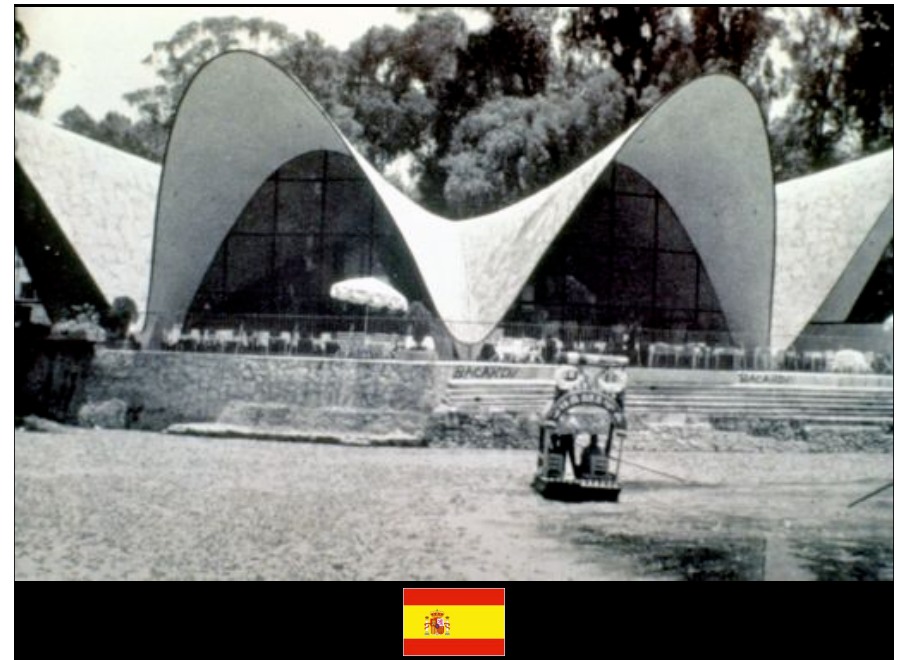
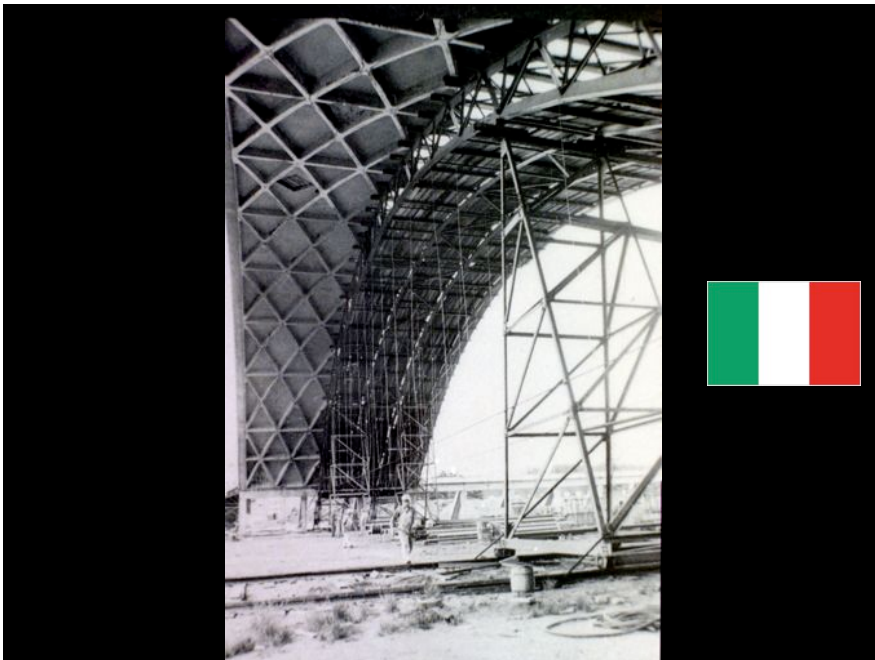


Roof Vaults and National Styles

Early 20th Century

- The German approach: analysis and geometry
- The Italian approach: ribs, coffers, and buttresses
- The "Spanish" approach: double curvature and thinness
- Concrete shells and stiffness
- Economy of labor vs. efficiency of materials
- Complexity of analysis vs. complexity of form



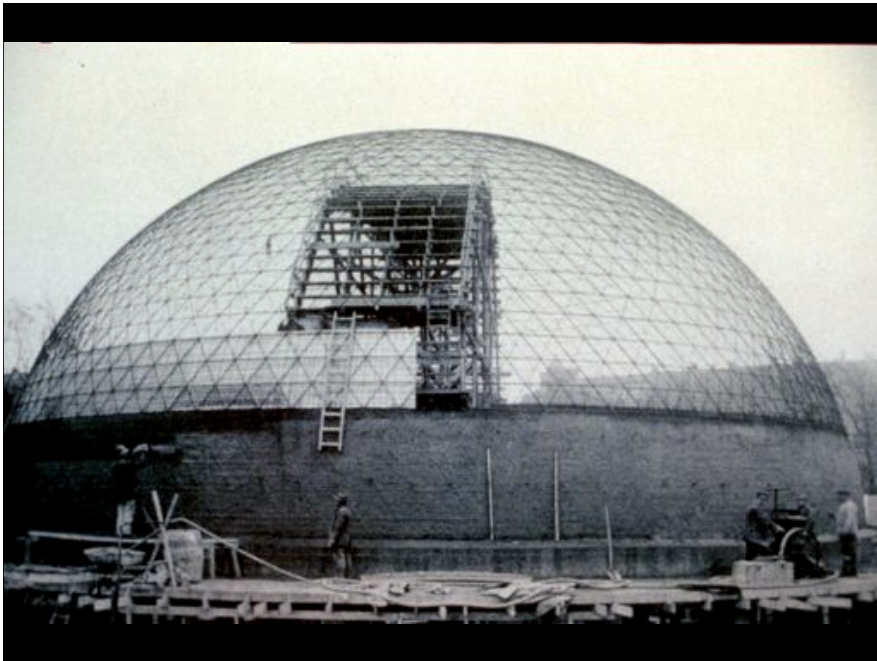
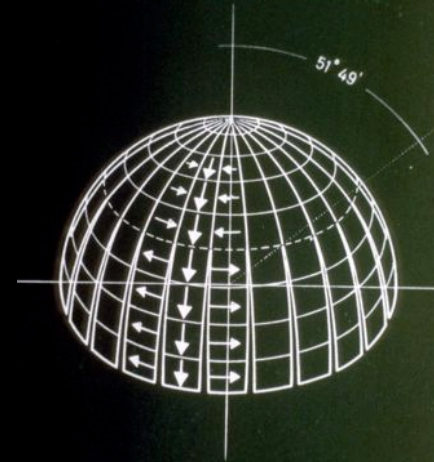
German Tradition

Firm of Dyckerhoff and Widmann

F. Dischinger (1887-1953)

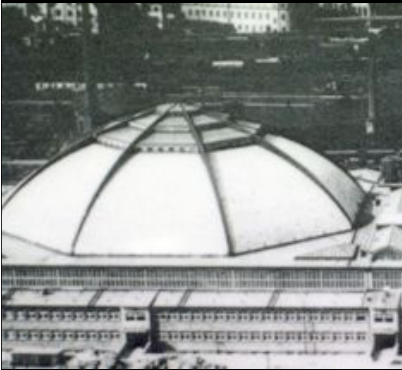
U. Finsterwalder (1897-1988)

A. Tedesko (1903-1994)



Longest Spanning Domes in the World

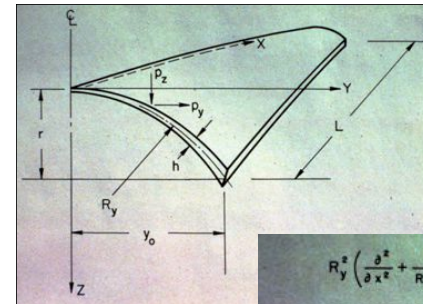
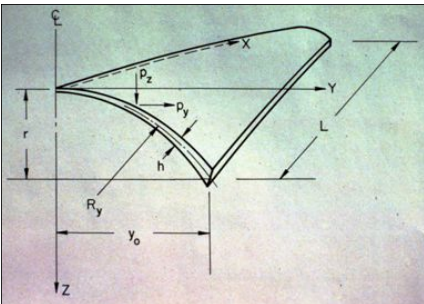
Date	Place	Span (m)	Rise (m)	Weight (metric ton)
1590	Rome	42	21	10,000
1913	Breslau	67	16	6,340
	Wroclaw Poland			
1929	Leipzig	76	17.5	2,160



Centennial Hall Wrocław Poland

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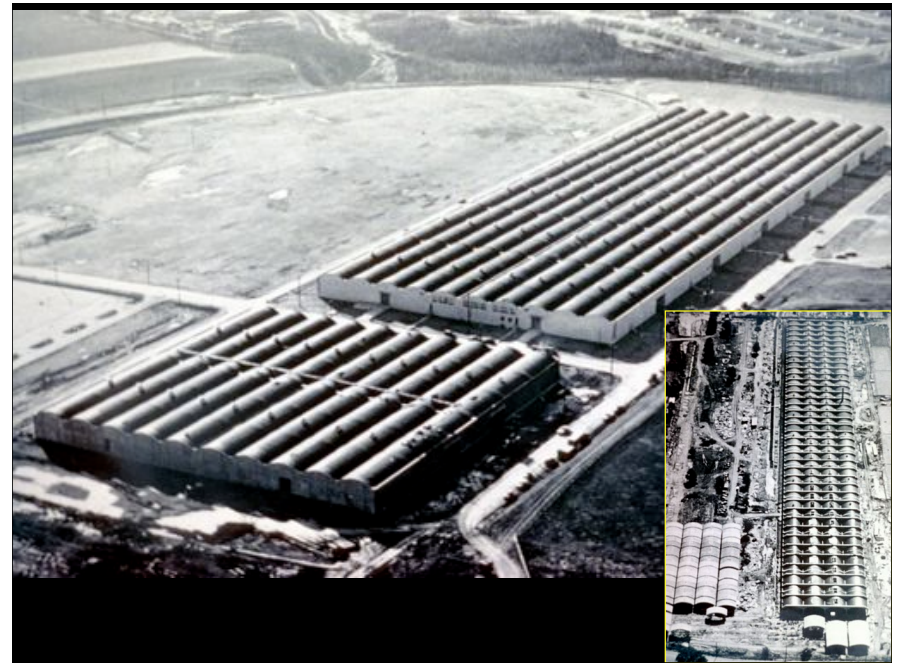
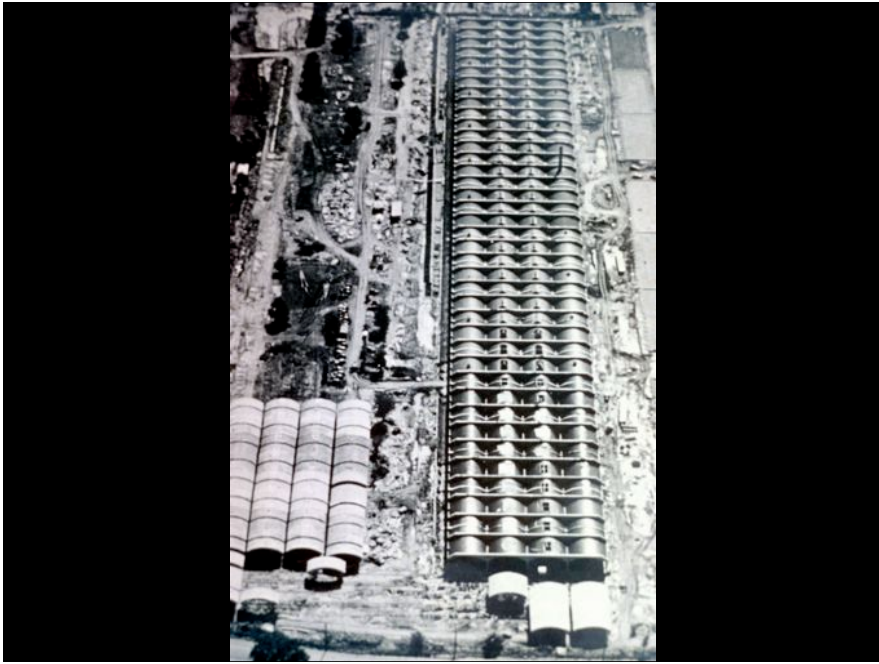
$$R_y^2 \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{R_y^2 \partial \phi^2} \right) w + \frac{12}{h^2} \frac{\partial^4 w}{\partial x^4} = f(p_x, p_y, p_z)$$

