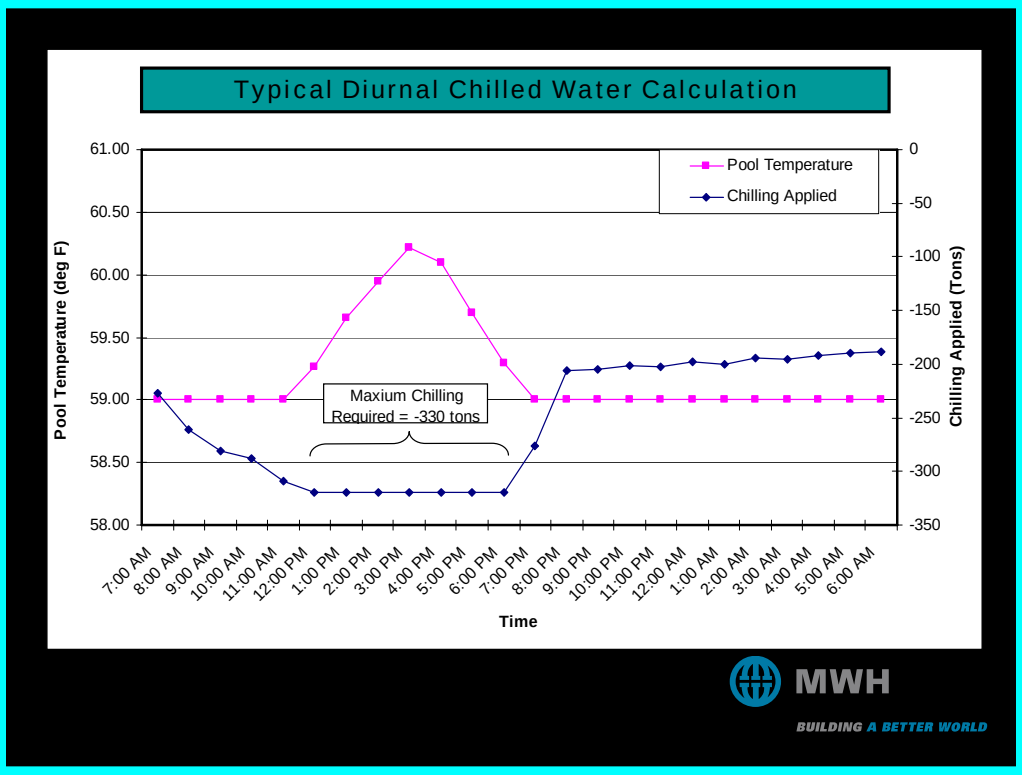


….we must be more careful with our energy usage

Standard energy conservation measures are essential:

VFD (variable frequency drives)
Optimizing the pump sizing,
Optimizing the chilling and heating usage,
Off Peak usage of chilled water,
Thermal Storage

Those are a given. But that’s not enough.



