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Illustrating the Use of The Nine Chapters in the Classroom

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Illustrating the Use of
The Nine Chapters
in the Classroom

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January 6, 2008

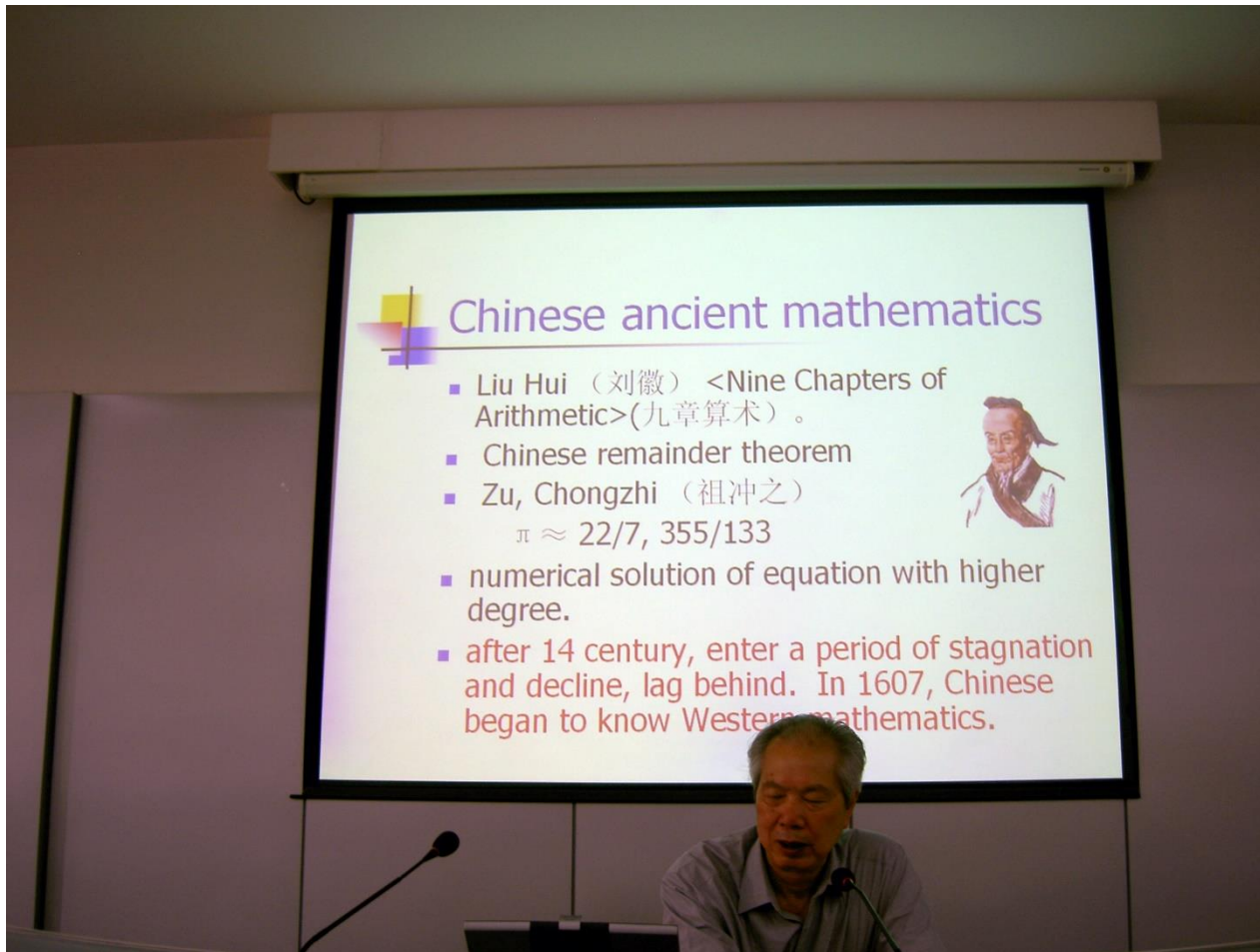
MAA Session on


Using Ideas from Asian Mathematics in the
Classroom

Dianzhou lecture




Dianzhou lecture



 Chinese ancient mathematics

- Liu Hui (刘徽) <Nine Chapters of Arithmetic>(九章算术)。
- Chinese remainder theorem
- Zu, Chongzhi (祖冲之)
 $\pi \approx 22/7, 355/113$
- numerical solution of equation with higher degree.
- after 14 century, enter a period of stagnation and decline, lag behind. In 1607, Chinese began to know Western mathematics.



