Legend

Blue dashed lines: Era boundaries

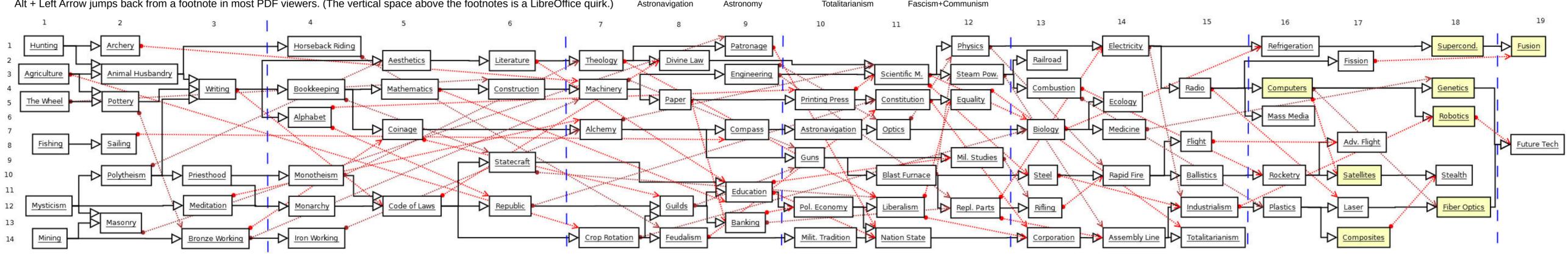
Red dotted arrows: Additional tech requirements (two different shades of red to make them less difficult to trace) Yellow shade: Spaceship (SS) parts

Blue text: Different from BtS. Mere name or research cost changes not highlighted. When a tech name is blue, then almost everything about it is different from BtS.

Green text: Difference from BtS that is already implemented in AdvCiv.

Rationales in footnotes. These are mostly about historicity, whereas stat-changes.pdf mostly addresses game balance.

Alt + Left Arrow jumps back from a footnote in most PDF viewers. (The vertical space above the footnotes is a LibreOffice quirk.)



- Hunting (60): Scout, Camp, Spearman (with Copper)
- Agriculture (60): Farm, Plantation (on Silk, Dye, Incense)³
- Wheel (60): Road, Chariot (with Horse)
- Fishing (60): can work Coast, Work Boat, faster movement along rivers²
- Mysticism (60): Monument, Stonehenge, reveal Incense¹
- Mining (60): Mine, can clear Forest and Jungle for no yield³
- Archery (60): Archer, Great Wall (req. 2 Walls)²
- Animal Husbandry (100): Pasture, reveal Horse and Silk,1 Stable (with Horse or Ivory)⁵
- Pottery (90): Granary (with Agriculture)⁶, Cottage, Workshop on Plains⁷
- Sailing (120): Galley⁸, Lighthouse, trade along unowned Coast
- Polytheism (70):9 Moai Statues (with Sailing)10, Culture slider11, found Hinduism if discoverer owns a Buddhist city or if Buddhism not yet founded¹²
- Masonry (60): Quarry, Walls, Great Lighthouse (with Lighthouse), Pyramids¹³
- Writing (150): Library, Open Borders
- Priesthood (80): Temple, Temple of Artemis¹⁴, Oracle¹³
- Meditation (90):¹⁵ Monastery¹⁶, found Buddhism if discoverer owns a Hindu city or if Hinduism not yet founded12
- Bronze Working (120)¹⁷: Axeman (with Copper or Iron), reveal Copper, 20 yield from chopping Forest, Forced Labor¹⁸