$$\frac{du}{dy} = -\alpha_y \frac{\pi}{L} v + \alpha_y \frac{2}{Eh} N_{xy} \qquad \frac{dM_y}{dy} = -\alpha_y \frac{\pi^2}{L^2} \frac{Eh^3}{6} \theta + \alpha_y S_y$$

$$\frac{dv}{dy} = \alpha_y \frac{W}{R_y} + \alpha_y \frac{N_y}{Eh} \qquad \frac{dN_y}{dy} = \alpha_y \frac{\pi}{L} N_{xy} + \alpha_y p_y$$

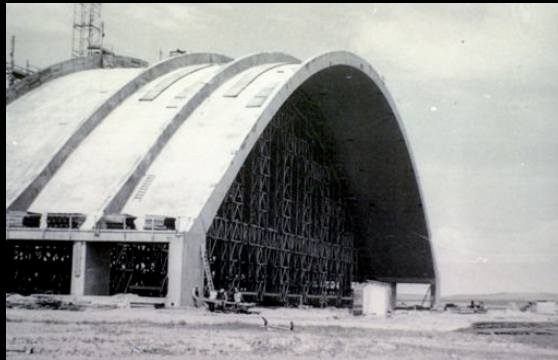
$$\frac{dw}{dy} = \alpha_y \theta \qquad \frac{dN_{xy}}{dy} = \alpha_y \frac{\pi^2}{L^2} Eh u + \alpha_y p_x$$

$$\frac{d\theta}{dy} = -\alpha_y \frac{12}{Eh^3} M_y \qquad \frac{dS_y}{dy} = -\alpha_y \frac{N_y}{R_y} + \alpha_y p_z$$



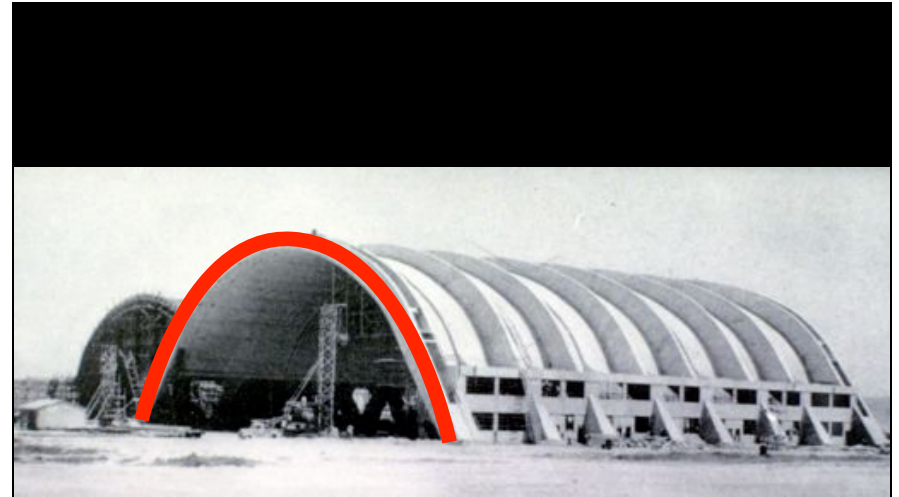


1941



Ribbed barrels by
Anton Tedesko

1948



1D ribs = Stiffness

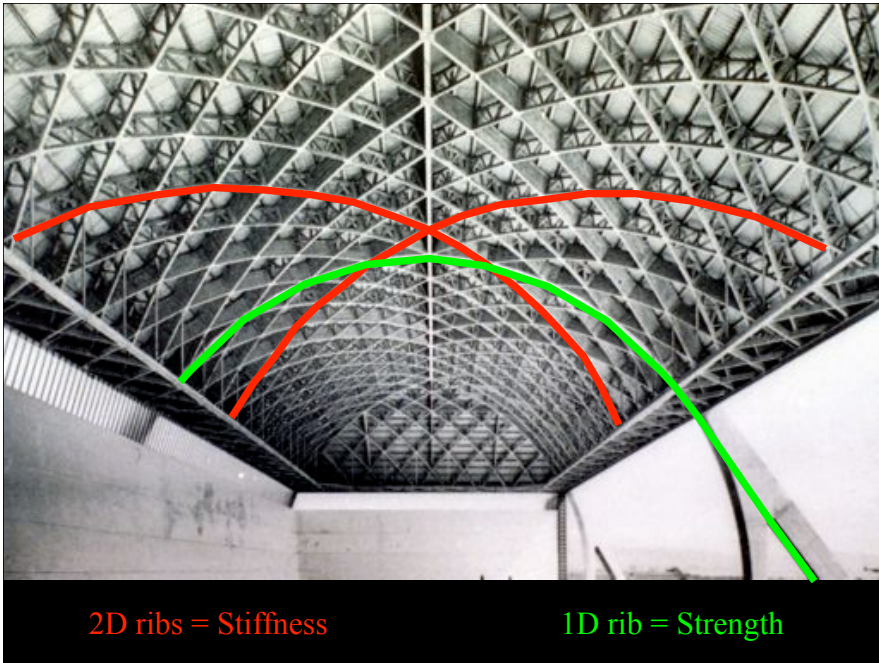
Describe the method used by the German school for finding forms for roof structures.

Why would such an approach be justified for structural engineering?

Why might it be limiting for structural art?

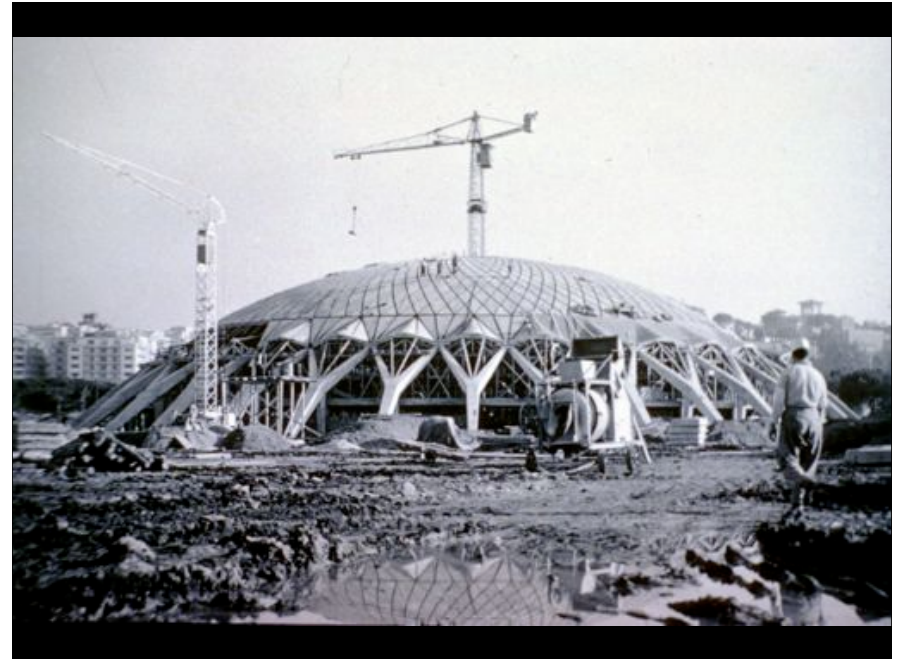
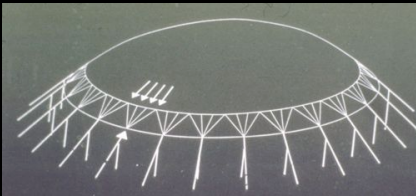
Italian Tradition

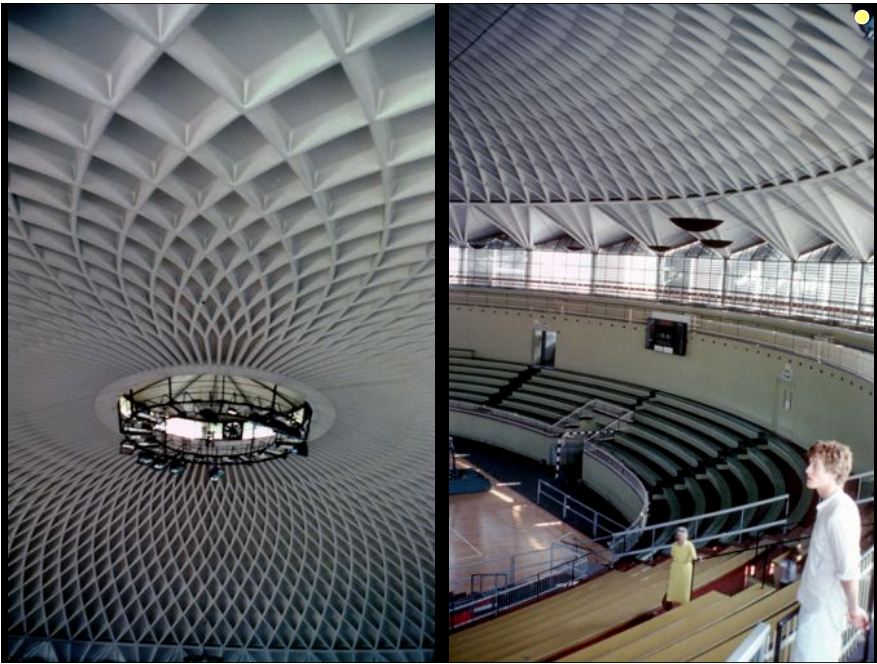
P.L. Nervi (1891-1979)

