Water Feature Costs

- Average water feature costs is between $200-300k
- Assumes:
  - Basic pool shape and finishes
  - Standard water effects, nozzles or waterfalls
  - Standard lighting
  - No interactive components
  - < 100’ distance to equipment space

Understanding the Medium
or
All about Water

- Terminology
  - Knowing the difference between water effects
- Execution of effects
  - In order to execute you need to know how they work
- How to make them work
  - The devil in the details
- Knowing the details
  - Construction methods and tolerances

Types of Waterfalls

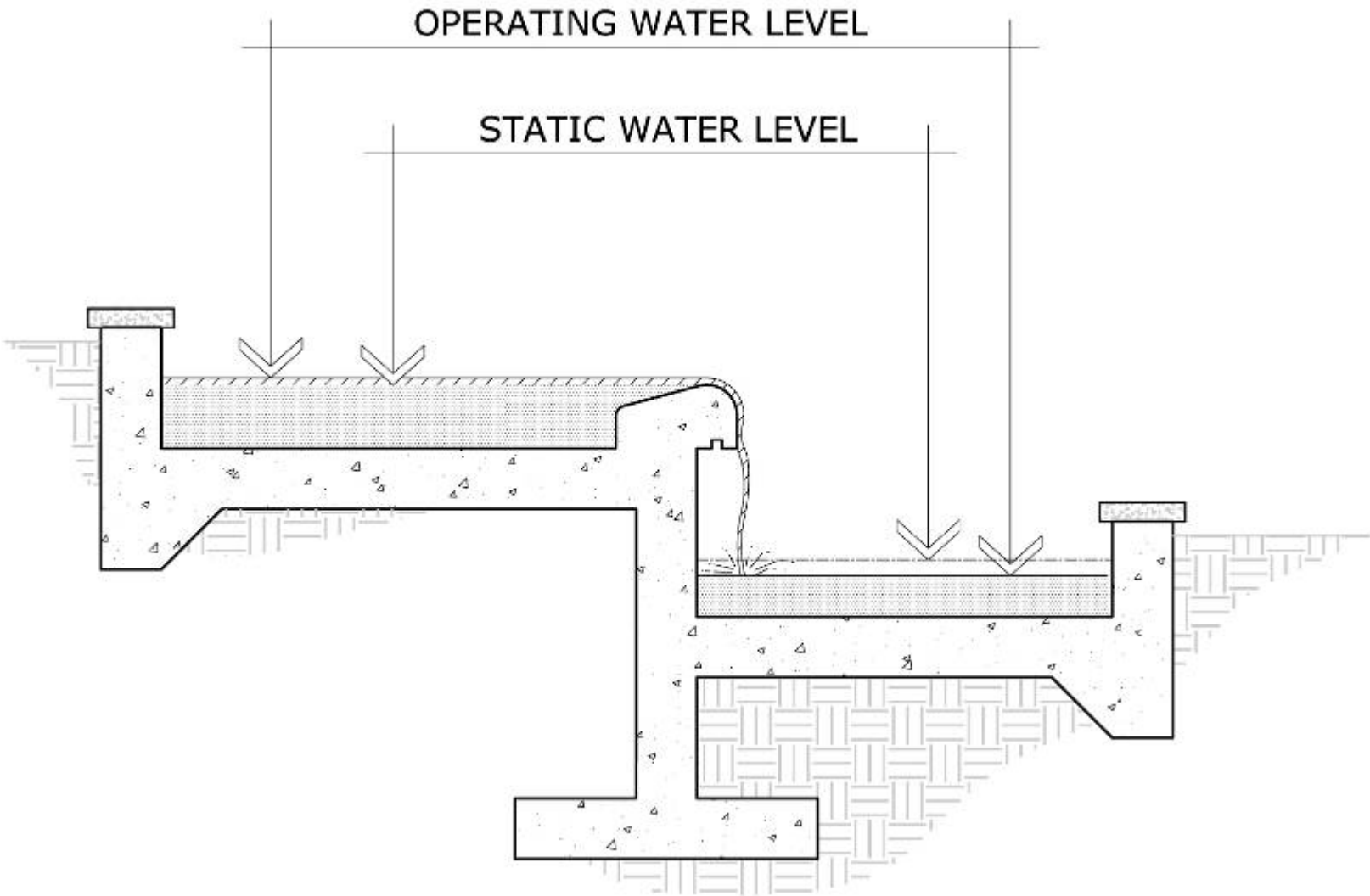
- Cascades – heavy flows and falls
- Steps – aerated white water
- Veils or Sheet falls – smooth flows
- Waterwalls
  - Aerated – contained white water
  - Textured – controlled roll waves
  - Tension – smooth wave patterns