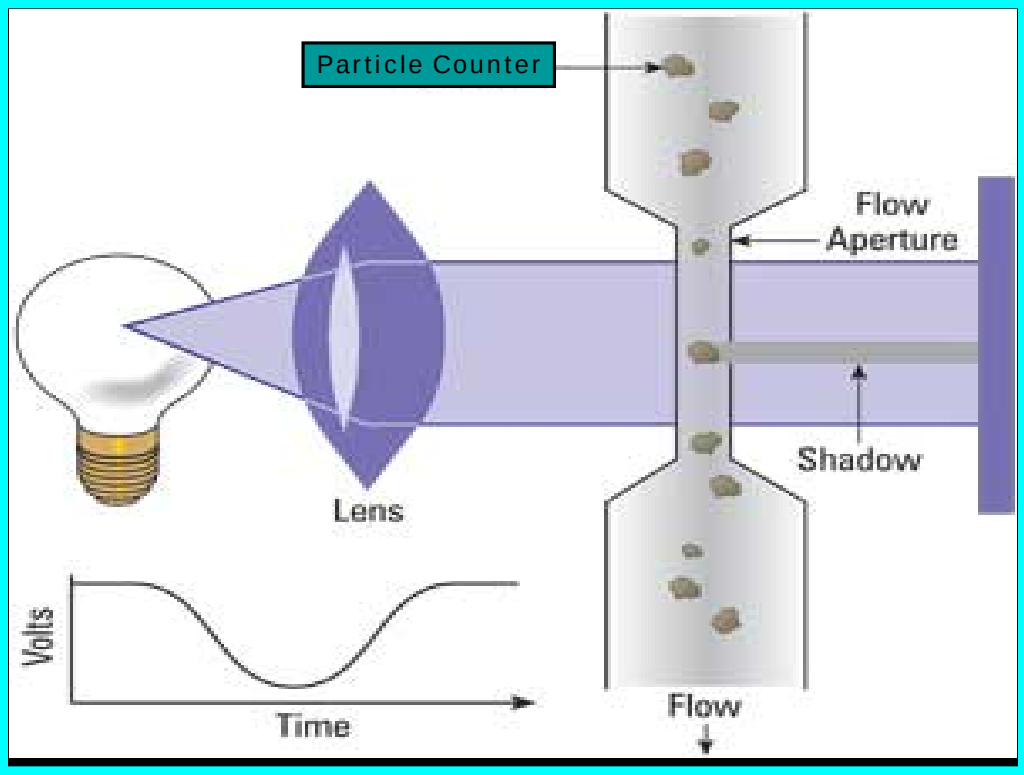
First, there needs to be a better understanding between the design engineers and the exhibit designers in providing energy efficient exhibits. For example, in some cases cooling energy requirements can be equal to the pumping loads. Therefore, reducing the size of the thermal surface area of the pools could reduce energy requirements. Providing protection from wind or increased exposure to the wind – depending on whether you are heating or cooling. On the screen is an example of detailed chilling calculations that are possible with advanced modeling techniques that allow us to analyze these effects.

We need to be smarter in our exhibit design to improve energy efficiency.

Second, we need to optimize system performance.

When the conditions are right…can we save energy by adjusting our operations?

It starts with optimizing the equipment sizing. Not over sizing the equipment. This means sizing based on anticipated loading. But we do that. But we always pick the conservative loading which doesn't always materialize. Just because the pump is designed into the system doesn't mean you need to run it - performance feedback that tells the operator the loading and operational conditions exist that REQUIRE the pump to be turned on – that is what we need. Now that saves energy - shutting the pumps off. How many operators are shutting pumps down in the system because the loading doesn't match the design loading? None. I look at it and it seems to me that the systems are probably 25 to 50% under loaded. Yet the operators are running all pumps designed. If we can shut those pumps down we can save about 25% of the power requirement for the systems. Big Big energy savings!



So how could this work?

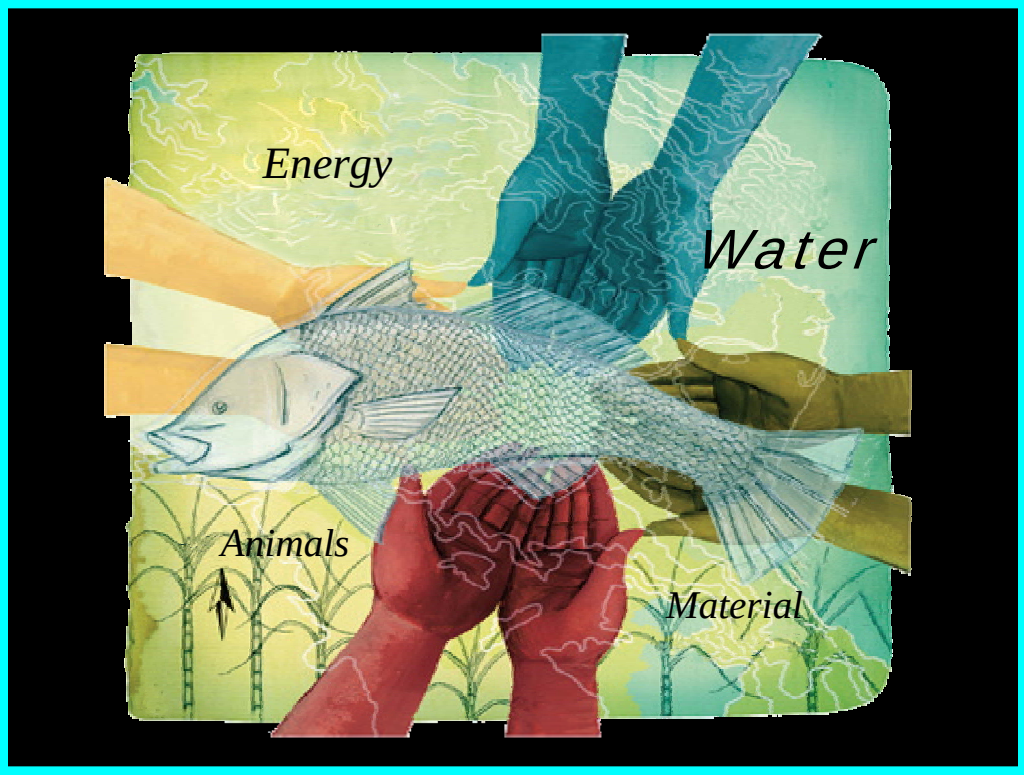
When the water is clear and the loadings are low, part of the system is turned off. This can be done with particle counters or SDI (Silt Density Index) analyzers. When the water is cloudy and the loading is increasing, the system is turned back on. Optimization of the system to match the actual loading rather then theoretical loading.