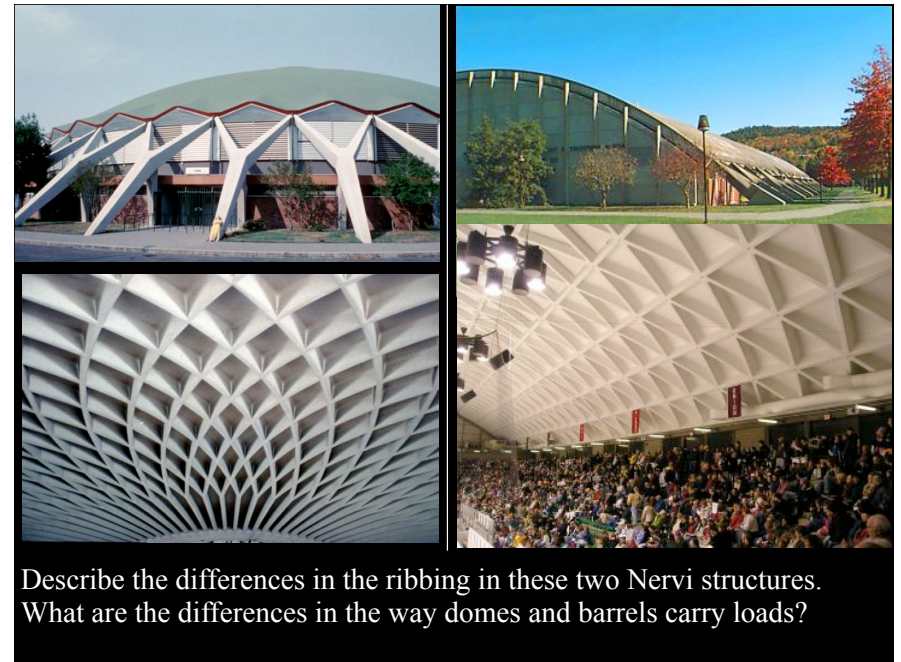
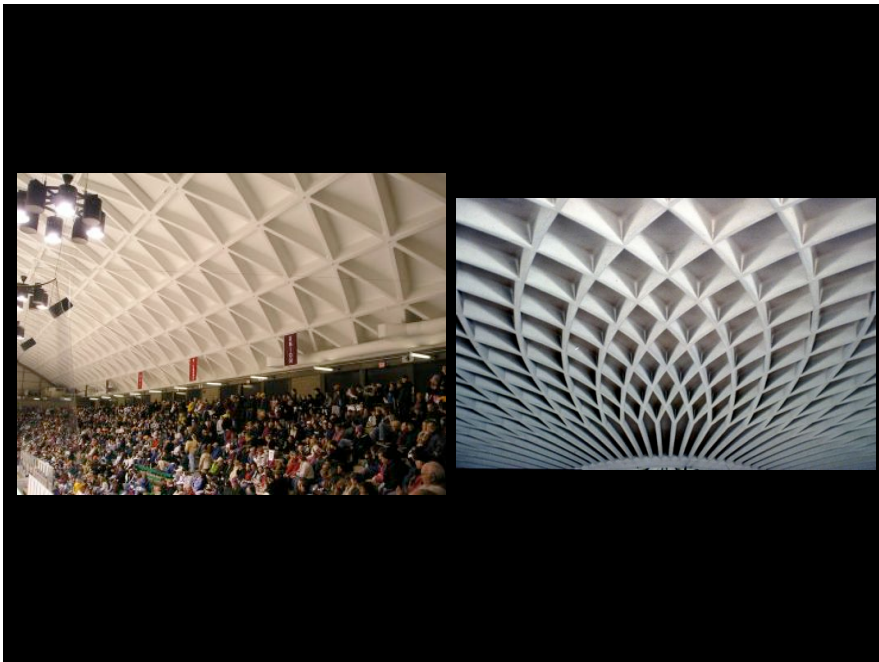




Little Sports Palace
1957

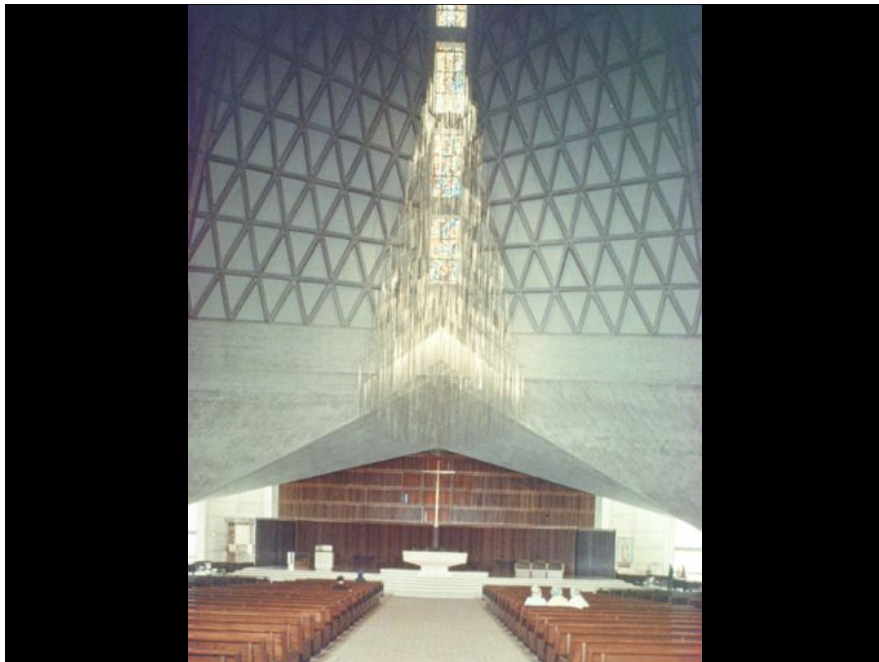




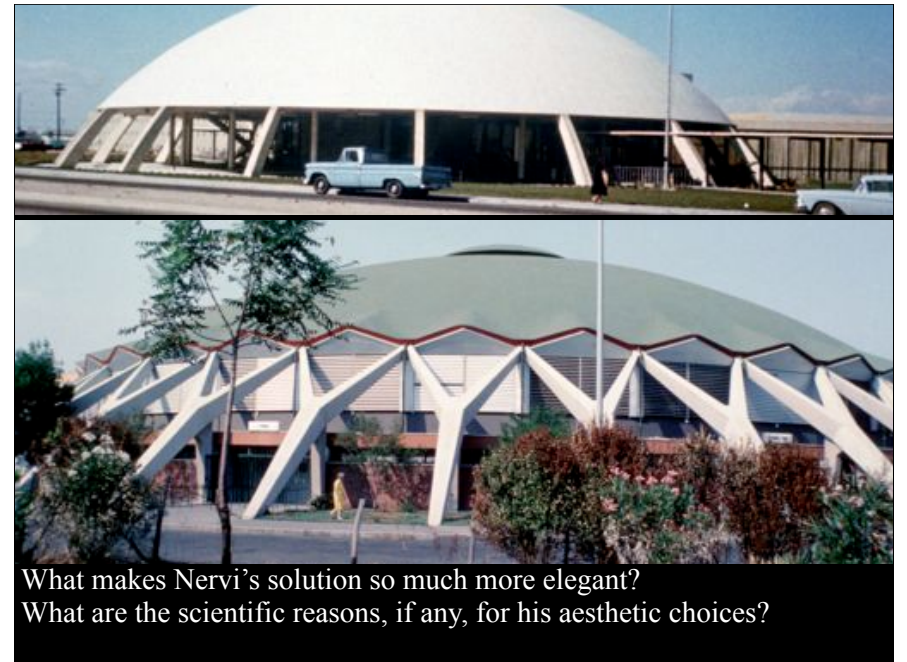
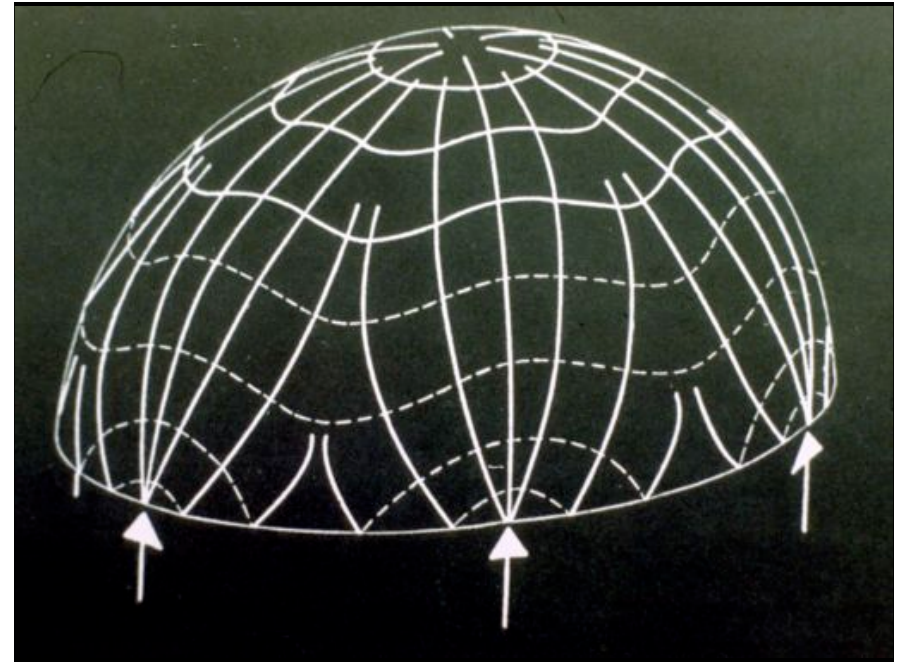
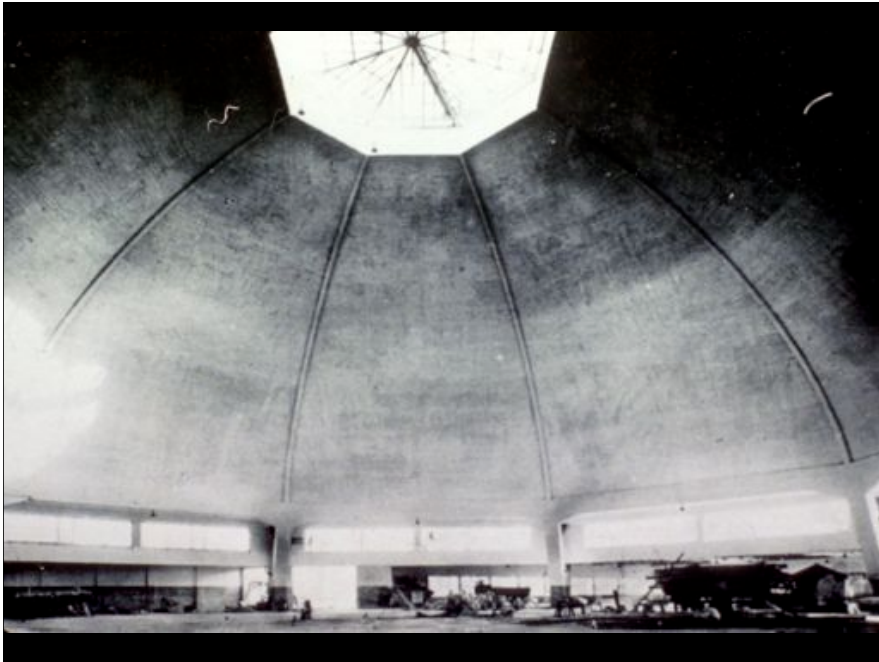


