50 cents microscope with involuntary focusing

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Abstract: Microscope is one of earliest and yet sustained invention in history of scientific instrumentation. Its utility cannot be overstated. What is attempted here is an invention of extremely low-cost, portable, reasonably robust, simple microscope capable of viewing onion cells or pollen grains. It attains a high value of ∑MUF (Sum of Most Useful Functions), which includes involuntary focusing mechanism and independence from daylight. Without trade-off, it also simultaneously attains a remarkably low value of ∑MDE (Mass, Dimensions and Energy consumed). The ratio ∑MUF/∑MDE called Factor of Idealization is hence genuinely high, enabling design and manufacture of this device to be included in hands-on STEM education, a case of trimming in engineering by innovative design course and a rigorous exercise in life-sciences' based entrepreneurship programs.

1) **Functional Performance**: Every technical system, viz. product or process is defined by two parameters and their ratio as third, derived parameter. First parameter is ∑MUF or Summation of Most Useful Function(s) performed. It could be considered as its Functional Performance. In case of $1 microscope, ∑MUF = MUF(1) + MUF(2) + MUF(3) + MUF(4) so far. MUF(1) = magnification of close-by objects, mostly belonging to living world. MUF(2) = operation in absence of daylight. MUF(3) = travel friendly, compact, robust. MUF(4) = easy, involuntary focusing. The list of MUF is informally that of so-called features of the product and sales people are rather quick at it. It is MUFs that excite invention and the continuous time-line of invention of any product has ascension of MUFs discretely. Needless to mention, In other words, ∑MUF always increases with time, man would like it to get infinity (a product performing a million functions like a miracle!).

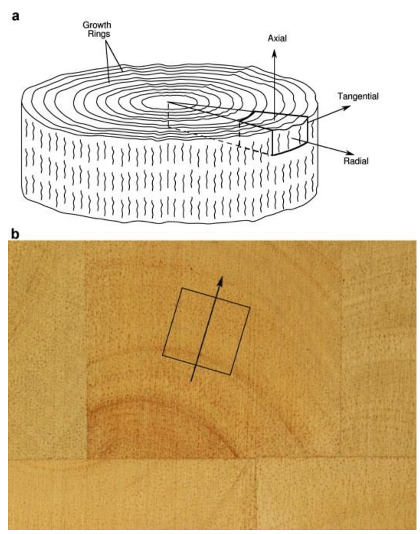
   In this 50 cents microscope, we have achieved –

   MUF(1) by optically quality borosilicate ball that acts like a 'thick' lens. Even though, it does not obey common-place high school equations of lens (those for thin lens), it has it own physics. Bottom line is that thick lenses magnify, with an added evil of distortion. It is akin to seeing our funnily wide or thin images in convex or concave mirrors somewhere in a children museum. We don't bother on shapes here, as primary objective of microscope be to detect pollen grains, or detect diseases by confirming/denying micro-organisms. Moreover, micro-organisms have no sense of humor.

MUF(2) by using low-power SMD (LED). It has a feeble 0.2W of consumption.

MUF(3) by slide-easy, layered structure. Lowest layer has SMD, with prepared glass slide (object to be examined) on it, followed by glass ball embedded in balsa wood, followed by human eye observing it.

MUF(4) by using anisotropic balsa wood whose elastic deformation along axial direction. *Under compression in the axial direction the material exhibits a linearly elastic regime that terminates by the initiation of failure in the form of localized kinking. Subsequently, under displacement-controlled compression, a stress plateau is traced associated with the gradual spreading of crushing of the cells through the material. The material is less stiff and weaker in the tangential and radial directions. Compression in these directions crushes the tracheids laterally but results in a monotonically increasing response typical of lateral crushing of elastic honeycombs. The elastic and inelastic properties in the three directions have been established experimentally as a function of the wood density.



