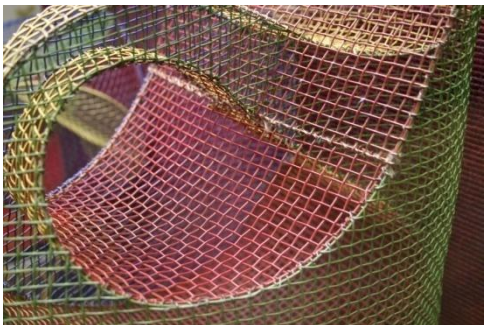
Task 3 – Museum guarding (35%)*


"Surface"

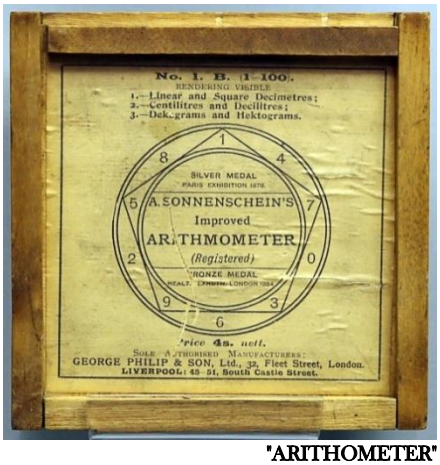
You work for a mathematical consultancy firm. Your employer has been hired as mathematical modelling consultants for a client that is setting up a series of mathematics-themed museums. The client has no mathematical knowledge. The part of the consultation project that your team has been tasked with is security arrangements. The client needs to know the number of security guards they must hire to effectively guard their museums. They will position guards at stationary points and require that every point within each museum is in line of sight of a guard at all times. The layouts of their museums are given in the appendix to this document.

"Calculator"

Part 1 – Group management (in groups; 10%)

Component 1 – Plan of work (5%)
Write around 400 words explaining how your team is going to approach task 3. You should have done some basic investigation of the topic by now and be able to be clear on how the work is to be approached and divided up among team members. **Deadline: end of session 10 Feb 2009.**

Component 2 – Minutes from meetings (5%)
Showing clearly actions given and work completed against each team member. **Deadline: Submitted each week according to the schedule.**



"ARITHOMETER"

Part 2 – Reports (in groups; 50%)

These reports are practical solutions to these problems. You should not provide proofs of theorems but should refer to proven theorems by name (with references) and apply their results. You should illustrate your reports with original diagrams where appropriate.

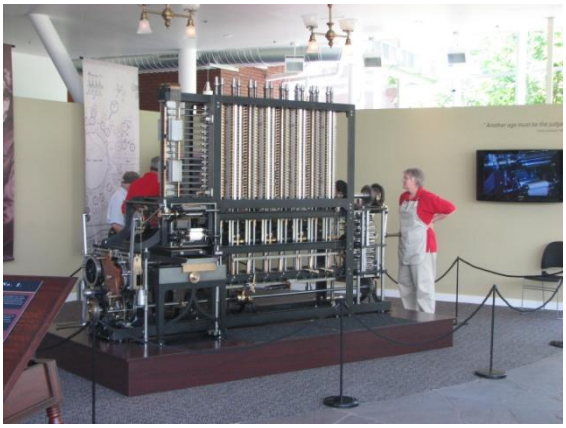

"Glass geometric shapes"

Component 1 – Report to client (25%)
Write a report of up to 2500 words giving your solution to the problem for all the client's museums. This must be fully referenced and grounded in mathematical theory but remember that the report is for a business client and not an audience knowledgeable in mathematics. You should use language and a level of mathematical content that is

* Please note: Task 3 is worth 35% not 30% as previously advertised. Task 4 will be worth 15%.

appropriate for this audience.

You must show the process you have used to solve the problem for each museum with appropriate original diagrams. You must be clear about the assumptions you have made in solving the problem and the limitations of your solutions in the real world. The client should be aware of what changes of circumstances will render your analysis inaccurate.