This type of system is becoming more prevalent in the HVAC area - they call it air acuity. Measuring the air quality in a building and matching the operation of the HVAC system to that air quality. Life support systems could use the same techniques.

Aquariums need to look at water acuity.

It gives the operators the option of picking their power consumption - optimization of energy.

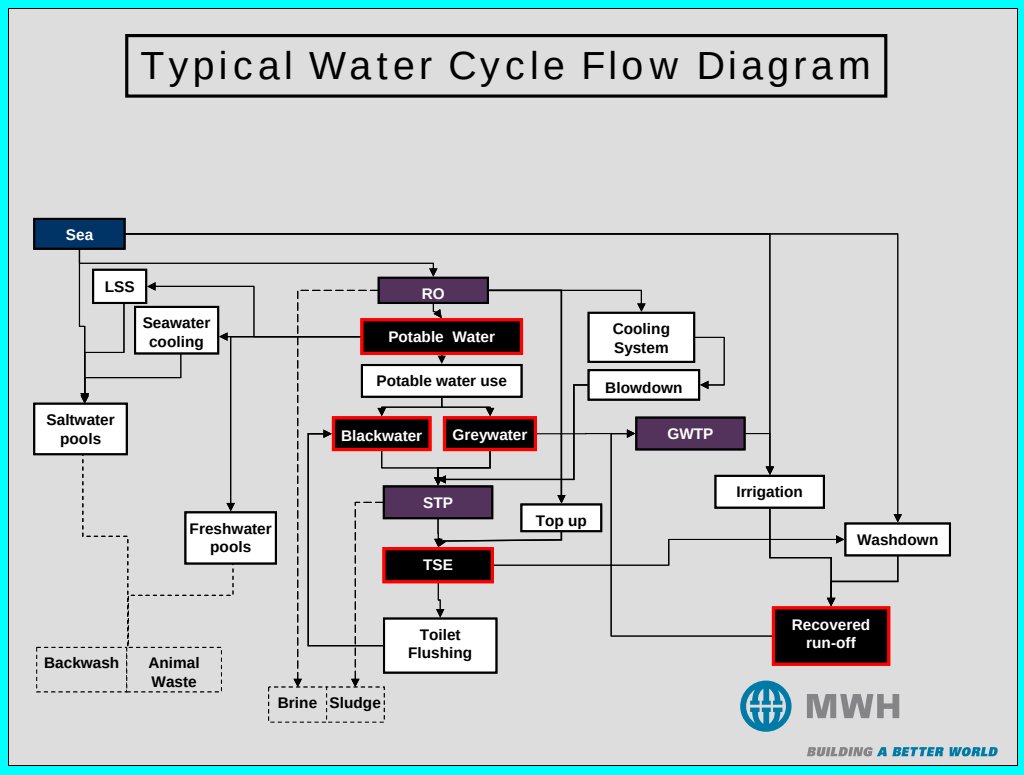
So we need a breakthrough - a bridge between the design and operational side to allow for operational optimization and energy savings.



Now let’s move on to the water side of sustainability

You think we are running out of oil.