- Horseback Riding (220): Horse Archer (with Archery, Horse)
- Bookkeeping (160):¹⁹ Market, gold trading,²⁰ Temple of Kukulcan (with Priesthood)²¹
- Alphabet (200): Spy, Espionage slider²², Commando promotion²³, build Research, increases tech diffusion²⁴
- Monotheism (150):²⁵ Organized Religion, Winery,²⁶ unless discoverer owns a Holy City, found Zoroastrianism; if already founded, found Judaism instead²⁷
- Monarchy (200): Hereditary Rule, Barracks, Fort²⁸
- Iron Working (190): Swordsman (with Iron), Forge²⁹, reveal Iron
- Aesthetics (280):30 Mausoleum of Mausolos31, Statue of Zeus (req. 2 Monuments), Angkor Wat³²
- Mathematics (240):³³ Aqueduct (with Mining)³⁴, Hanging Gardens (with Aqueduct), centers the map³⁵, Trireme (with Sailing, Bronze Working)³⁶
- Coinage (320):³⁷ +1 trade route, build Wealth, Shwedagon Paya³⁸ (with Meditation)
- Code of Laws (270):³⁹ Courthouse, Caste System, Vassal agreement⁴⁰
- Literature (350): Heroic Epic (with Library),⁴¹ Great Library (with Library), Theater⁴²
- Construction (400):⁴³ Catapult (with Archery⁴⁴), Harbor⁴⁵ (with Lighthouse)⁴⁶, Colossus⁴⁷ (with Forge), Bridge building
- Statecraft (400):48 War Elephant49 (with Horseback Riding Ivory), Forbidden Palace⁵⁰ (with Courthouses), Guerilla promotion⁵¹, found Confucianism if discoverer owns a Taoist city or if Taoism not yet founded52
- Republic (420):⁵³ Parthenon (with Priesthood)⁵⁴, Arena (with Masonry)⁵⁵, Academy⁵⁶, Triumphal Arch (with Construction)⁵⁷

• Theology (800):58 Apostolic Palace, Hagia Sophia, found Christianity if discoverer owns a Jewish or Zoroastrian city⁵⁹

Correspondence between techs:

Calendar

Currency

Drama

Civil Service

Philosophy

Metal Casting

Divine Right

Bookkeeping

Coinage

Statecraft

Republic

Alchemy

Crop Rotation

Divine Law

Patronage

- Machinery (800):⁶⁰ Watermill, Lumbermill, +50% chopping yield, 61 Crossbowman (with Iron or Copper) 62
- Alchemy (700):⁶³ Pacifism, +10% research from Monastery,⁶⁴ found Taoism if discoverer owns a Confucian city or if Confucianism not yet founded⁶⁵
- Crop Rotation (800):66 Serfdom67, can build Farm on Grassland without irrigation⁶⁸
- Divine Law (1000):⁶⁹ Theocracy,⁷⁰ Spiral Minaret, found Islam if discoverer owns a Christian, Jewish or Zoroastrian city⁵⁹
- Paper (1200):⁷¹ University of Sankore, Bureaucracy (with
- Guilds (1300):⁷³ Pikeman (with Iron), Maceman (with Machinery, Iron),⁷⁴ Plantation (on Banana, Spice, Sugar)⁷⁵, Workshop on all flat tiles⁷⁶
- Feudalism (800): Longbow (with Archery, Iron Working)⁷⁷ Knight⁷⁸ (with Machinery, Iron, Horse), Castle⁷⁹, Vassalage civic
- Patronage (1400):80 Sistine Chapel, build Culture, Cathedral
- Engineering (1500): Trebuchet, Windmill⁸¹, Notre Dame (with Theology), Taj Mahal (with Divine Law)82
- Compass (1400):83 Map trading84, Explorer, Grocer (with Guilds)85, Whaling Boats86
- Education (1500):⁸⁷ University, Oxford University (with University)
- Banking (1500):⁸⁸ Bank, Great Merchant if first to discover⁸⁹