2) Mass, Dimensions & Energy consumed by the Technical System or ∑MDE

In case of 50 cents microscope, Mass is about 10gms or so, Dimensions about 5cm x 3cm x 1cm in closed configuration, Energy consumed about 0.2W. ∑MDE is a tricky question. This product has a remarkable low ∑MDE achieved and hence is a convoluted product, so to say. In evolution of technical systems, it has been observed that this parameter first increases & then decreases. We have Gillette Mach1, Mach2, Mach3, Mach4 with each shaving razor heavier and bulkier (more blades as going from mono-system to bi-system to poly-system..) From 1980's to present, ∑MDE is piling up. I doubt if Mach5 will ever be invented. It is high time and a invention with lower ∑MDE is now expected and welcome. It means Gillette or another company should come up with a single blade razor than performs as good as Mach4 or 5. Needless to point out, a lower ∑MDE often coincides with low labor, effort of manufacturing, material consumption and hence low cost.

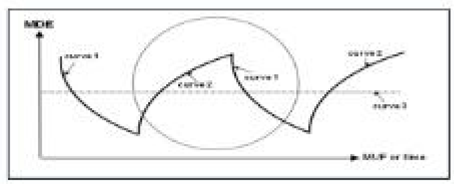


Figure 47

Encircled portion is isolated & examined now. Figure 48.

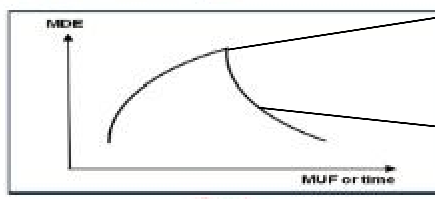


Figure 48

An envelope curve over curve 2 and curve 1 is drawn, generating a dotted final curve. Figure 49. Notice, it has expansion followed by contraction or convolution. It is in latter part of curve, representing convolution that we are focusing upon in current book.

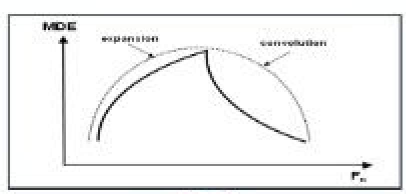


Figure 49

3) Factor of Idealization, I

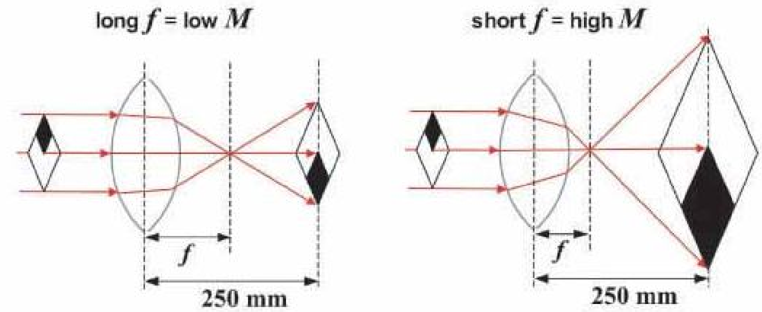
I = ∑MUF/∑MDE. It may be regarded as efficiency in simple terms. This microscope attains a high I since ∑MUF is quite high and ∑MDE is quite low. As compared to conventional (basic) optical compound microscopes, it has a 10 times higher Factor of Idealization or efficiency.

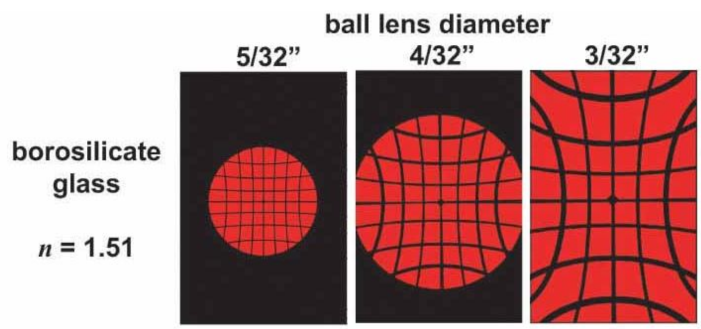
4) Physics of Thick Lenses; Borosilicate ball as thick convex lens