Describe the differences in the ribbing in these two Nervi structures. What are the differences in the way domes and barrels carry loads?

failures in translation



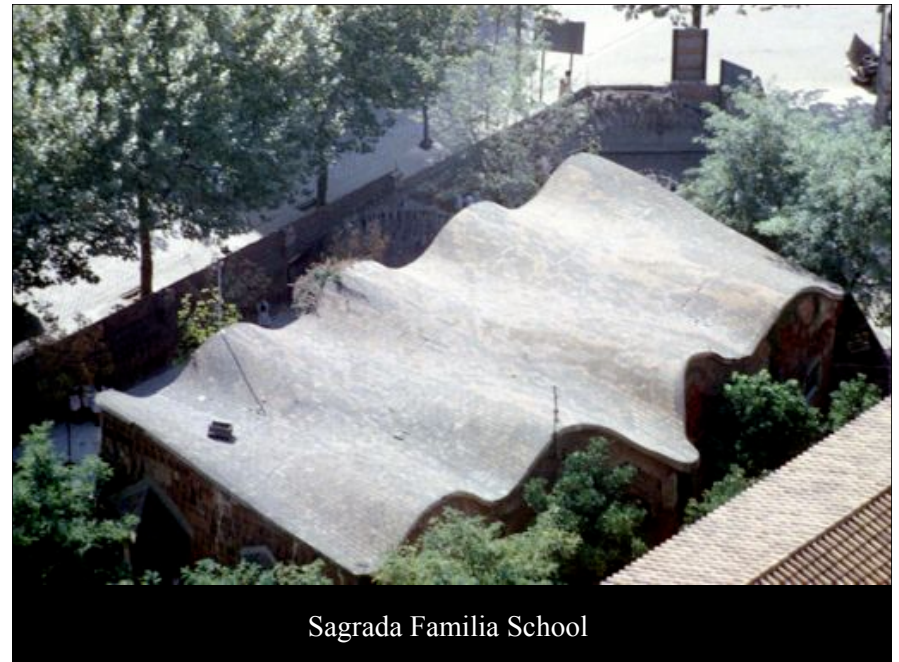
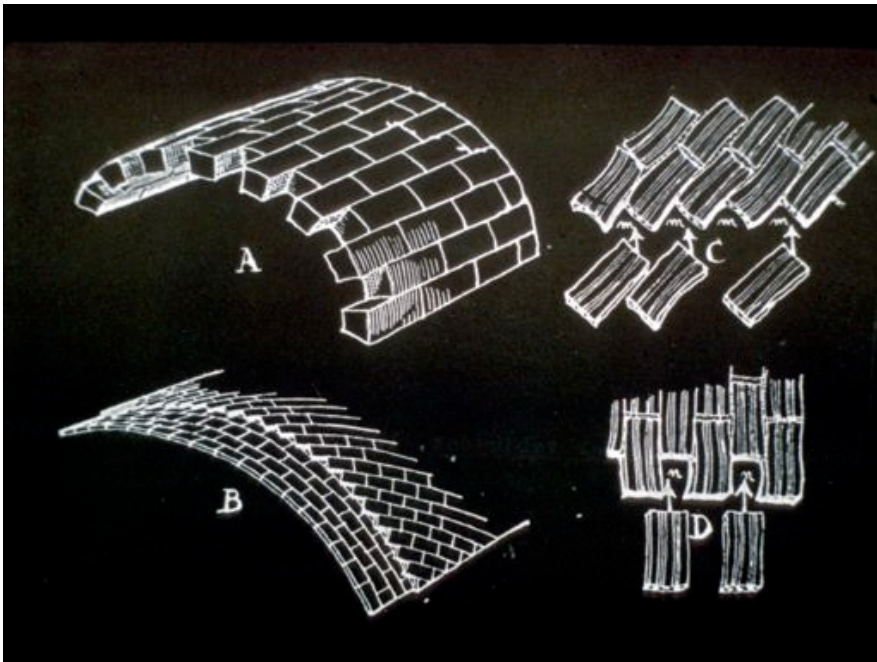
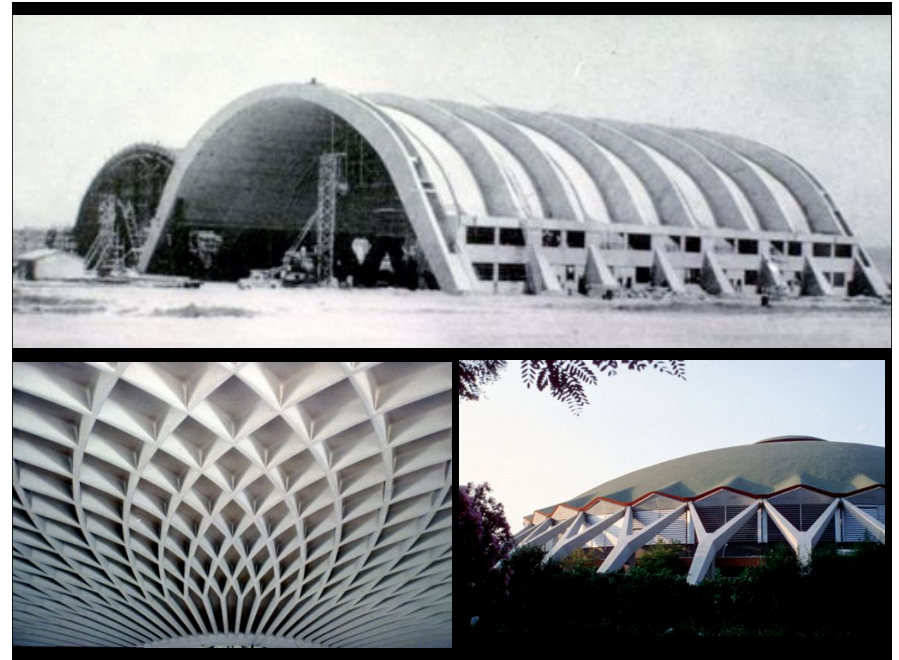
structure, not structural art

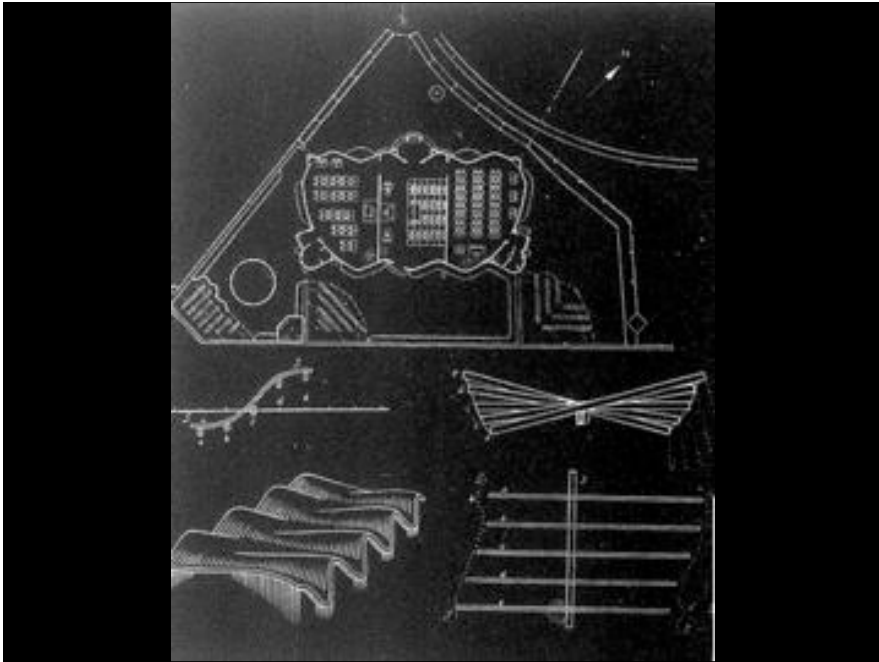


What makes Nervi's solution so much more elegant?
What are the scientific reasons, if any, for his aesthetic choices?

Spanish Tradition
Catalan influence

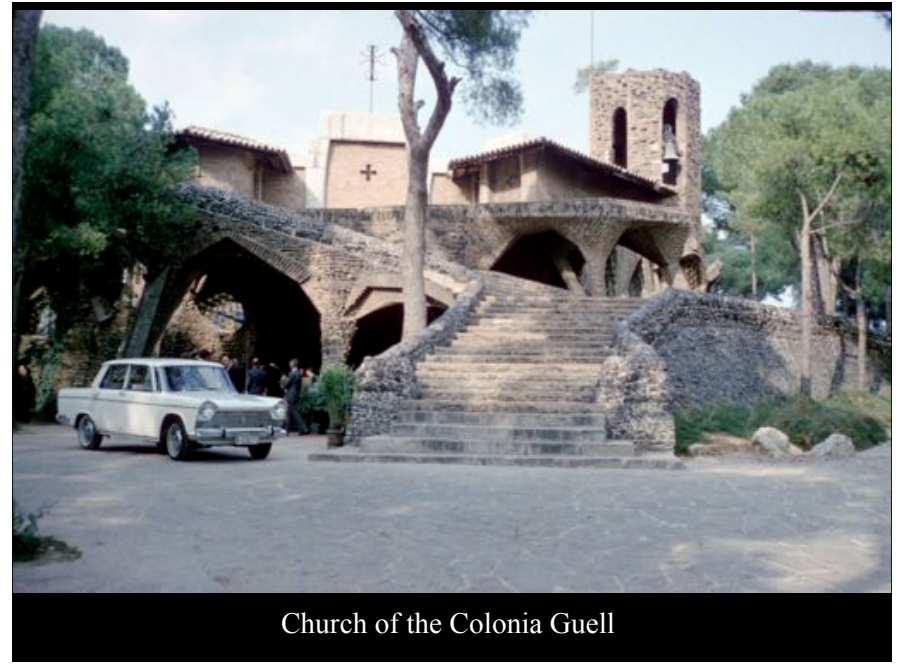
- A. Gaudi (1852-1926)
- E. Torroja (1899-1961)
- F. Candela (1910-1997)
- E. Dieste (1917-2000)