"Charles Babbage's Difference Engine No. 2"

Component 2 – Report to a mathematical audience (25%)

Your employer would like to take the opportunity to build its expertise in the area of surveillance consultancy. Write up your findings on this type of problem for your co-workers. This should not refer specifically to the problem from the client but be a more general guide to the family of problems suitable for a mathematically literate audience. This will be used by your employer as a body of knowledge for future similar projects. Provide a critical analysis of the limitations of the model used and consider: How realistic are the assumptions made?

Outline some possible extensions to this problem in other areas. Extensions could include *but are not limited to* moving guards, 3D, guarding an exterior, illuminating a room, etc. You might consider the following questions: Can guards see in all directions at once? What if you have a particularly valuable artefact that needed to be watched by at least two guards at once? **Part 2 deadline: 13 March 2009**

"Museum of Science Mathematics"

Part 3 – Presentation (in groups; 30%)

"Science Museum_9941"

Your employer runs 'in house' seminars on mathematical topics. Co-workers have read your report and are interested in the topic so your team has been asked to give a presentation on an interesting extension to the surveillance problems. You should assume the audience knows the basic problem and focus on one of the extensions you have discussed in Component 2 of Part 2 (report to a mathematical audience). Describe a real world scenario in which a surveillance problem arises and translate this into a generalised mathematical problem. If the extension you have chosen has been solved, give the solution from the literature. If it has not be solved try to show why the approaches used in other areas of surveillance problems do not yield a solution. **Part 3 deadline: Presentations will take place on 23 and 24 March 2009.**

Suggested reading

Topics

Chvátal's art gallery theorem

Fisk's proof of that theorem

Triangulation

The Fortress Problem

Illumination Problem

Some articles and chapters

DO, N., 2004. Art Gallery Theorems. *Gazette of the Australian Mathematical Society*, 31(5), 288-294.
[N.B. also available at: http://www.austms.org.au/Publ/Gazette/2004/Nov04/mathellaneous.pdf]

Chapter "How to guard a museum" in AIGNER, M., and ZIEGLER, G.M., 1998. *Proofs from THE BOOK*. London: Springer.

Chapter on Chvátal's Art Gallery Theorem (pp. 104-110) in HONSBERGER, R., 1976. *Mathematical Gems II*. Washington, DC: Mathematical Association of America.

SHERMER, T.C., 1992. Recent Results in Art Galleries. *Proceedings of the IEEE*, 80(9), 1384-1399.
[N.B. Also available at: http://www.cs.ubc.ca/nest/theory/thread/papers/shermer2002.pdf]

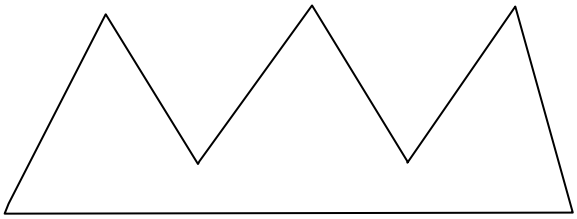
Wikipedia has a page on these problems which may provide a useful starting point but **must not be referenced in any submitted work**.

Plus many more.