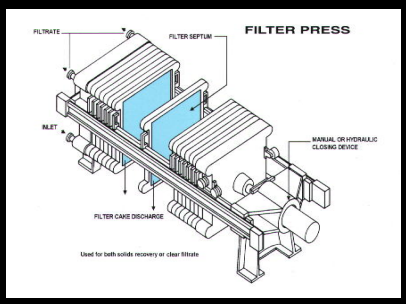
In some areas of the world we are also running out of water.



We do projects all over the world. And believe me, many countries ran out of freshwater a long time ago and even using and disposing of seawater has environmental ramifications.

This is a water balance for just such a project. Water is used, reused and re-re-used. We are being asked more and more to exam the entire water balance for the facility (not just the animals) and optimize the use of the water across the board. Conserve, reuse, reclaim. Get use to it. It is coming.

Fractionator



Solids Dewatering

Bead Filter

MWH

BUILDING A BETTER WORLD

And the technology exists to close the aquarium up and use minimum water.

1. Fractionator spray down recovery.

2. Solids dewatering and digestion. Wringing the water out of the solids and reusing both the solids (for energy production) and re-using the water.

3. Bead filters – Reduce filter backwash.

Conserving every drop. Complete and absolute 100 percent water conservation.

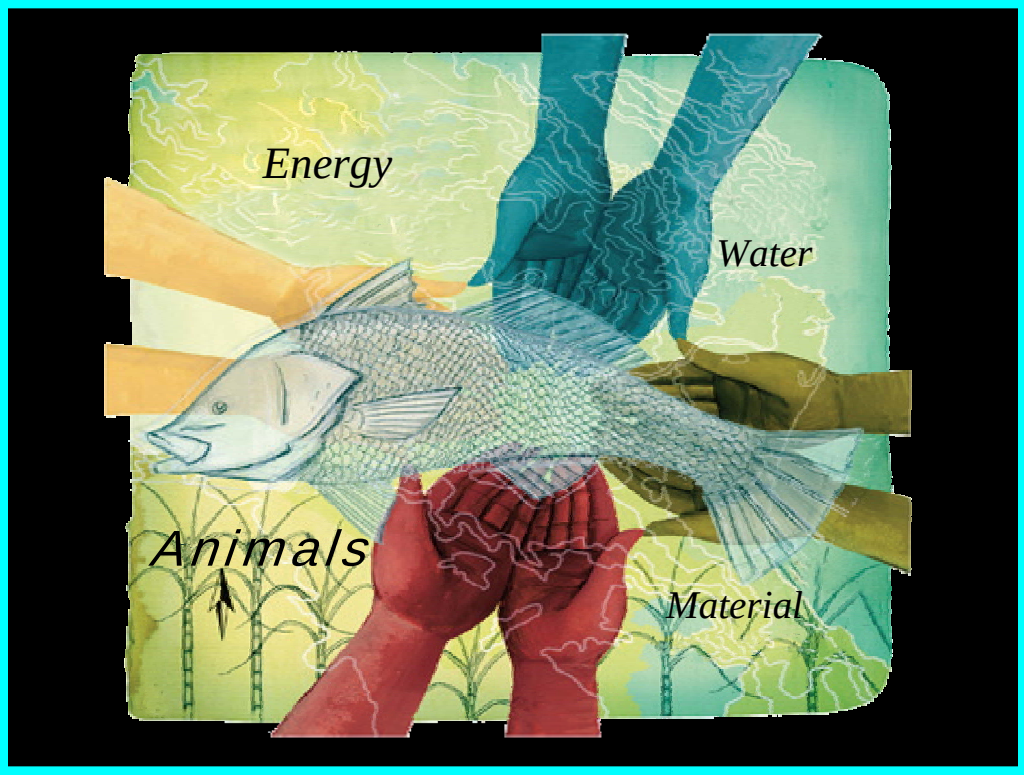
Now let us talk about materials. The materials that make up life support systems.

Life support systems are equipment intensive. And because of the seawater corrosion they are exotic material intensive - plastics, exotic metal, and expensive materials.