The *Nine Chapters on the Mathematical Art*

- Problems organized by solution technique.
- A mathematics text for civil servants.

Civil Servants throughout history



Civil Servants throughout history



三彩文官俑
唐 (618-907)
1957年陕西西安出土
Tri-colored Pottery Figurine of
Civil Servant
Tang Dynasty (618-907)
Unearthed in Xi'an, Shaanxi Province 1957

From lecture by Ji

A Story on Testing Minor Functionaries

in *Addendum for History of Tang Dynasty* 《唐阙史》 (8th.c)

Yang Sun (a high official in Tang Dynasty), was famous for selecting and promoting the civil service members not through private influence or personal preference but by taking general opinions on their merits.

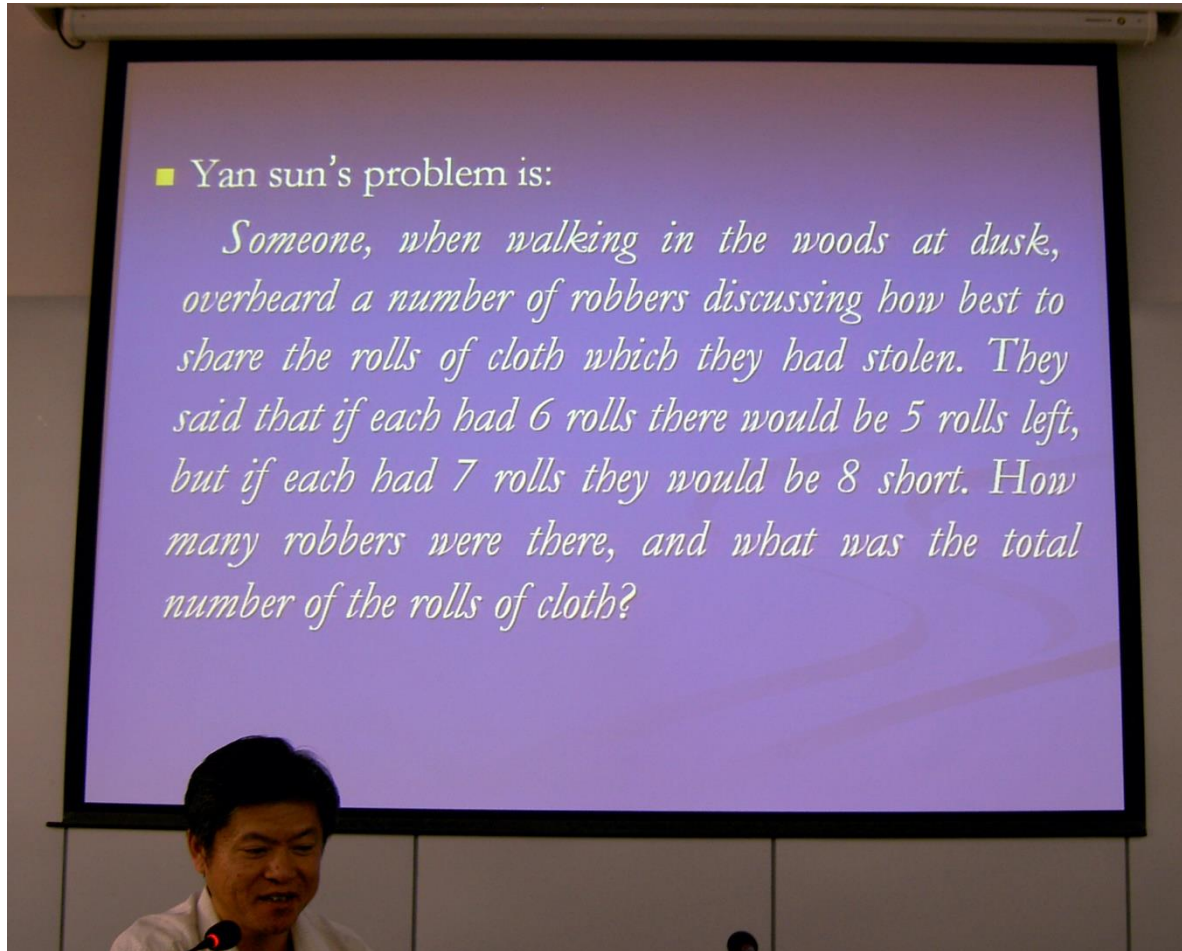
Once there were two clerks who held the same rank and had equal lengths of government service. They had even acquired the same commendations and the criticisms in their personal dossiers were identical. The responsible official was quite baffled by the problem of their promotion, and appealed to Yang Sun.