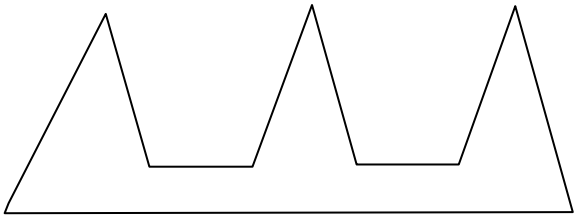
Image credits

Appendix: Layout of the client's museums

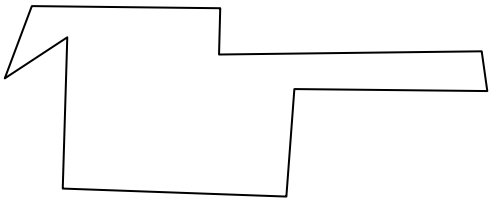
Museum of Vectors



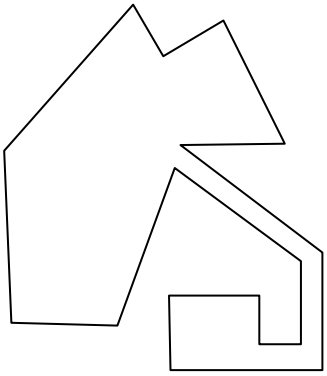
Museum of Primes



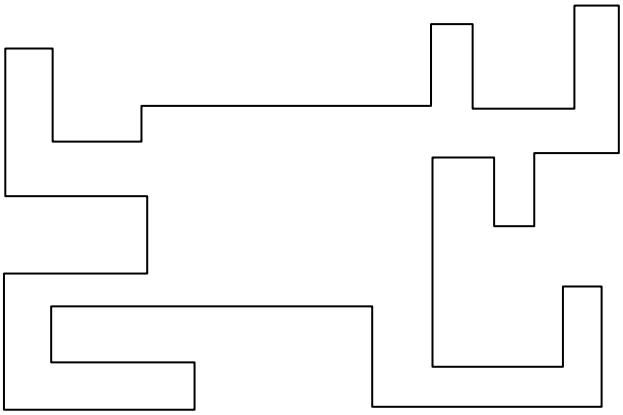
Museum of Limits



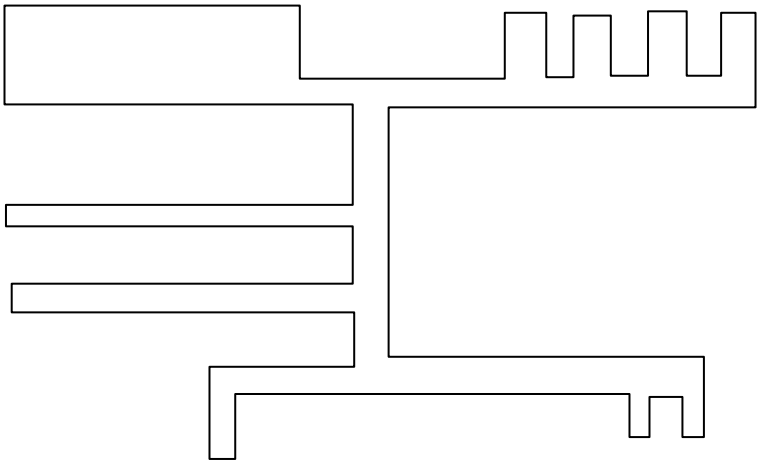
Museum of Fractals



Museum of Knots

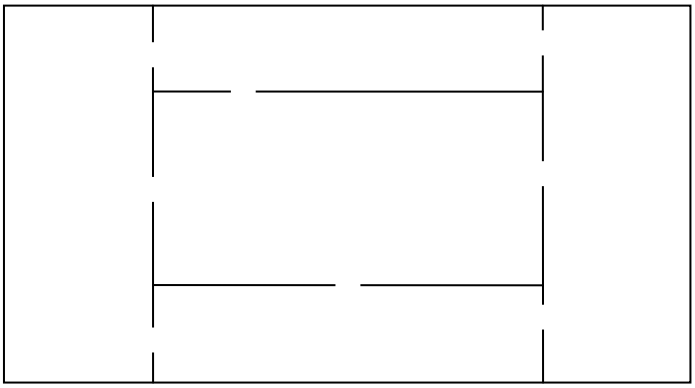


Museum of Polytopes

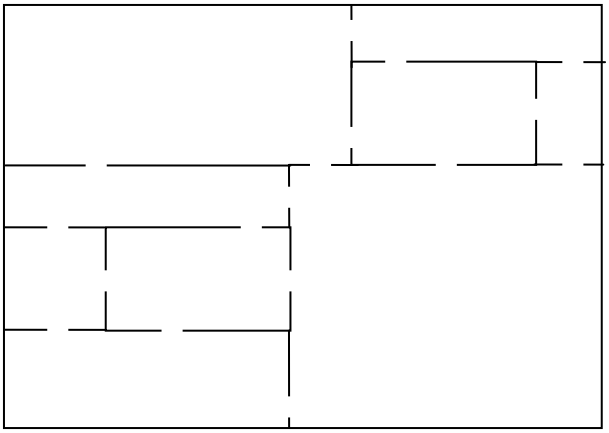


The following museums have separate rooms with interconnecting doors:

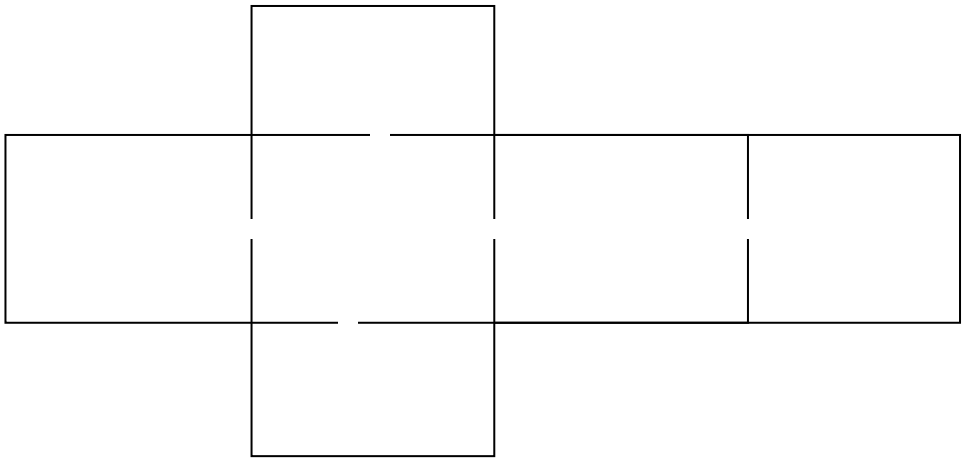
Museum of Tensors



Museum of Venn Diagrams

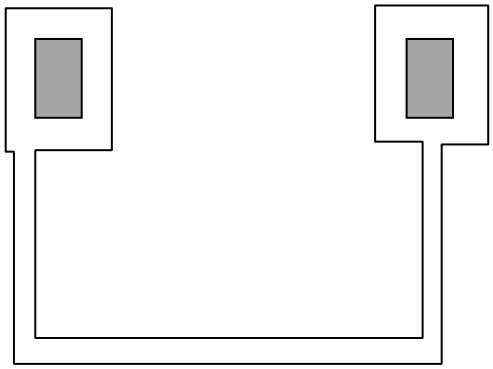


Museum of Graphs

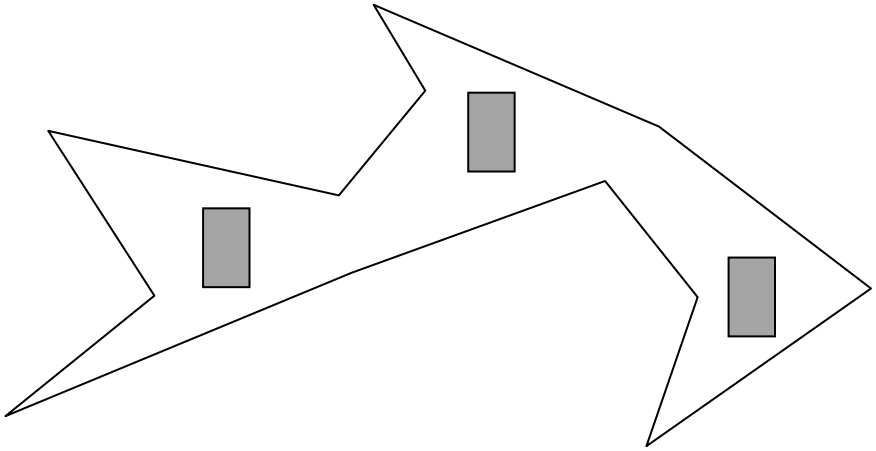


The following museums contain exhibits which cannot be seen through (marked as grey boxes).

Museum of Non-orientable surfaces



Museum of Lemmas



Museum of Rings