Hydraulic Design

- Waterfalls
  - Types: Smooth Sheets, Cascades, Steps, Waterwalls require different flow rates and physical arrangements
  - Flow requirements are per lineal foot but knowledge of how this translates into flow depth is important
  - Weir design is very important to the execution of any given water effect

Flow rates for water depths

- 1/8” depth = 5 gpm per lineal foot
- 1/4” depth = 10 gpm per lineal foot
- 1/2” depth = 17 gpm per lineal foot
- 3/4” depth = 28 gpm per lineal foot
- 1” depth = 40 gpm per lineal foot
- 1.5” depth = 70 gpm per lineal foot
- 2” depth = 105 gpm per lineal foot


OPERATING WATER LEVEL
STATIC WATER LEVEL

Shut Down Rise

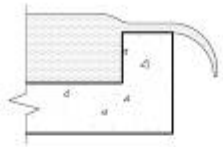
- Area of upper pool ($ft^{2)}$ x Depth of water (ft) = volume of water to catch (ft^3)
- Volume of water to catch (ft^3) ÷ Area of lower pool = Shut down rise (ft)
  - Example:
  - Upper pool size 10 x 20 = 200 sq. ft.
  - Lower pool size 20 x 4 = 80 sq. ft.
  - Flow over waterfall = 1" = .083'
  - 200 sq. ft x .083 ft = 16.6 cu. ft.
  - 16.6 cu. ft. ÷ 80 sq. ft = .2075' = 2.49"

Laminar Flow

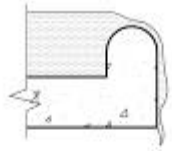
- Non turbulent, non crossing flow – with a Reynolds number of 2000 or less
  - Stable in nozzles
  - Stable in water falls
  - Usually does not occur in pipes larger than ¾”

Weir

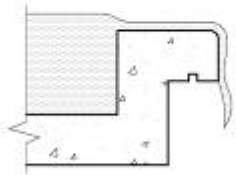
- A dam used to hold back or set the elevation of a waterway.
  - Types of weirs
    - Blade weirs
    - Broad crested weirs
    - Broad crested with end contractions
    - Round crested
    - Sharp crested
    - Notch weirs, comb weirs, filigree



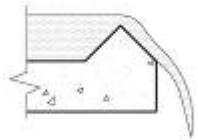
SHARP-CRESTED



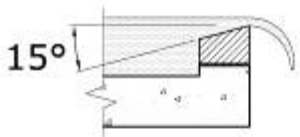
ROUND-CRESTED



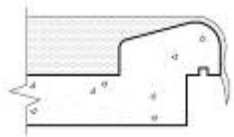
BROAD-CRESTED
DEPRESSED NAPPE



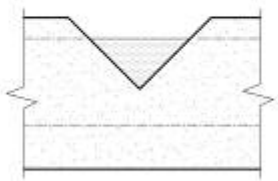
TRIANGULAR-CRESTED



SHARP-CRESTED
CORRECT
CONFIGURATION



ROUND-BROAD-CRESTED



V-NOTCHED
(FRONT-ELEVATION)

Cascades

- Easiest to execute because of weir tolerances
- Tolerant to turbulence
- Works with all types of stone finishes
  - Stone finish types:
    - Polished – smooth
    - Honed – just under polished
    - Thermal/flamed/exfoliated – coarse texture from heat
    - Sawn – rough cut
    - Split face – rough cleave

Sheet Falls

- Most difficult to execute
- Smooth approach velocity required
- No turbulence
- Proper weir profile
- Proper flow volume
- Max height 10-12 feet

Waterfalls

- Flow requirements:
  - Cascades:
    - Over cut stones or concrete allow up to 35 gpm per foot
    - Over coarse or natural stone allow up to 50 gpm per foot
  - Smooth Sheets:
    - 3-5’ fall allow 40 gpm per foot
    - 5-10’ fall allow 100 gpm per foot
    - 10-12’ fall allow 150 gpm per foot

Waterwalls

- Aerated – textured rough surface – white water look
- Tension – smooth surface – surface waves
- Textured – tooled surface – roll waves
- Chadar – textured, tiled or tooled and battered – moderate white water or textured water