Church of the Sagrada Familia
Gaudi, 1882 - present



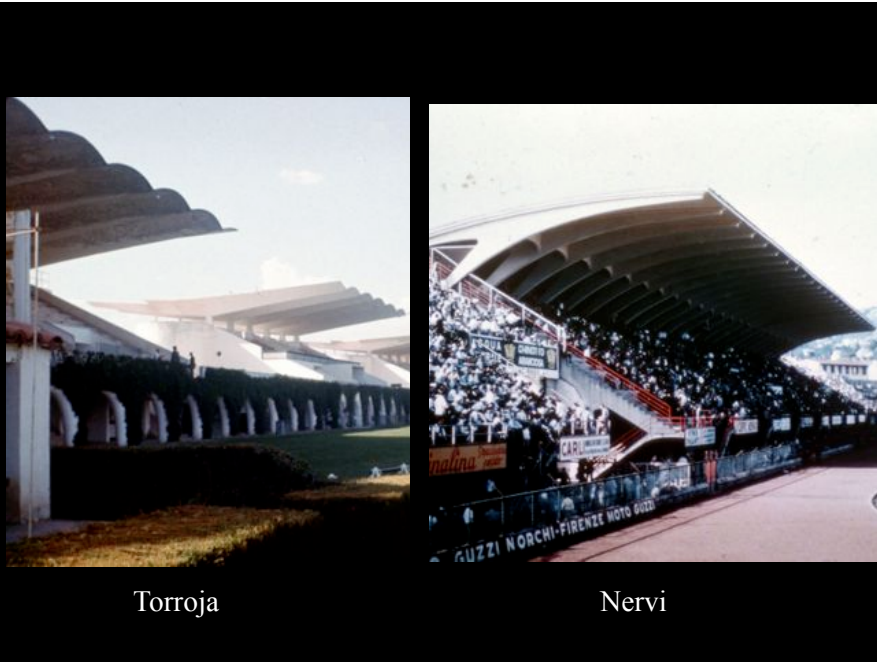


Church of the Colonia Guell



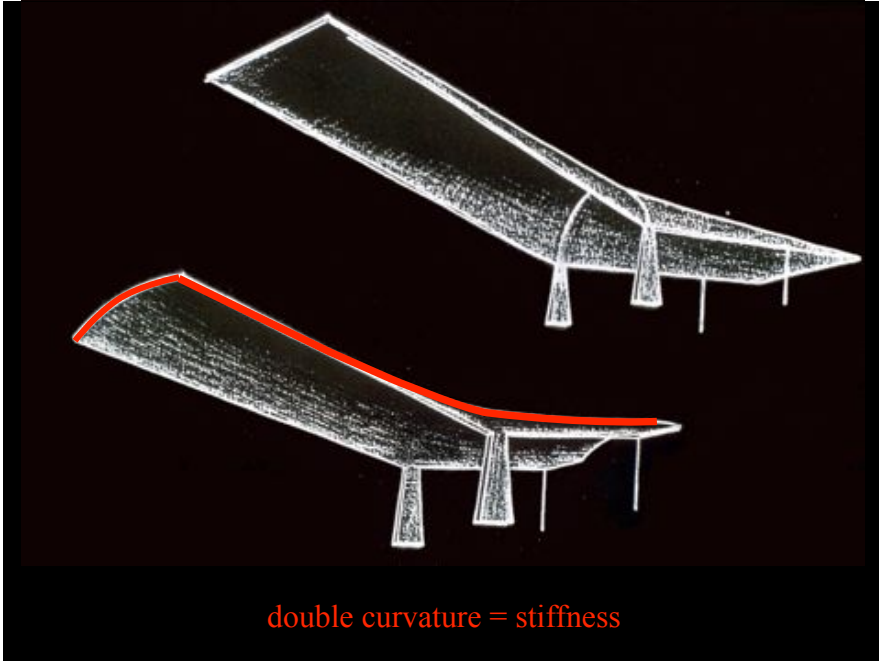


Zarzuela Hippodrome (1935), Eduardo Torroja



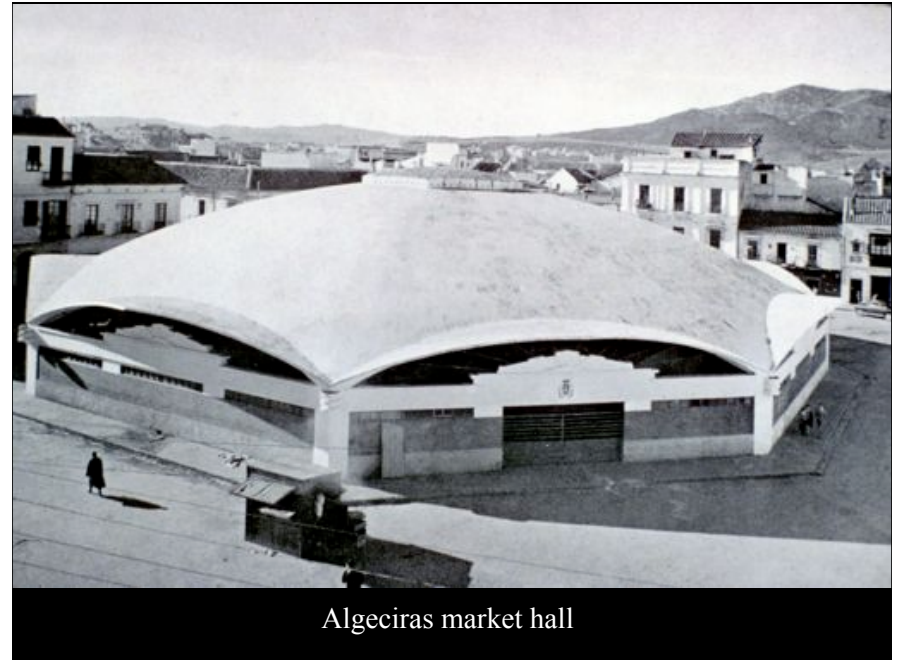
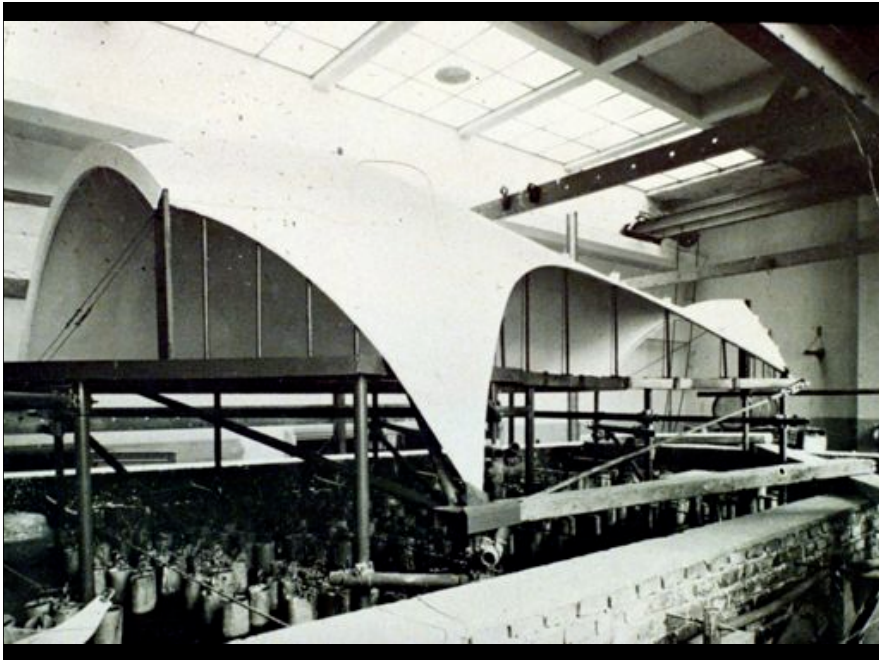
Torroja