Yang Sun thought the matter over, and said: “ **One of the best merits of minor clerks is to be quick at computations.** Let both the candidates now listen to my question. Whoever first gets the right answer will obtain the advancement. ”

Problem for civil servants

- Yan sun's problem is:

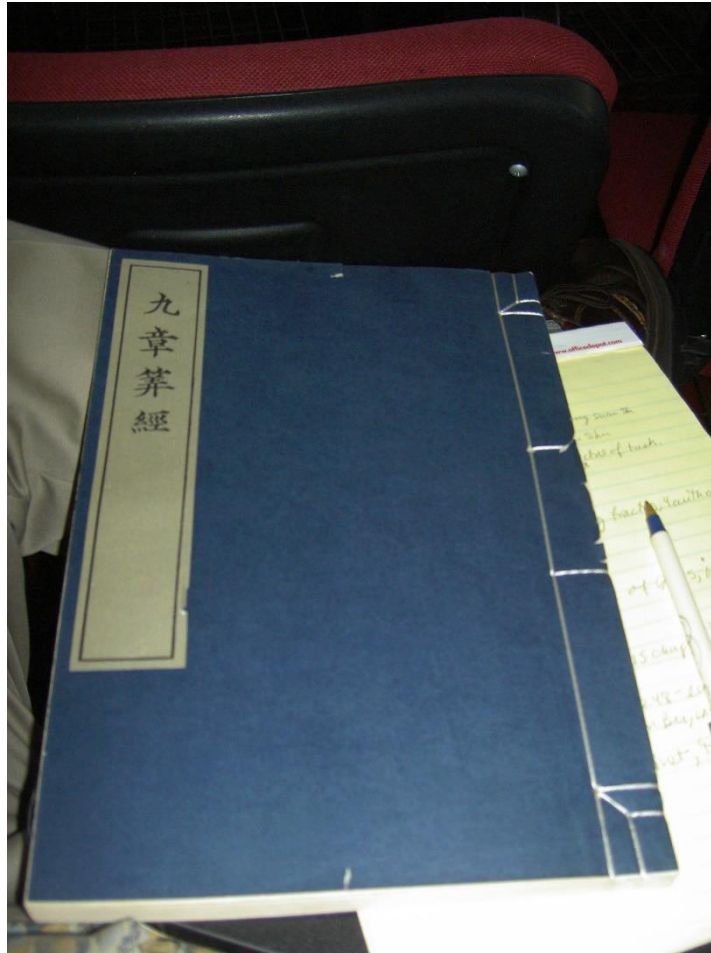
Someone, when walking in the woods at dusk, overheard a number of robbers discussing how best to share the rolls of cloth which they had stolen. They said that if each had 6 rolls there would be 5 rolls left, but if each had 7 rolls they would be 8 short. How many robbers were there, and what was the total number of the rolls of cloth?