Chadar: *n,* a cloth used for head covering by Hindu and Muslim women

Batter: n, a backward or upward slope of a wall or the like

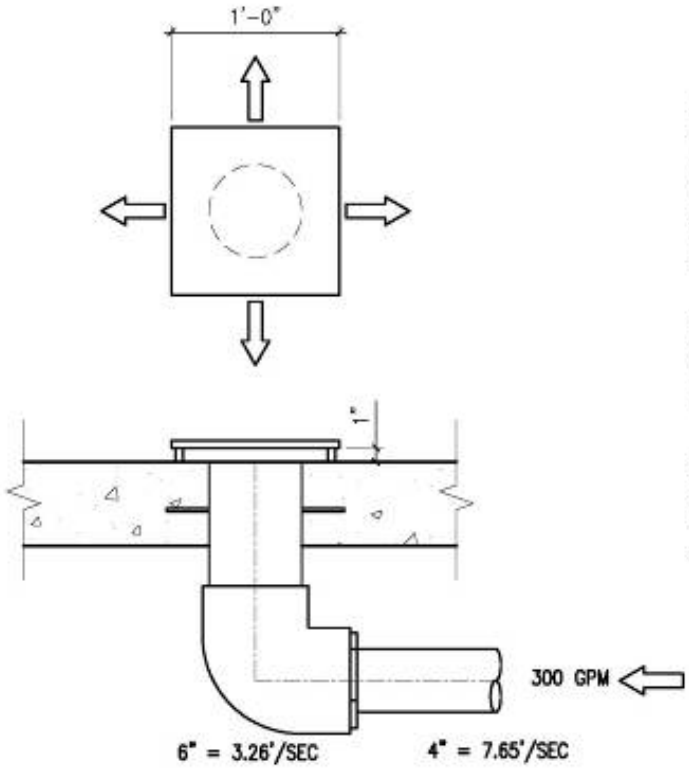
Flows for Waterwalls

- Aerated waterwalls - up to 35 gpm per lineal foot
- Tension and textured waterwalls - 4-8 gpm per lineal foot

Designing for velocity and turbulence

- Discharge velocity has to be controlled with proper pipe and fitting sizing
- Velocity calculation
  - GPM ÷ 60 = gallons per second
  - GPS ÷ 7.48 = cubic ft. per second
  - FT^3 ÷ open area of fitting (ft^2) = feet per second
- Gallons ÷ 7.48 = cubic feet
- Open area in sq. inches ÷ 144 = sq. feet
- Typically design for 3'/sec from fittings

Figuring velocity



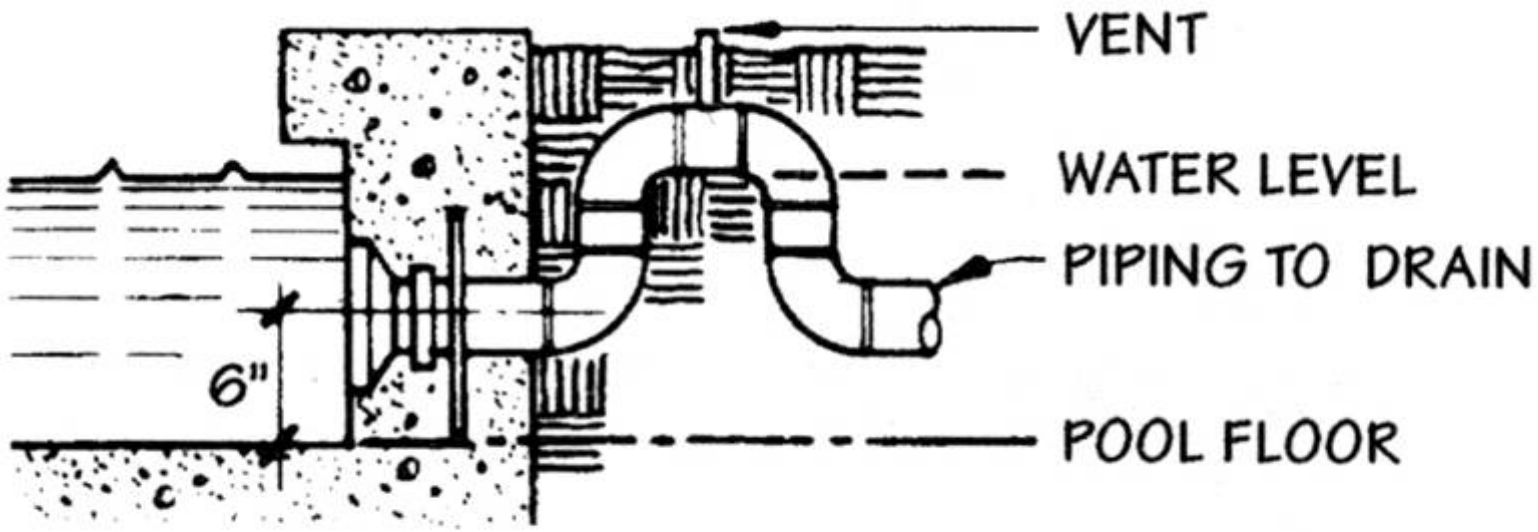
PERIMETER = 12"
12" X 4 SIDES = 48"
OPENING = 1"
OPEN AREA = 48 IN^2
48 IN^2 ÷ 144 = .33 FT^2