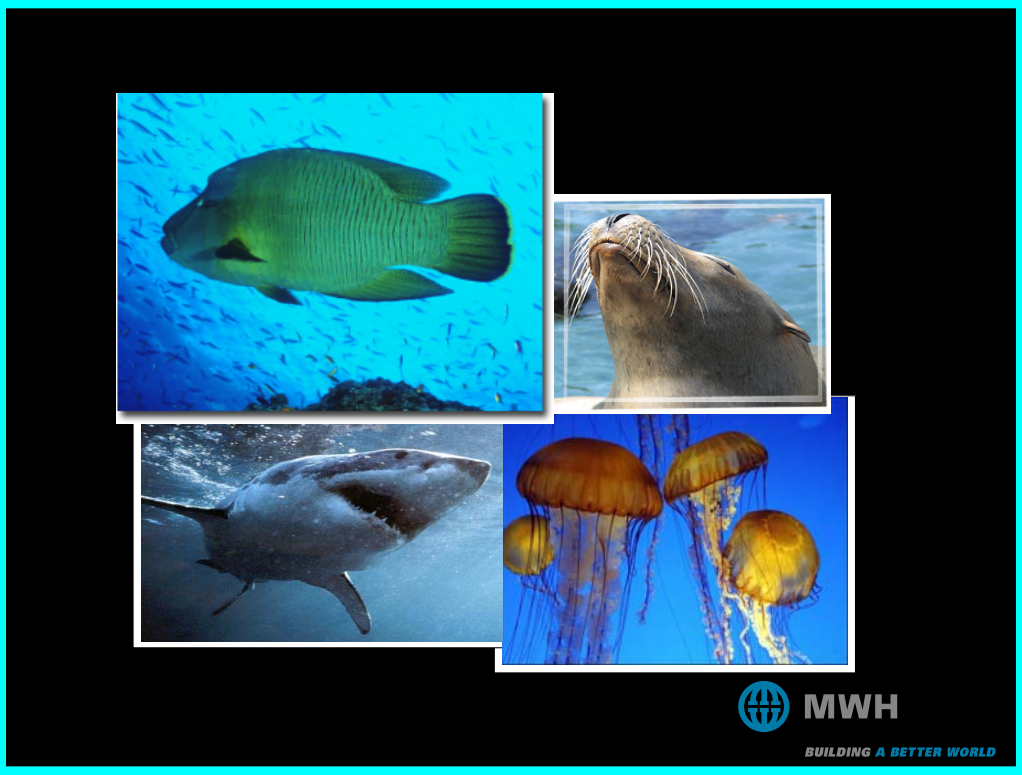
But if we are using all of these exotic materials that “last forever”, why do all of our specifications require NEW MATERIALS?

Could we change our specifications to use renewable materials for LSS equipment - pipes, valves, pumps and filters? Turning junk into…..!

A useful product….seems doable….sustainable.



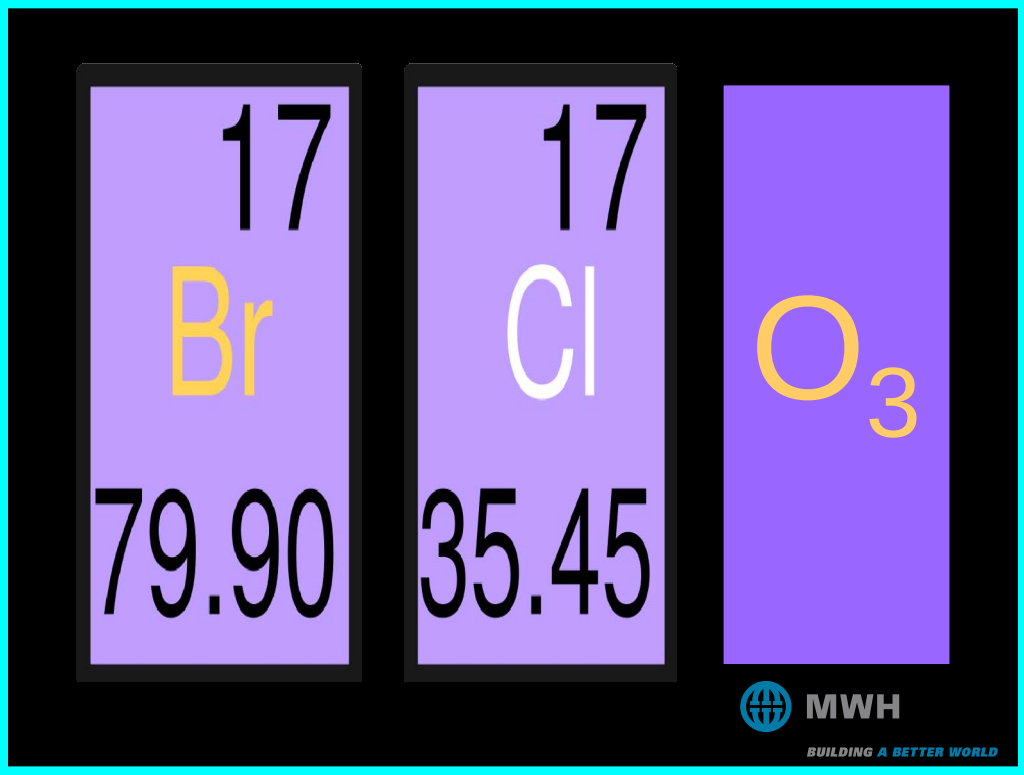
So how can we have a discussion about the sustainability of the life support system without discussing the sustainability of animals!!