Civil Servants throughout history



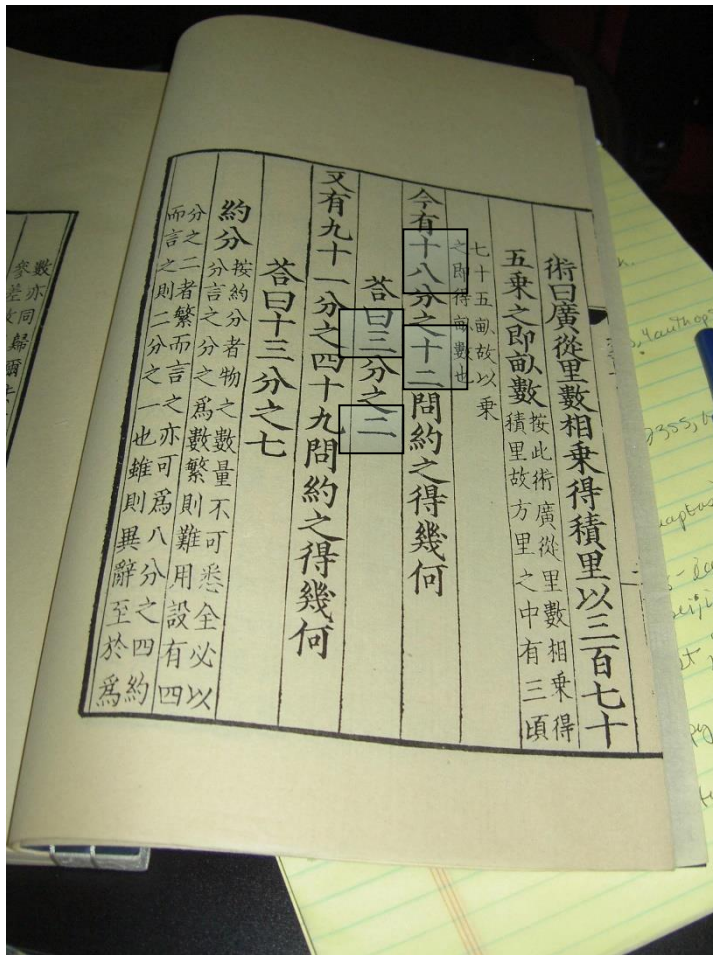
Early *Nine Chapters* text



Contents of the *Nine Chapters*

- Chapter 1. Field Measurement.
- Chapter 2. Millet and Rice.
- Chapter 3. Distribution by Proportion.