Nervi

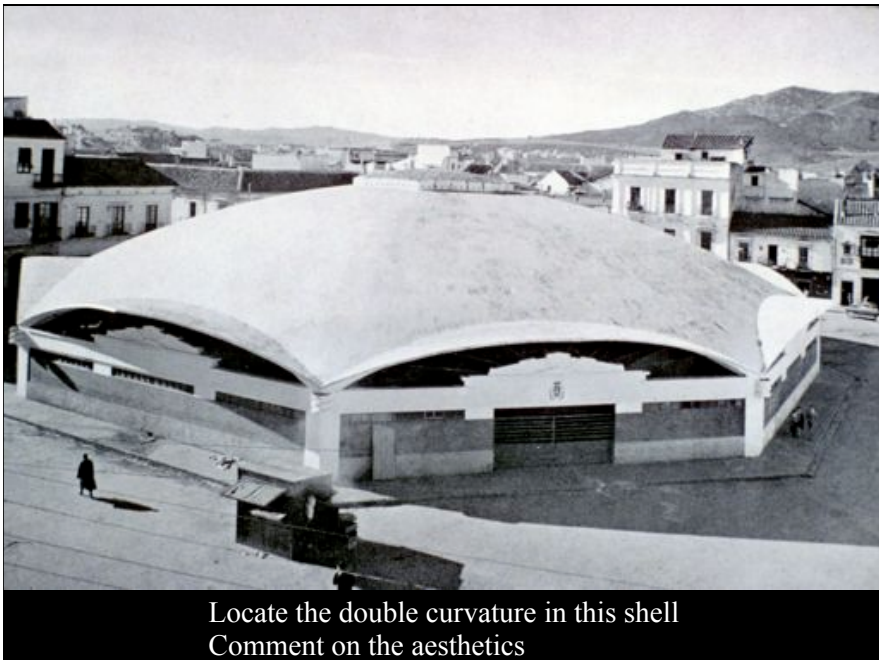


double curvature = stiffness

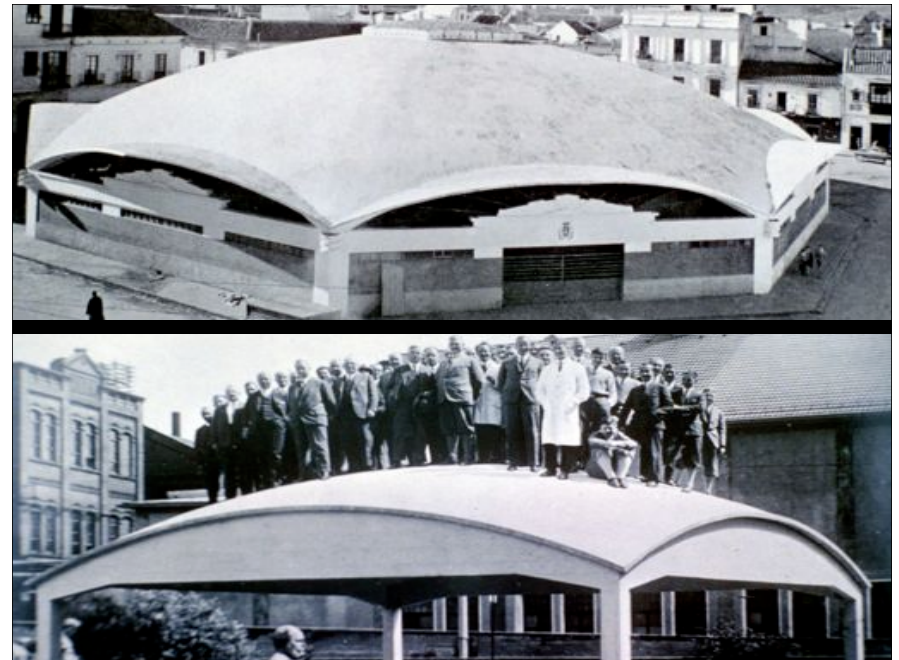


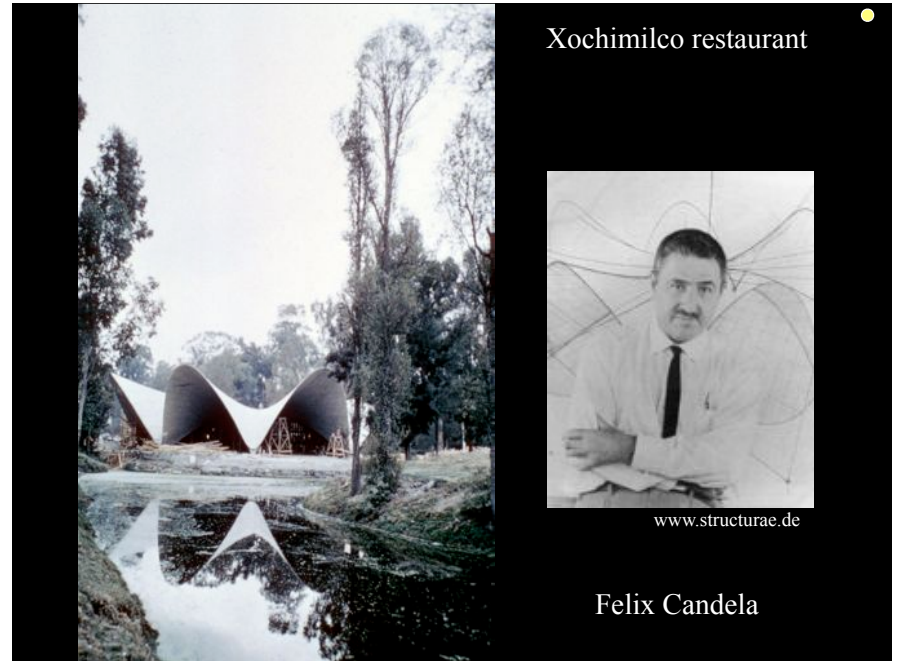
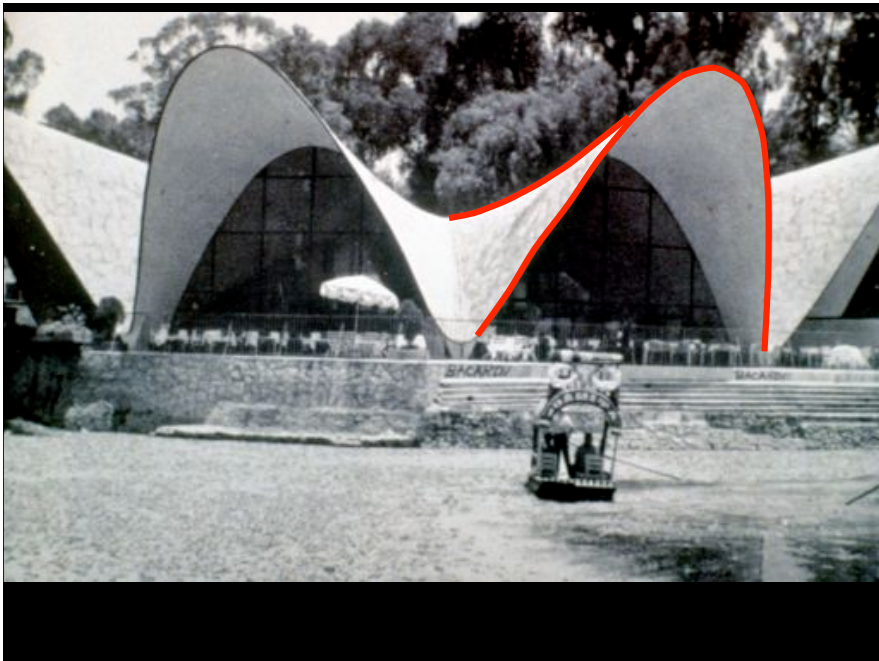
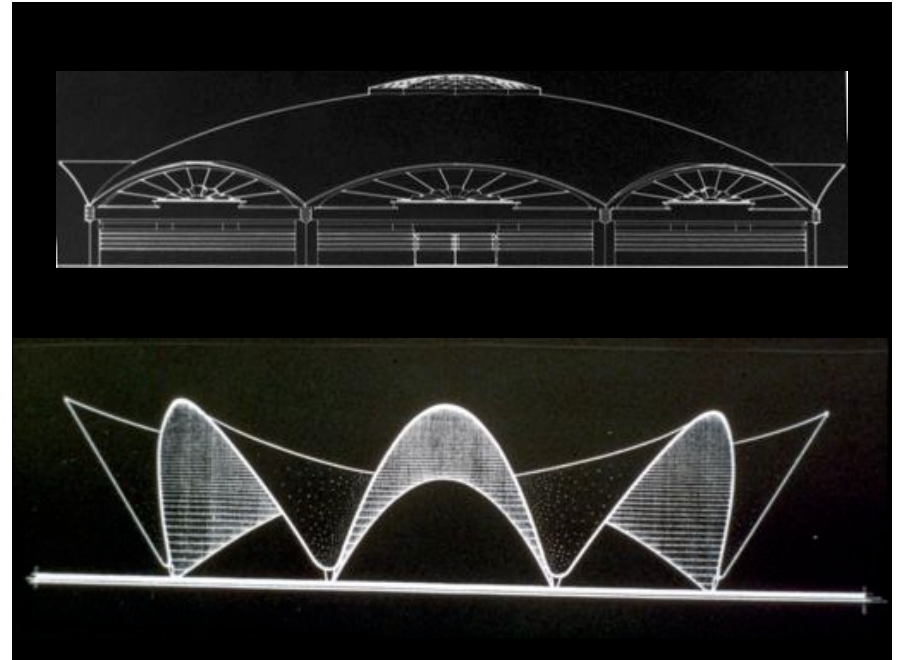
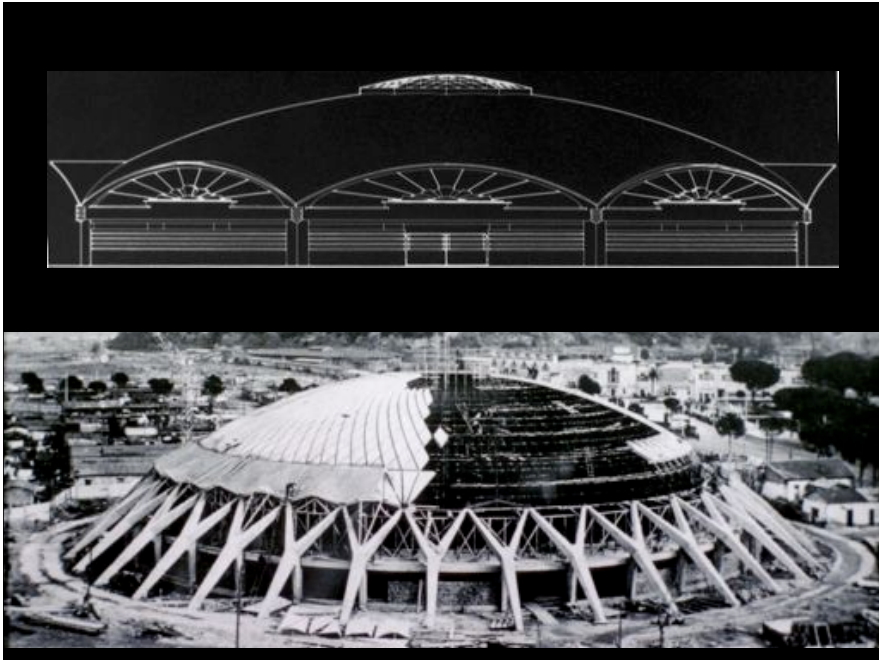


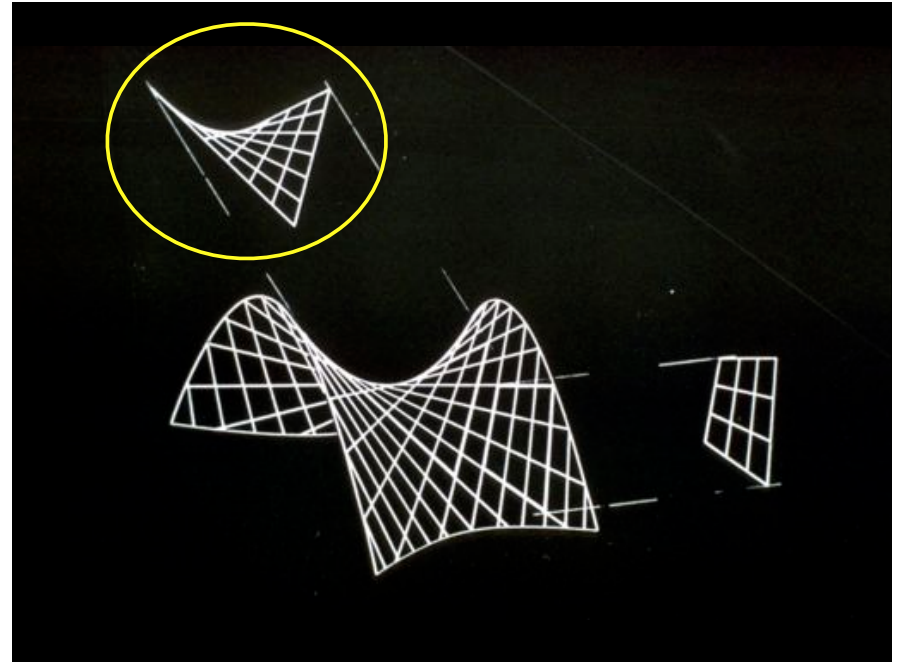
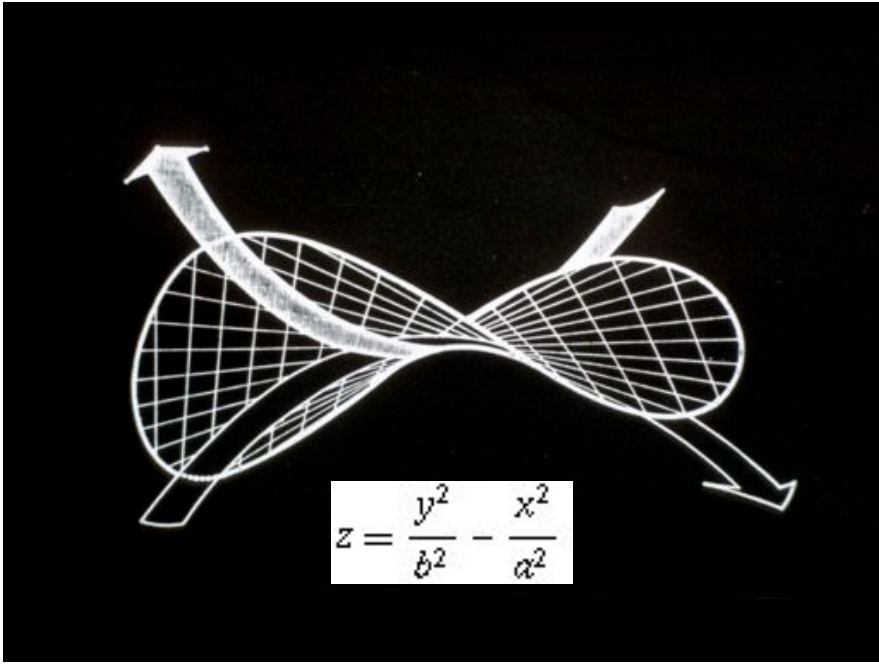
Algeiras market hall