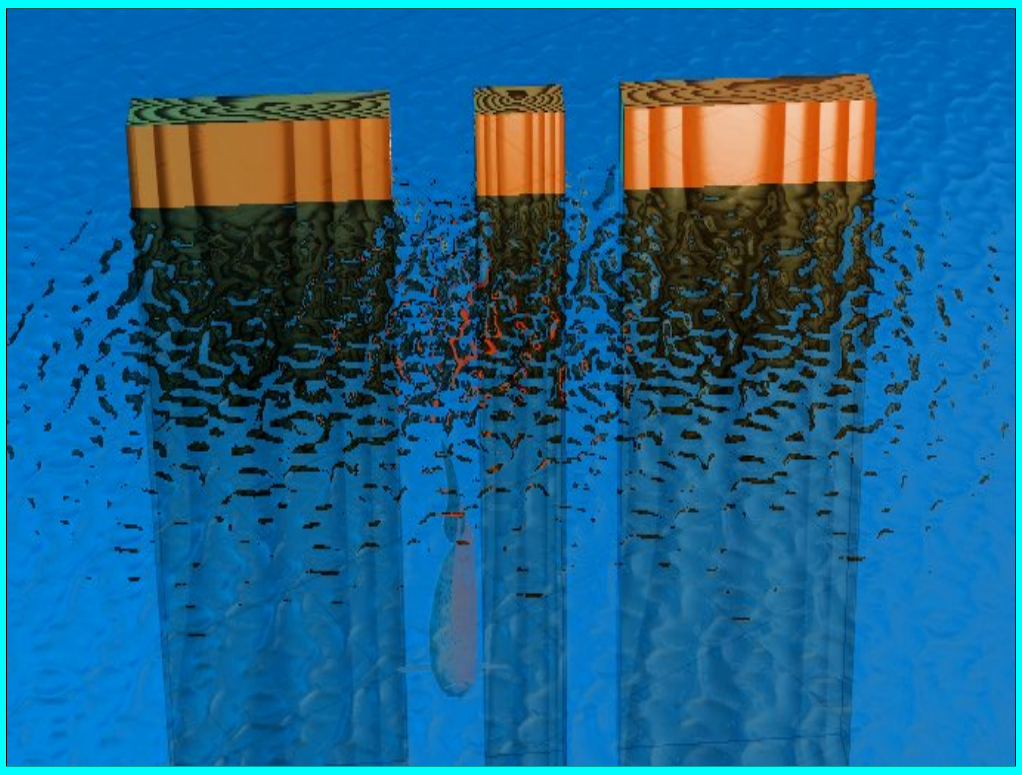
So I thought about that. I thought about the acceleration of technology, water treatment technology and how that acceleration is affecting the life support system design and sustainability.

Life Support Systems are designed for people rather than for the animals. Clarity controls the design. Clarity so we can see the animals. The animals don't always want to be seen but we want to see them. What would the life support system look like if they were designed for animals first and people second?