GPM ÷ 60 (sec) = GALLONS PER SECOND
GPS ÷ 7.48 (GAL PER CUBIC FT) = CU. FT / SEC
CU. FT. / SEC ÷ SQ. FT = FT/SEC

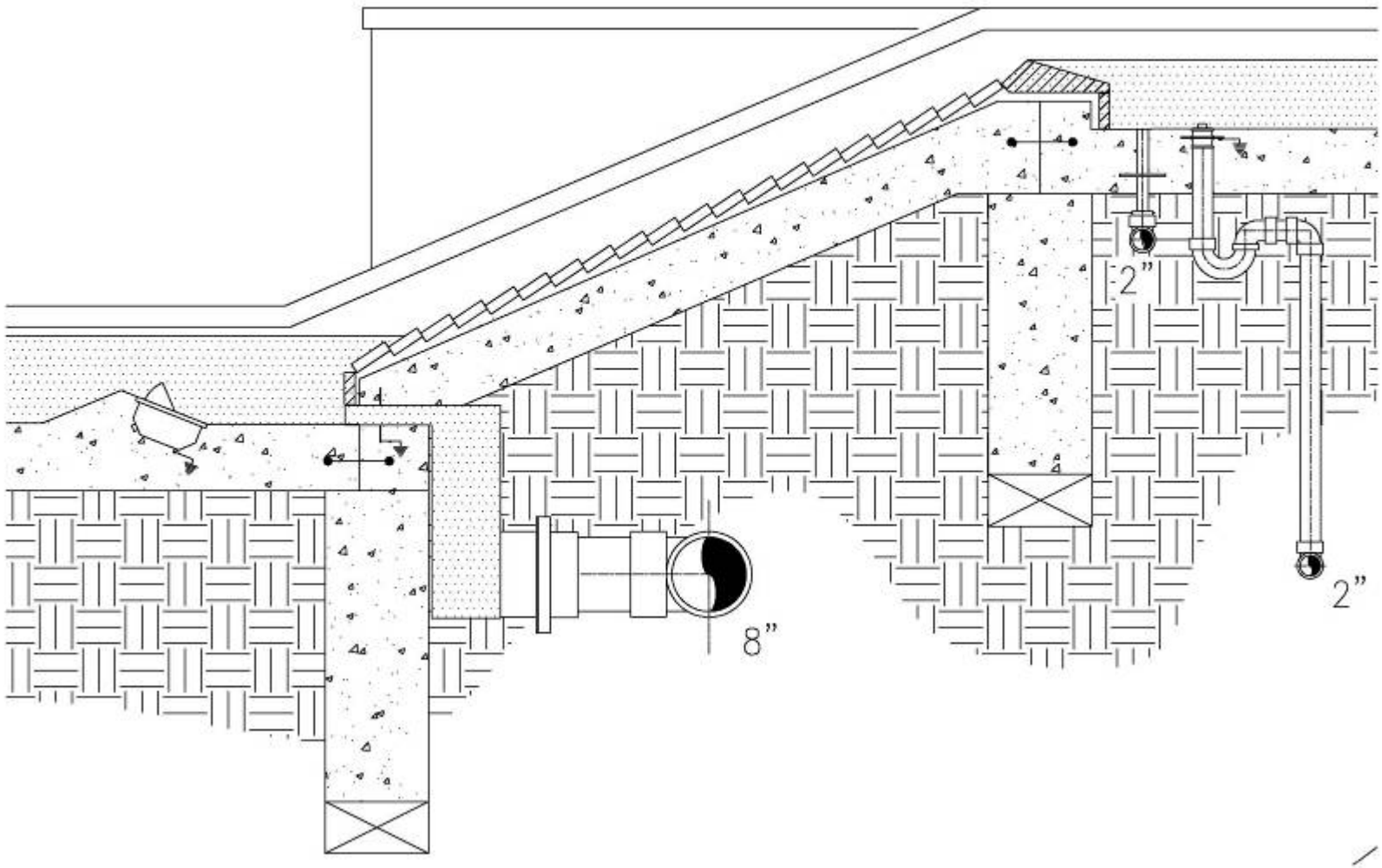
300 (gpm) ÷ 60 = 5 GPS
5 GPS ÷ 7.48 = .66 CU. FT. / SEC
.66 ÷ .33 = 2.0 FT/SEC