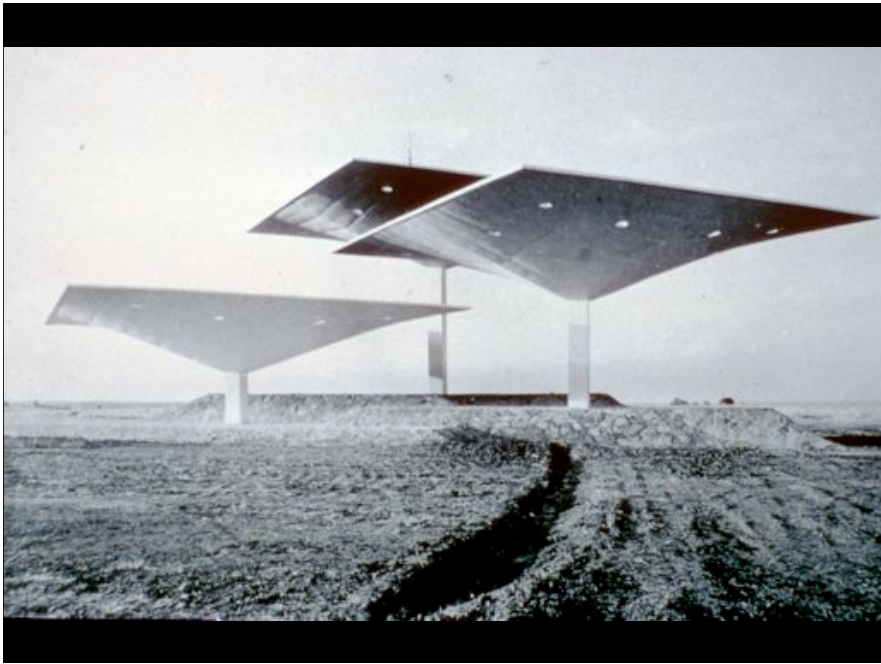
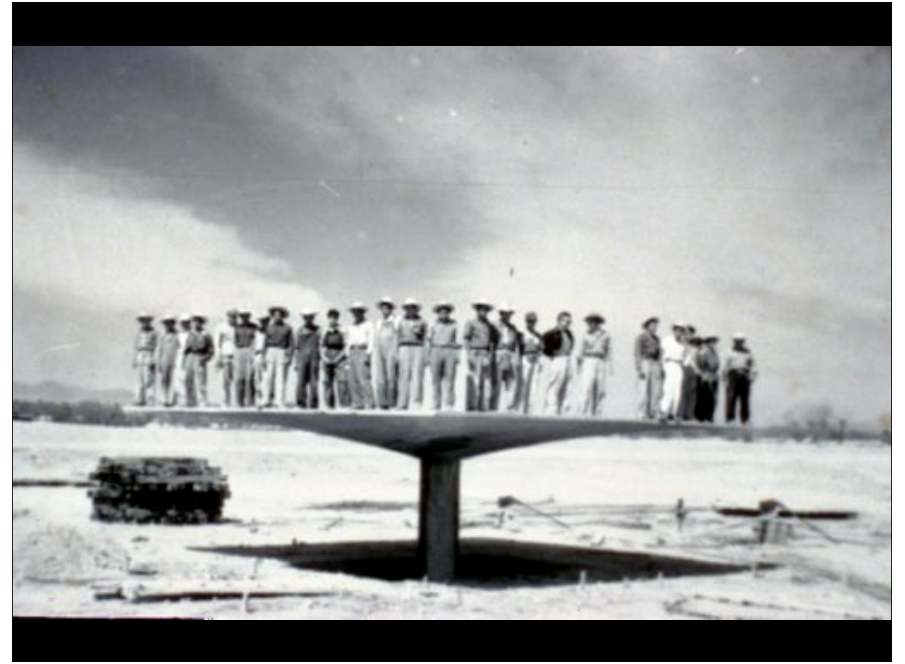
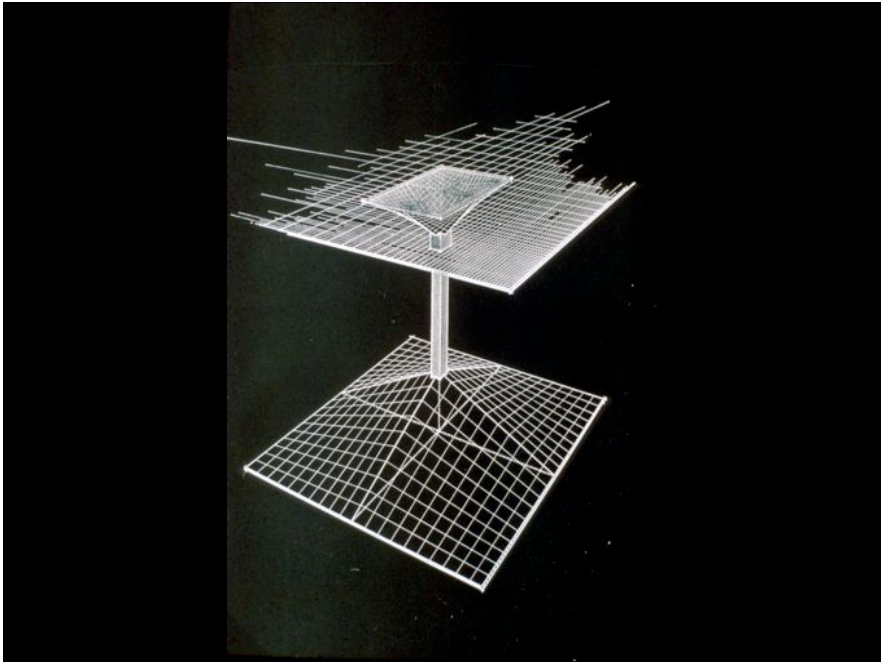


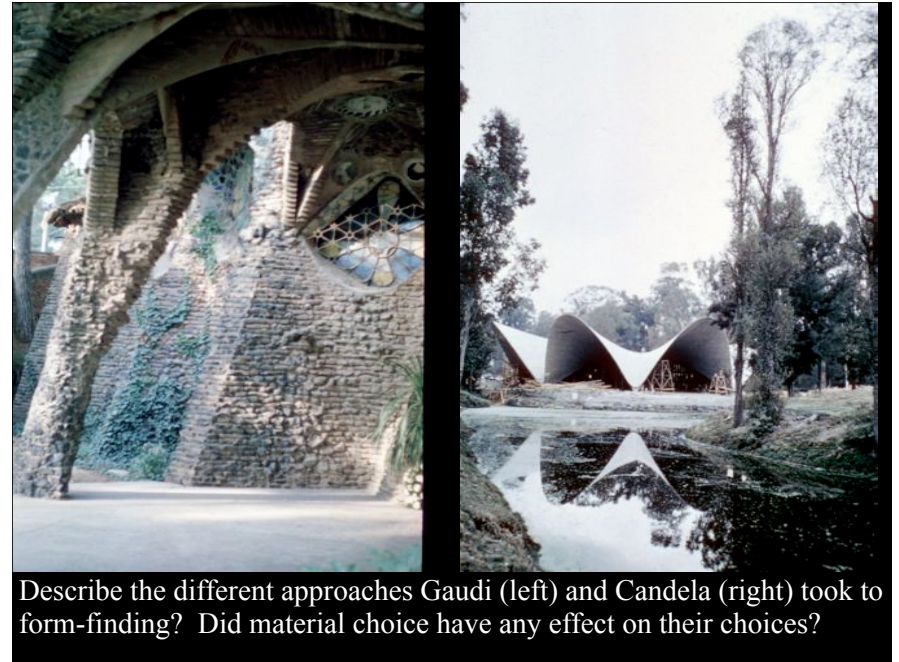
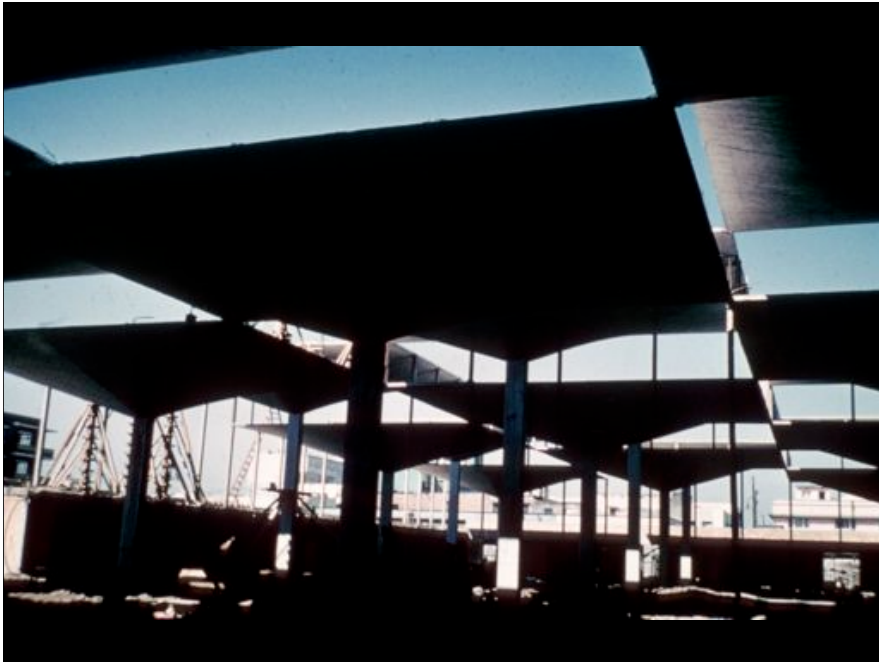
Locate the double curvature in this shell
Comment on the aesthetics