ball lens equation $$\frac{1}{f} = \frac{4\,(n-1)}{n\,d}$$

Magnification Equation

$$M = \frac{250\ \text{mm}}{f}$$

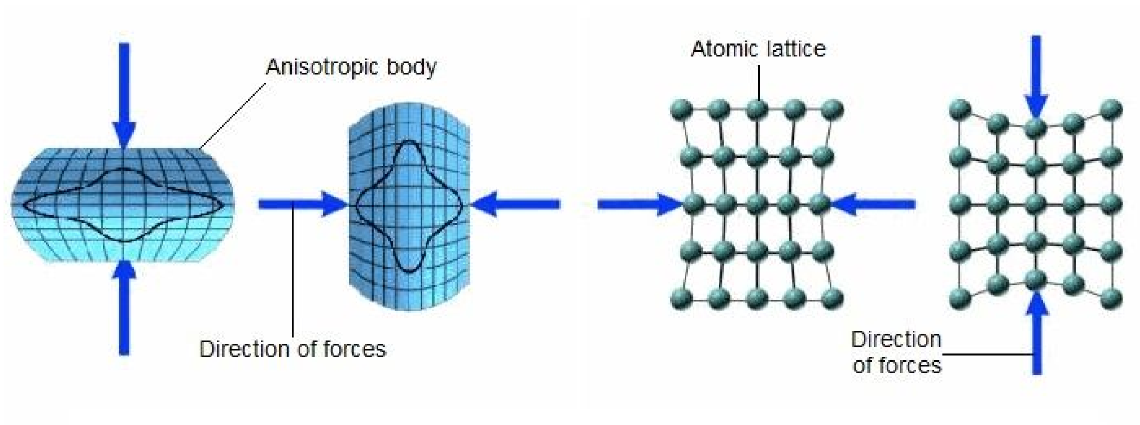




Focal Length & Magnification of Ball Lenses

lens material	d (inch)	d (mm)	f (mm)	M
borosilicate glass n = 1.51	3/32	2.38	1.76	142.02
	4/32	3.18	2.35	106.52
	5/32	3.97	2.93	85.21

5) Focusing Function by Anisotropy of Balsa Wood



Altering the direction of the applied forces changes the orientation and spatial order of the atoms and molecules in the solid body. This changes the elastic properties of the body in a direction-dependent manner. The anisotropy of a solid body depends on the crystal symmetry. The lower the crystal symmetry, the more pronounced the anisotropy.

Anisotropic behavior of several woods (at 12% moisture); Tensile and Compressive strengths given in psi:

Formula used: $A = A(X_0, X_1)$

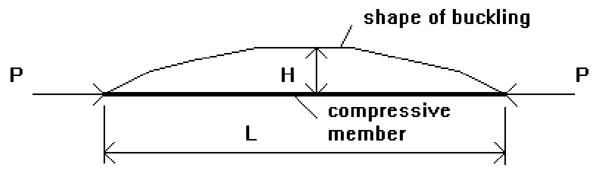
A – anisotropy

X_0 – direction of forces

X_1 – material structure

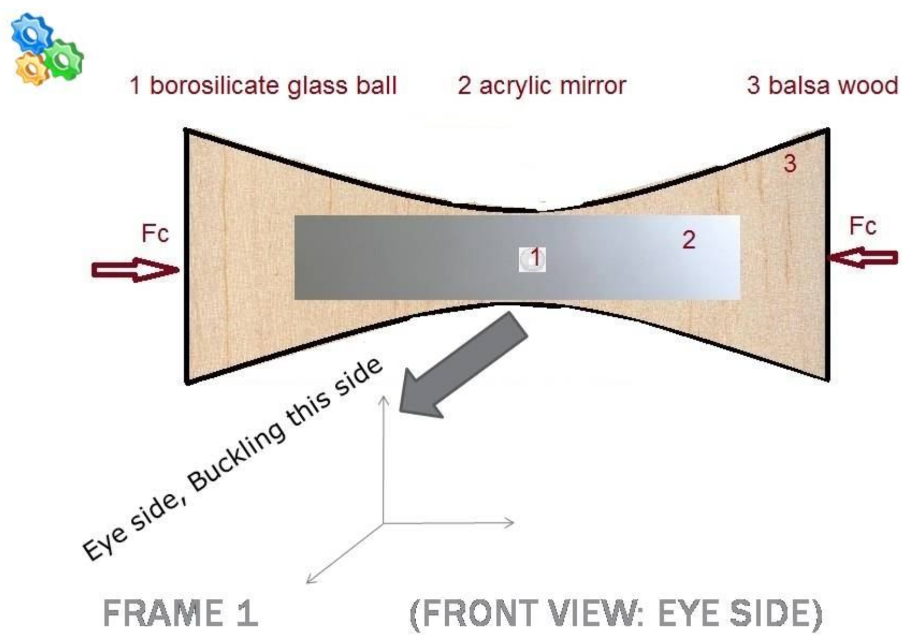
	Tensile Strength Longitudinal	Tensile Strength Radial	Compressive Strength Longitudinal	Compressive Strength Radial
Beech	12.500	1.010	7.300	1.010
Elm	17.500	660	5.520	690
Maple	15.700	1.100	7.830	1.470
Oak	11.300	940	6.200	810
Cedar	6.600	320	6.020	920
Fir	11.300	390	5.460	610
Pine	10.600	310	4.800	440
Spruce	8.600	370	5.610	580

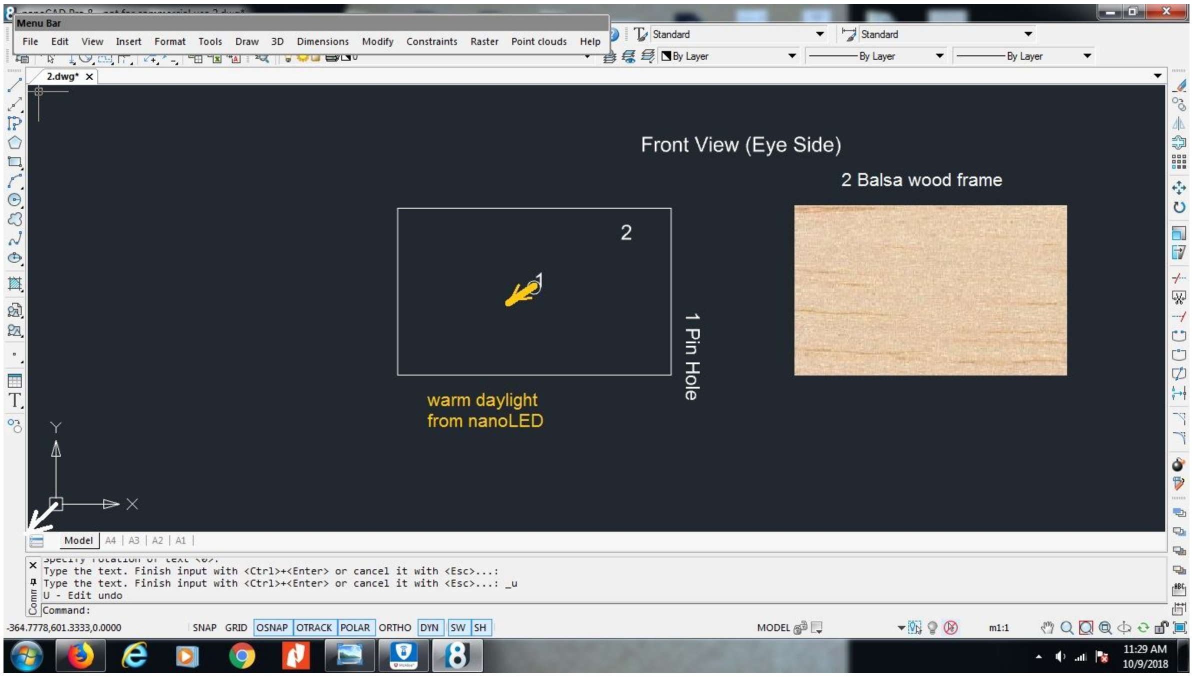
Mechanically, balsa wood or Ochroma pyramidale is Anistropic. (opposite to Isotropic).The cellular microstructure includes a very significant volume of empty space. Balsa wood has superior specific axial stiffness and strength. Even more importantly, it exhibits outstanding energy absorption characteristics that derive from the relatively low relative density. Indeed, it may be the only material with specific energy absorption that resembles that of axially loaded hexagonal honeycombs.