Early *Nine Chapters* text

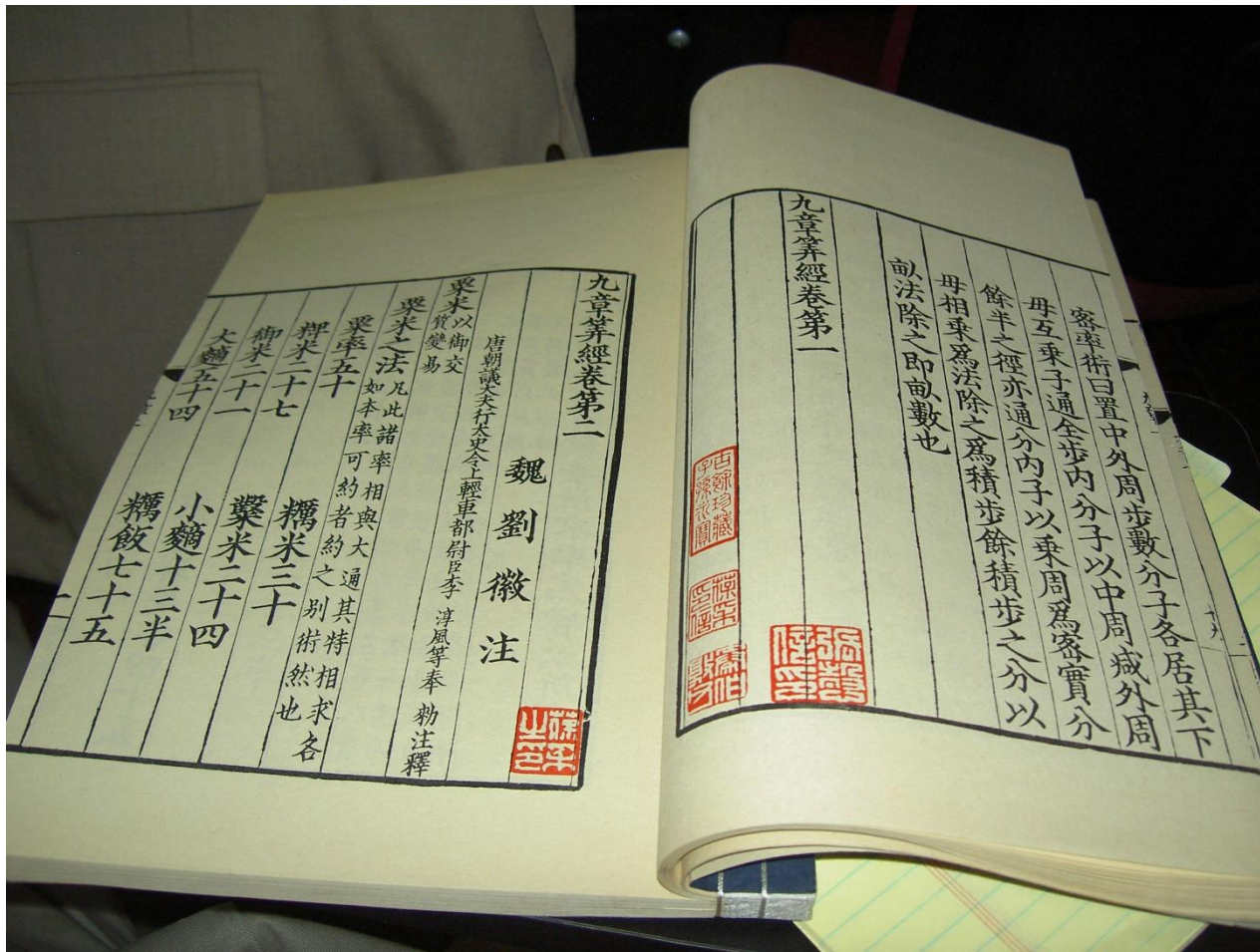


一	二	三	四	五
1	2	3	4	5
六	七	八	九	十
6	7	8	9	10
百	千	零	○	
100	1,000	10,000	0	

Zu Chongzhi approximation of π



Early *Nine Chapters* text



Husking rice



Measures of Capacity (Volume)



Contents of the *Nine Chapters*

- Chapter 4. Short Width.
- Chapter 5. Construction Consultations.
- Chapter 6. Fair Levies.