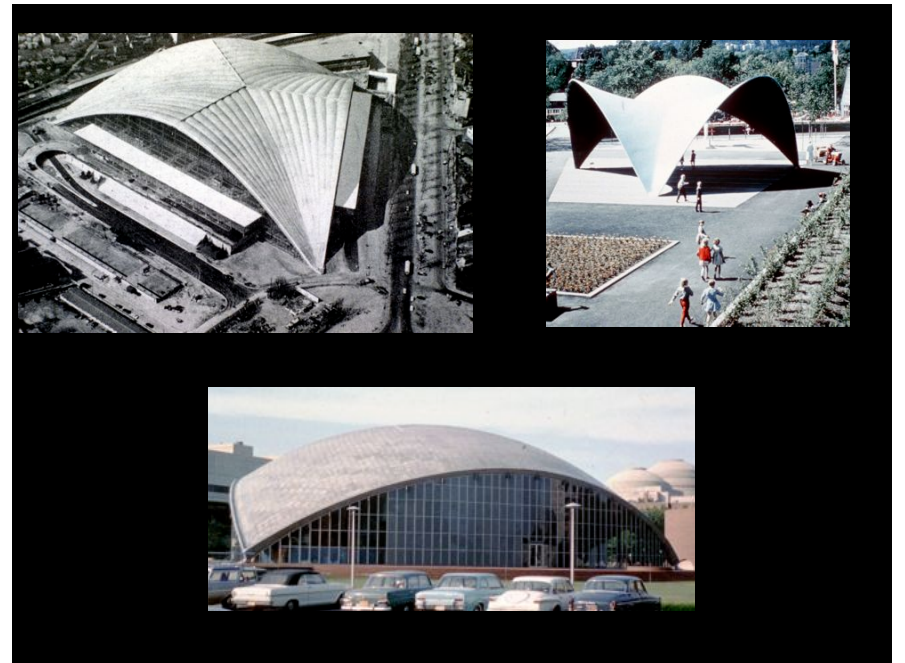
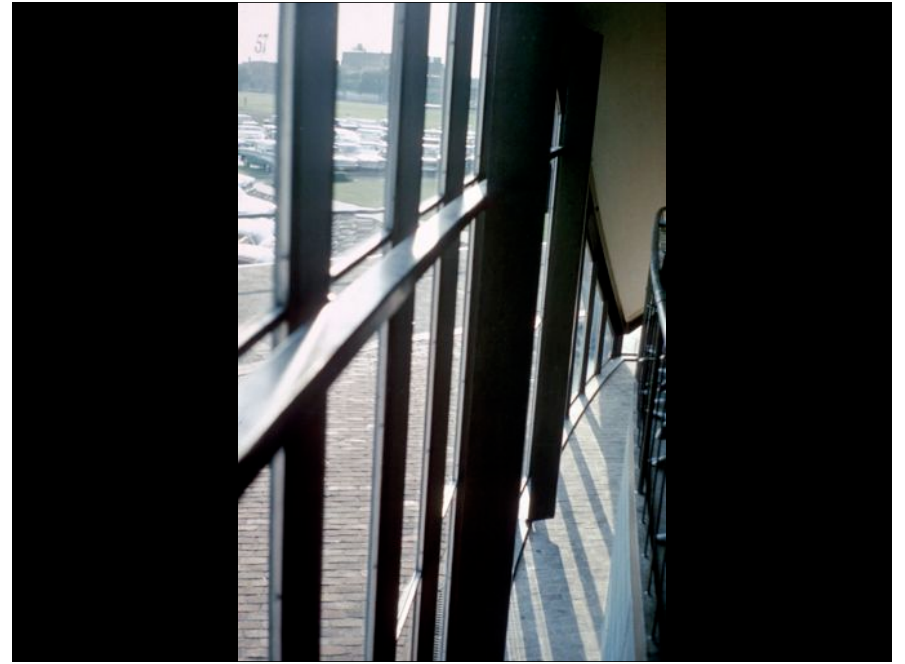
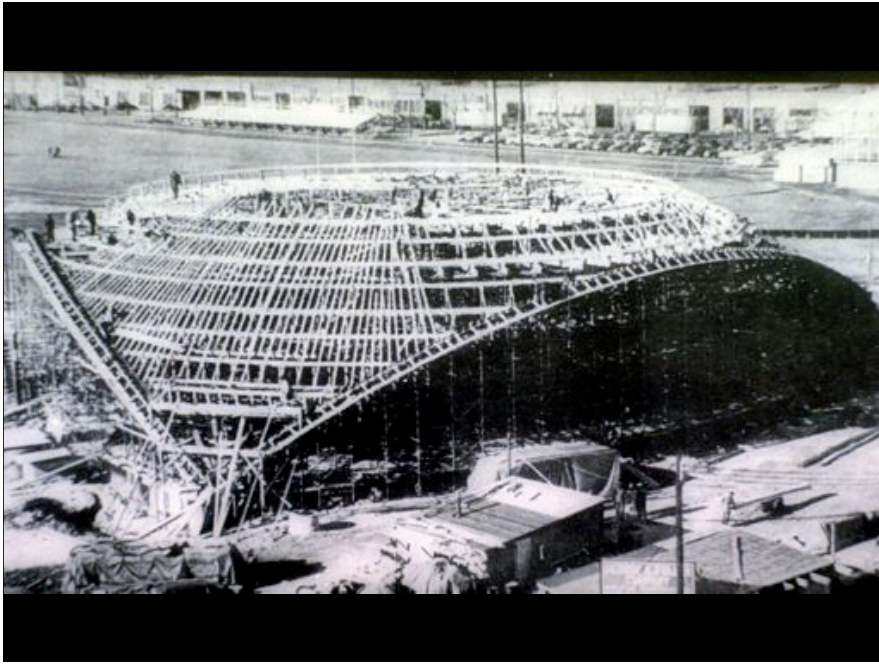


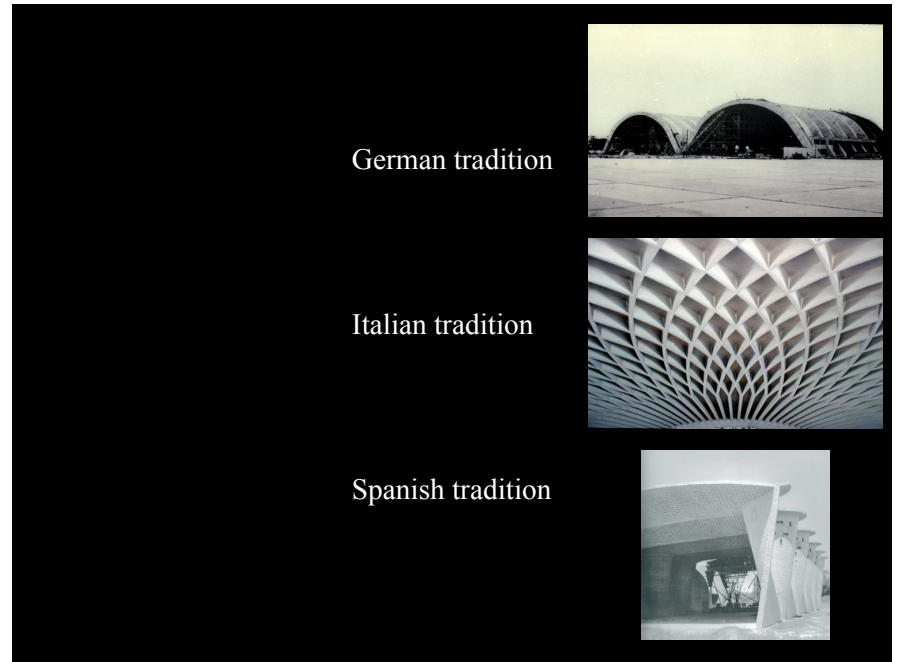
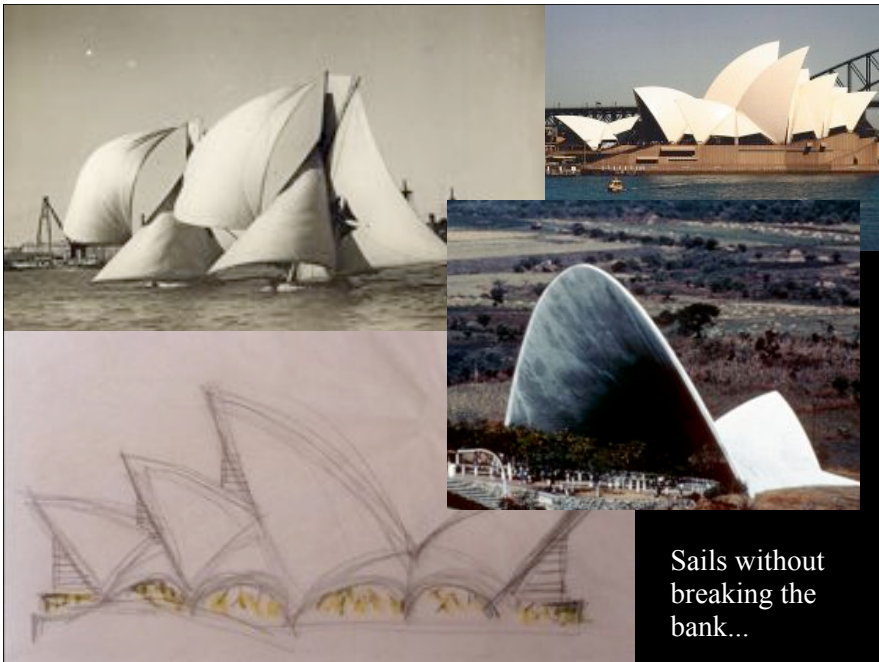
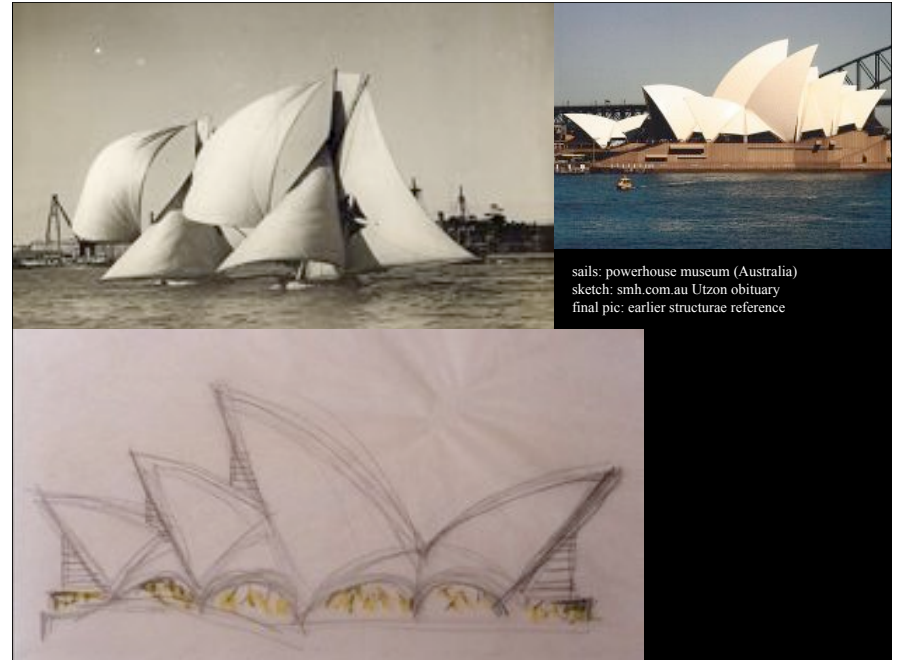
Describe the different approaches Gaudi (left) and Candela (right) took to form-finding? Did material choice have any effect on their choices?

who needs tradition?



Kresge Auditorium (MIT)





Exam 1 Next Tuesday

1. Study IDs from online index website > exam review (can be printed) (also linked from UMass moodle page)
2. Study Tower and the Bridge. This is the core material for questions
3. Study each lecture theme. Practice writing and answering questions based on them
4. No calculation, but quantitative questions and axial force / moment diagrams are fair game

Format: IDs; multiple choice/matching/blanks