6) Components & Assembly

Coin Cell 3.0V, Copper conductive foil replacing wires, balsa wood cut to shape, borosilicate glass ball, micro switch, SMD LED with 3.2V forward voltage, acrylic mirror, slide with specimen of say onion cells or pollen grains. Simple tools used.




Front View (Eye Side)
2 Balsa wood frame
2
1 Pin Hole
warm daylight
from nanoLED
File Edit View Insert Format Tools Draw 3D Dimensions Modify Constraints Raster Point clouds Help
Type the text. Finish input with <Ctrl>+<Enter> or cancel it with <Esc>...:
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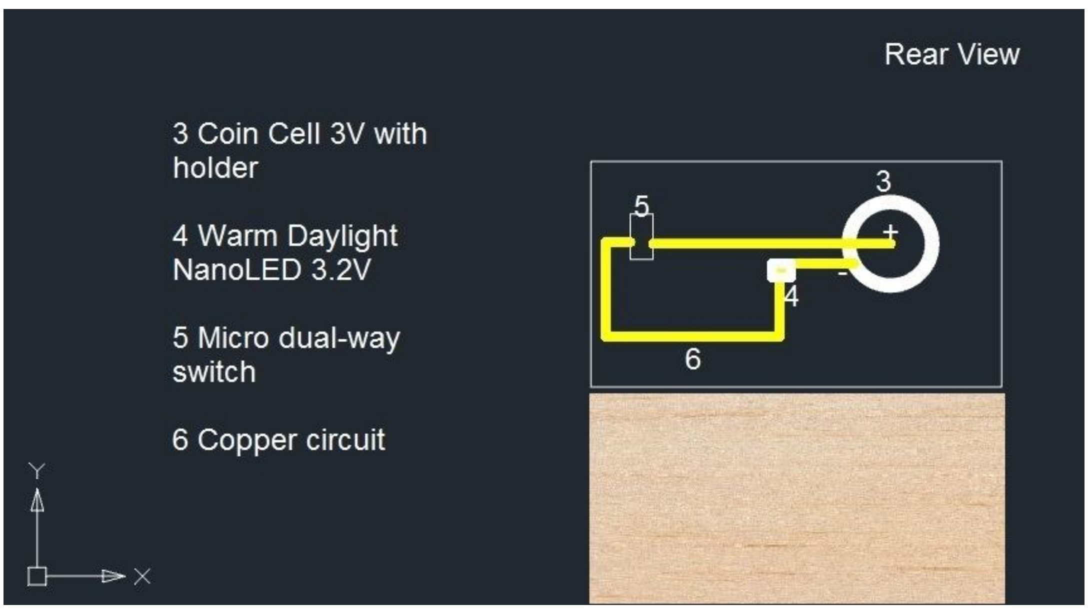
Rear View
3 Coin Cell 3V with holder
4 Warm Daylight NanoLED 3.2V
5 Micro dual-way switch
6 Copper circuit
3
5
4
6
+
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