City Wall, Xi'an



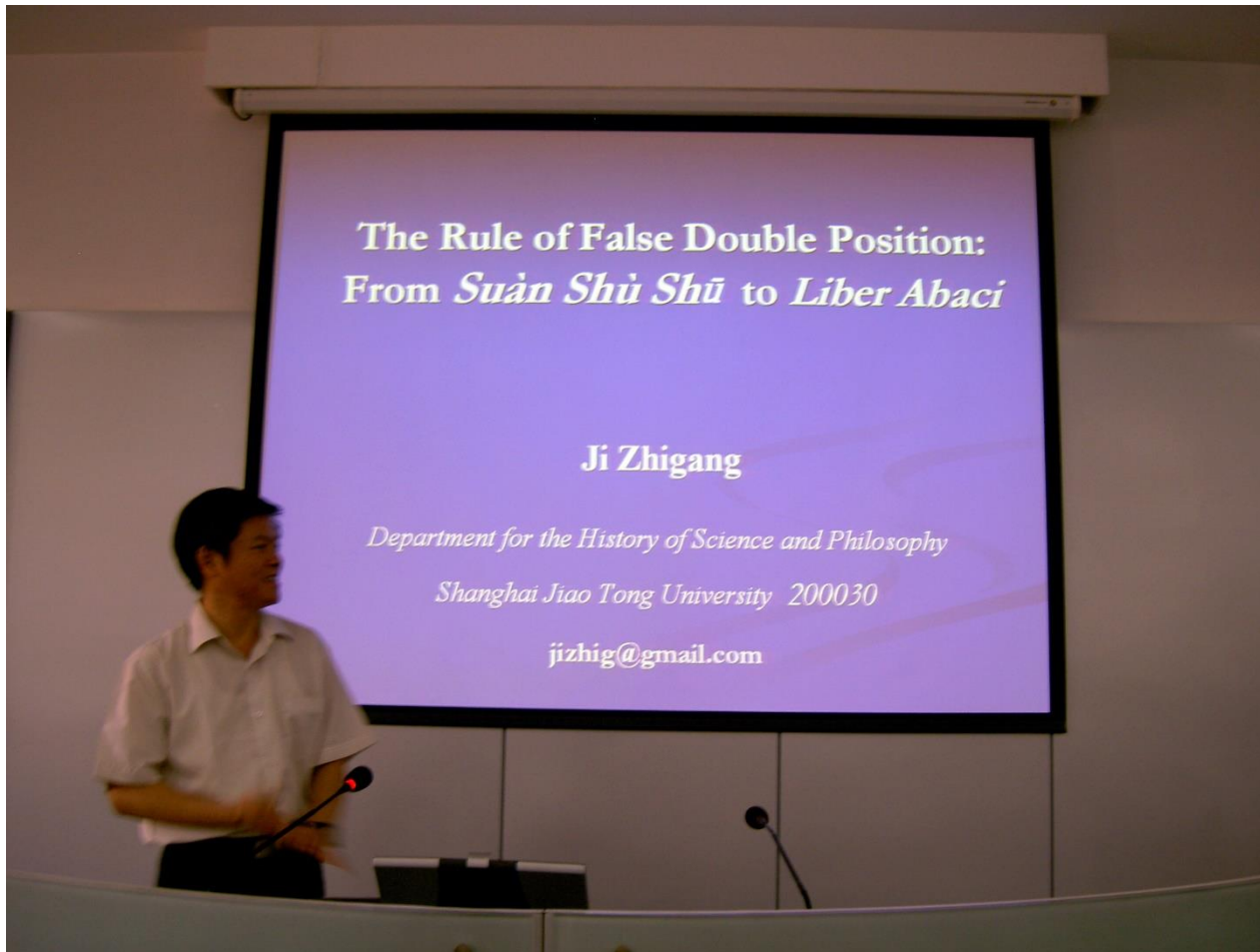
Model of City Wall, Xi'an



Contents of the *Nine Chapters*

- Chapter 7. Excess and Deficit.
- Chapter 8. Rectangular Arrays.
- Chapter 9. Right-angled Triangles.

Excess and Deficit still under discussion




Excess and Deficit still under discussion

The Characteristic of *Yin Bu zu* Method

*Setting Down Double Positions;
Cross-Multiplying*

—This is the method of double false position

$$\begin{array}{ccc} \begin{array}{cc} x_2 & x_1 \\ \diagdown & / \\ e_2 & e_1 \end{array} & \longrightarrow & \begin{array}{c} x_2 e_1 + x_1 e_2 \\ e_1 + e_2 \end{array} \longrightarrow \frac{x_2 e_1 + x_1 e_2}{e_1 + e_2} \end{array}$$


Example of Double False Position

17. Now 1 *mu* of good farmland costs 300 coins, 7 *mu* of poor farmland costs 500 coins. Now a total of 1 *qing* [=100 *mu*] farmland is bought, the price is 10,000 coins. Tell: the good and poor farmland, how much of each?

Answer: Good farmland $12\frac{1}{2}$ *mu*; poor farmland $87\frac{1}{2}$ *mu*.

Example of Double False Position

Let $f(x)$ be the number of coins, above the given amount 10000, required to purchase 100 *mu* of farmland at the rates given, if x *mu* is the amount of good farmland included.

Then $f(20)$

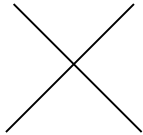
$$= 20 * 300 + (100 - 20) * (500/7) - 10000$$

$$= 1714 \frac{2}{7}, \text{ while}$$

Example of Double False Position

$$\begin{aligned} f(10) &= 10*300 + (100-10)*(500/7)-10000 \\ &= -571 \frac{3}{7}. \end{aligned}$$

The answer is found via

20	10
	
1714 $\frac{2}{7}$	571 $\frac{3}{7}$

$$x = \frac{20 * 571 \frac{3}{7} + 10 * 1714 \frac{2}{7}}{1714 \frac{2}{7} + 571 \frac{3}{7}} = 12 \frac{1}{2} \text{ mu.}$$

Western explanation via interpolation

Set up a proportion:

$$\frac{x-10}{571\frac{3}{7}} = \frac{20-10}{1714\frac{2}{7} + 571\frac{3}{7}}.$$

$$\begin{bmatrix} 20 & 1714\frac{2}{7} \\ x & 0 \\ 10 & -571\frac{3}{7} \end{bmatrix}$$

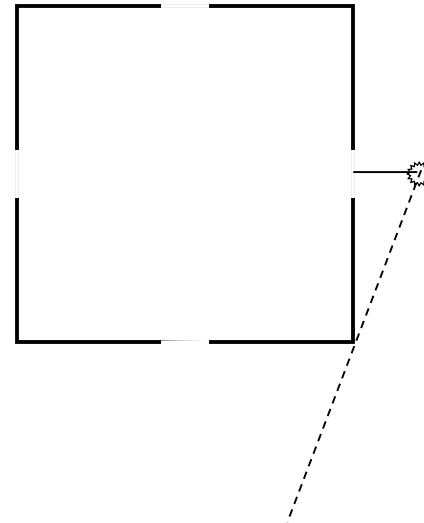
Solving yields

$$x = \frac{20 \times 571\frac{3}{7} + 10 \times 1714\frac{2}{7}}{1714\frac{2}{7} + 571\frac{3}{7}}.$$

Right-Angled Triangle problem 17

Now given a city 200 *bu* square, with gates opening in the middle of each side. 15 *bu* from the east gate there is a tree. Tell: at how many *bu* from the south gate will one see the tree?