So maybe the big sustainable breakthrough is changing the priority! When you put the animal first and look at animal health, what is the one element that is glaring obvious



…..it is oxidants – chlorines, bromine, etc… these do not exist in the natural environment yet we put our animals in them.. And the time is right. The technology breakthroughs are here to allow us (in certain circumstances) to eliminate oxidants.



So what happens when we combine

1. “animal first” life support systems,
2. “people second” life support system,
3. the accelerating water treatment technology,
4. the need to design sustainable system together?

The answer - membranes.

Membranes are becoming more universal in water treatment plants, wastewater treatment plants, and industrial treatment plants. They are getting cheaper, lower pressure, easier to maintain… yet we very seldom see membranes in aquariums life support design. Why is that?

The argument in the past has always been…

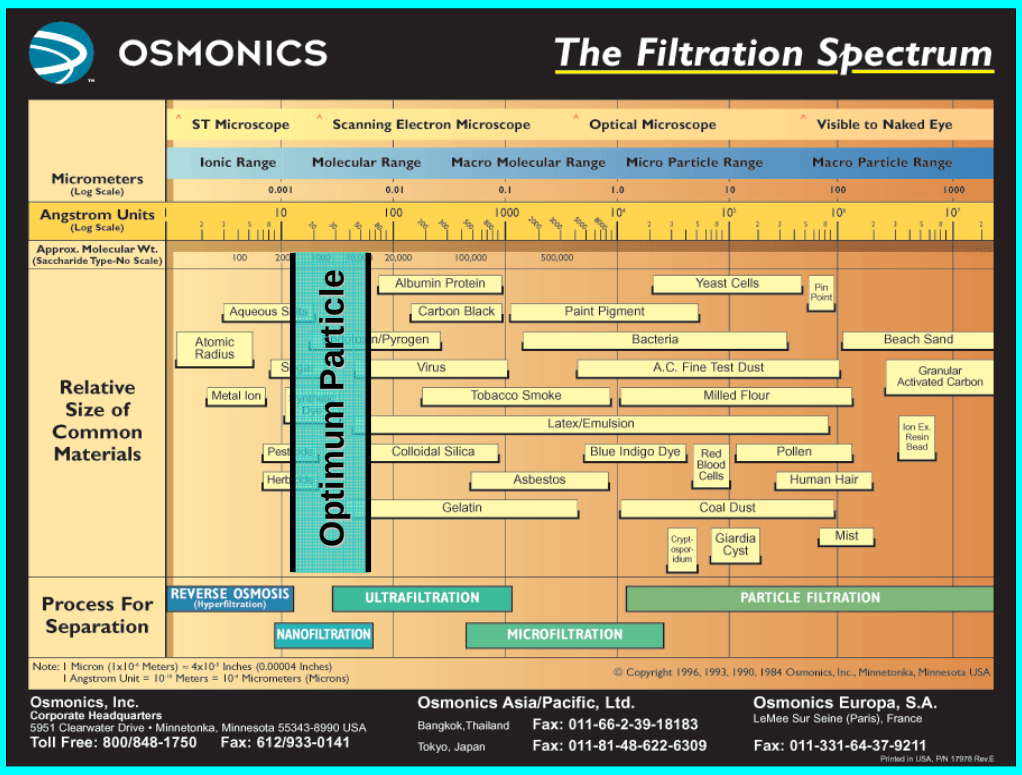
… cost.

But the systems are sized not with aquariums in mind and the requirements of animals. And membranes are improving and getting cheaper.

(Joe starts again here)

But for an operator, cost is not the bottom line. Are they maintainable, are they easy to operate, can my staff handle it or will it take too much time to backwash or replace or fix. Is my system dead in the water when these don't function properly? Can I get parts quickly? And, ultimately … do they deliver good water quality consistently because the bottom line is … we're all willing to spend a little more time and effort on operating and maintaining if we can count on great water quality day in and day out.

So, let's talk a little about membranes …



Obviously, membranes come in different sizes. We need to find a membrane that is low pressure, removes viruses, bacteria, pathogens, long chain organic compounds that produce color, and all organic compounds and low turbidity, leaves the water gin clear but leaves salts and trace elements.