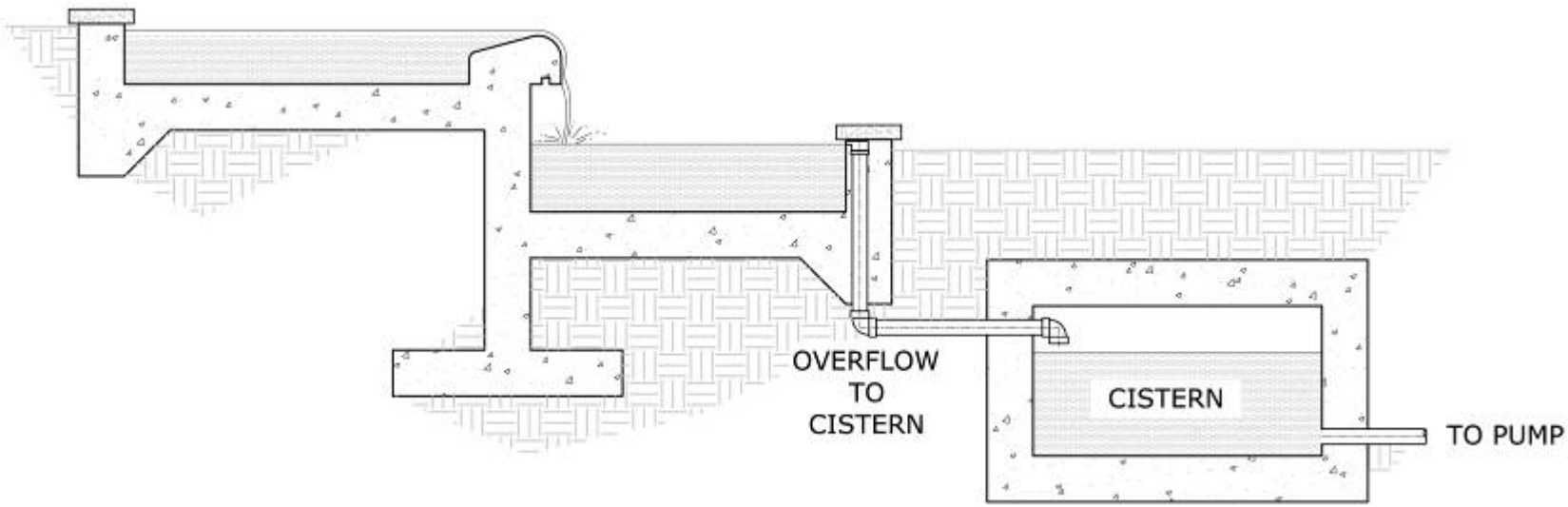
“High End Design”

- What is it and how do I get some?
  - Observation is your best teacher
  - There are very few new ideas but many new arrangements
  - Often the design is the idea that you have to work out but sometimes it is a simple but elegant detail
  - What feels right?



OVERFLOW FITTING


2”
2”
8”


OVERFLOW
TO
CISTERN
CISTERN
TO PUMP

Who has the ideas?

- Take the time to look through books and magazines – used book stores are great
- Look at the work of sculptors and artists for inspiration – who was Isamu Noguchi?
- Don't be afraid to try – ask for help - test
- Scale things up and down to fit your project
- Embrace technology but don't necessarily buy into it
- Surf the web

Interesting Web Sites

- wstudio.com/
- www.flow-forms.com/
- www.fountainkinetics.com/index.html
- www.inexan.com/
- www.williampye.com/
- www.pariswater.com/fontaines/fontaine.htm
- www.thais.it/citta_italiane/roma/fontane/fontane.htm
- www.fountainsinthecity.com/
- www.seattlesolstice.com/
- www.rockartist.org/index.html
- www.architecturalstone.net/index.html
- www.rhodes.org/
- www.gardenvisit.com/
- www.profloinc.com

Observation

- What does your library look like?
- Teach yourself to look at the surroundings of a project you like to find out how all of the elements contribute to the whole success.
- Carry a camera
- If you pay attention, you will learn something new every day

Where do you get help?

- Landscape Architects/Architects
- Fountain Consultants
- Fountain Manufacturers
- Artists – in all mediums
- Peers and contractors
- Manufacturer's representatives
- Universities – students and professors