Answer: $666 \frac{2}{3}$ *bu*.



Example of a Square Compound



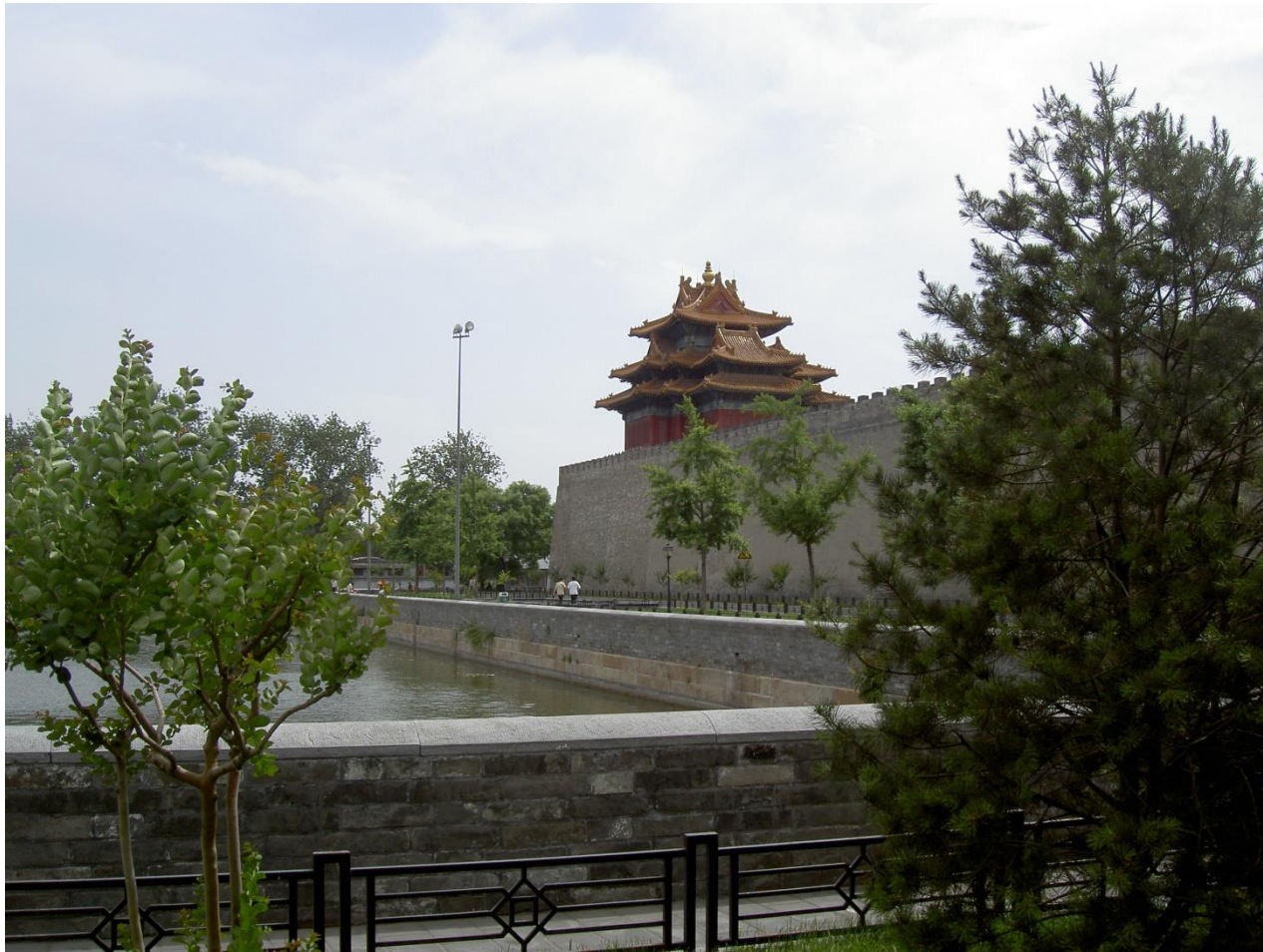
Example of a Square City, old Xi'an



Walls of Xi'an today



Watchtower, northwest corner of Forbidden City



Thank you for your attention!

Photo credits: Carol Dotseth and Joel Haack, while on the 2006 MAA Study Tour of China, led by Yibao Xu.