

# Simulating the Evolution of Ancient Fortified Cities

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Ancient cities and castles are ubiquitous cultural heritage structures all over Europe, and countless digital creations (e.g. movies and games) use them for storytelling. However, they got little or no attention in the computer graphics literature. This paper aims to close the gap between historical and geometrical modelling, by presenting a framework that allows the forward and inverse design of ancient city (e.g. castles and walled cities) evolution along history. The main component is an interactive loop that cycles over a number of years simulating the evolution of a city. The user can define events, such as battles, city growth, wall

creations or expansions, or any other historical event. Firstly, cities (or castles) and their walls are created, and, later on, expanded to encompass civil or strategic facilities to protect. In our framework, battle simulations are used to detect weaknesses and strengthen them, evolving to accommodate to developments in offensive weaponry. We conducted both forward and inverse design tests on three different scenarios: the city of Carcassone (France), the city of Gerunda (Spain) and the Ciutadella in ancient Barcelona. All the results have been validated by historians who helped fine-tune the different parameters involved in the simulations.

Code available at: <https://github.com/neich/BattleField>

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