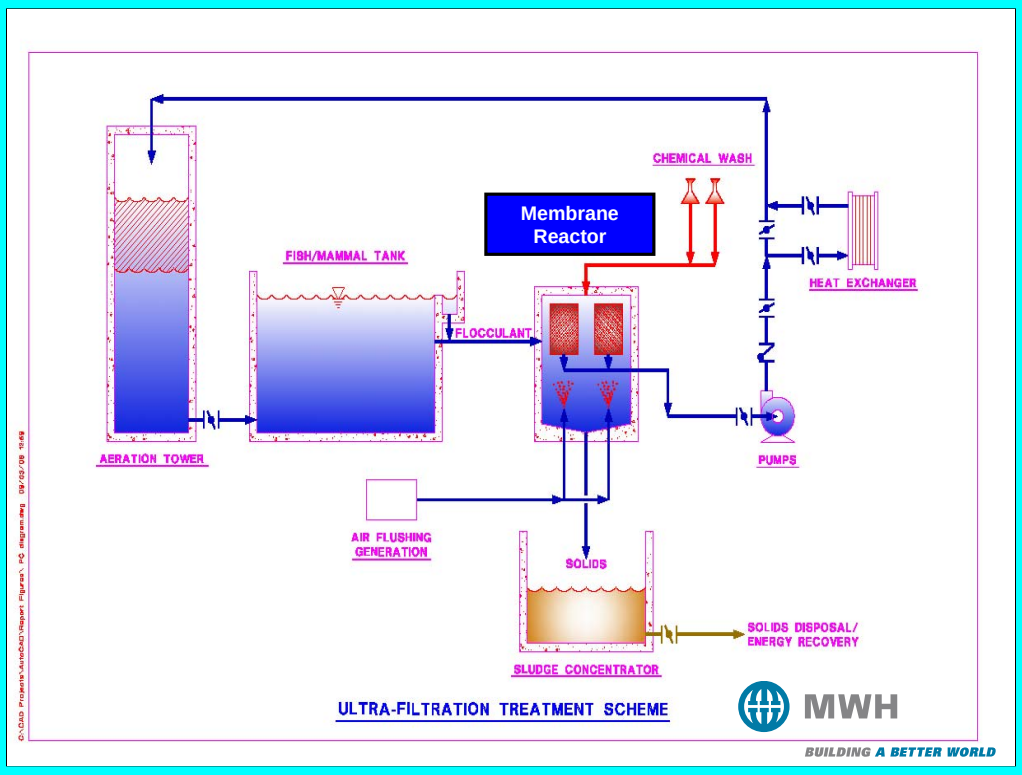
And it lies right here on the filtration spectrum. Right in the Nano/Ultrafiltration Range.

But something still is not right. There are still questions: 1) Sure they are getting less expensive but are they less expensive enough then sand filters? And 2) Can we deliver the turn over we need … 45 minutes in hippo exhibits, 1 – 1 ½ hr marine mammal?

Well, pound for pound, membranes can't compete with sand filters in terms of cost but consider this … superior filtering means we can have longer turnovers, fewer pumps, less equipment in general … cost saving.

Talk about Joe L's research on cost?

I believe that the time is right for applying membranes to life support systems…so what would it look like.



So here is my prediction for the future. Here is my melding of the current breakthroughs' in water treatment technology, putting the animals first, people second. This system eliminates sand filters, fractionators, ozone, substitutes a membrane bioreactor vessel utilizing ultra-filtration membranes, extremely low turbidities, consistently, AND NO OXIDANTS, low TOC and suspended medium nitrification/phosphorus removal. Everything! In a simple system! Easy to operate! Easy to provide for operational optimization, based on water acuity!

And who knows … membranes could be used on recovery systems to improve make-up water quality to a point where it further decreases the cost of the main life support system.

Design charrette using experts to optimize

We're not there yet but the ideas are coming together

NO3 and phos

They say the polar icecaps are melting. Disaster is eminent. The world is coming to an end. We're using up everything.

I don't think so. I guess I'm a bit more optimistic. Optimistic that we can….

…. work together to solve these problems. That means designers and operators and veterinarians. Economic stresses.

But I do know that we have an obligation to be more sustainable in the design of our facilities. Strive for simplicity, flexibility, reliability. Push the envelope of technology. Sustainable in:

Energy use,

Water consumption,

Materials usage and

Animal health.

I appreciate the opportunity to share some of my ideas for the IAC2008 Conference.