 Printing Press (2000): +1 commerce from Village and Town, obs. Great Library⁹⁰

BtS

Gunpowder

Economics

Nationalism

Military Science

Democracy+Communism

Chemistry

Artillery

Guns

Political Economy

Nation State

Ballistics

Rapid Fire

Equality

Blast Furnace

Military Studies

- Astronavigation (1900):⁹¹ Caravel (with Construction)⁹², Navigation II promotion⁹³, +1 sight on water⁹⁴
- Guns (2400):95 Musketman, Pinch promotion
- Political Economy (2100):⁹⁶ Mercantilism, +1 production from Lumbermill⁹⁷, Customs House⁹⁸ (with Harbor), Versailles (Monarchy)⁹⁹
- Military Tradition (2400):¹⁰⁰ Cuirassier (with Guns, Horse), Kremlin¹⁰¹, Militarism¹⁰², Defensive Pact
- Scientific Method (2500):¹⁰³ can impart tech¹⁰⁴, +1 research per specialist¹⁰⁵, obs. Statue of Zeus, Angkor Wat¹⁰⁶ and Monastery
- Constitution (2700):¹⁰⁷ Jail, Federation (with Nation State)¹⁰⁸, Representation, obs. Monument, Stonehenge¹⁰⁹ and Mausoleum of Mausolos¹¹⁰
- Optics (2500):¹¹¹ Galleon, Privateer (with Guns and Copper or Iron)¹¹², trade across Ocean, Lookout promotion for naval units¹¹³, obs. Great Lighthouse¹¹⁴
- Blast Furnace (2700):115 Cannon (with Iron)116, Frigate (with Optics and Iron), Grenadier¹¹⁷, Barrage promotion¹¹⁸, obs.
- Liberalism (2500): Free Market (with Nation State), 120 Free Religion, Statue of Liberty (with Harbor and must be in Emancipation and Free Religion)¹²¹, obs. Castle¹²², Oracle¹²³ and Temple of Artemis¹²⁴
- Nation State (2600):¹²⁵ Hermitage, Globe Theater (with Theater)¹²⁶, free Great Artist if first to discover¹²⁷
- Physics (2700):¹²⁸ Observatory¹²⁹, free Great Scientist if first to discover
- Steam Power (3400):¹³⁰ Levee¹³¹, Workers build improvements faster¹³², Ironclad (with Iron and Coal)¹³³, reveal Coal, Farms spread Irrigation¹³⁴
- Equality (3100):¹³⁵ Emancipation, Police Headquarters, Security Bureau. 136 obs. Deer 137
- Military Studies (2900): 138 Ship of the Line (with Optics, Blast Furnace and Iron), Military Academy (with Barracks)¹³⁹ +1 movement on Roads¹⁴⁰ and along rivers¹⁴¹, Blitz promotion¹⁴²
- Replaceable Parts (3300):¹⁴³ Drydock¹⁴⁴, +1 production from Windmill, Watermill and Workshop 145

- Railroad (3700):¹⁴⁶ Rail Track (with Coal or Oil), Public Transportation (with Oil)¹⁴⁷, can trade Crab¹⁴⁸, Mining Inc. Executive (with Corporation, University), obs. Walls¹⁴⁹
- Combustion (4100):¹⁵⁰ reveal Oil¹⁵¹, Oil Well, Airship (with Physics)¹⁵², Std. Ethanol Executive (with Corporation, University)¹⁵³, obs. Whale, Dye¹⁵⁴
- Biology (4700):155 +1 food from Farm, can build Farms without irrigation, Cereal Mills Executive (with Corporation, University)¹⁵⁶, obs. Temple of Kukulcan¹⁵⁷
- Steel (4200):¹⁵⁸ Bunker¹⁵⁹, Steelworks (with Iron, Coal, Forge)¹⁶⁰, Cristo Redentor (with Theology)¹⁶¹, construct Ancient and Classical buildings faster¹⁶², Creative Constructions Executive¹⁶³ (with Corporation, University)
- Rifling (4000):¹⁶⁴ Rifleman, Cavalry (with Military Tradition, Horse)
- Corporation (4200):165 Wall Street (with Bank), +1 trade route, State Property (with Equality)¹⁶⁶, can train Executives at Universities¹⁶⁷, obs. Great Wall¹⁶⁸
- Electricity (5000):169 reveal Aluminum170, Broadway (with Theater), +1 commerce from Watermill¹⁷¹, Coal Plant (with Coal)¹⁷², Hydroplant (with Steel), Three Gorges Dam (with
- Ecology (5100): Environmentalism¹⁷⁴, Treatment Plant¹⁷⁵, Preserve Forest, National Park, 176 obs. Ivory 177
- Medicine (4200): Hospital (with power), Red Cross (with Hospital), Fallout Shelter (with Steel, Manhattan Project)¹⁷⁸, Medic III promotion¹⁷⁹
- Rapid Fire (4800): Machine Gun,¹⁸⁰ Field Gun¹⁸¹, Interception I ¹⁸² and Ambush¹⁸³ promotions, Mount Rushmore¹⁸⁴
- Assembly Line (5200):¹⁸⁵ Factory (with Coal, Oil or power)¹⁸⁶ Infantry (with Rapid Fire)¹⁸⁷, Universal Suffrage (with Equality)¹⁸⁶
- Radio (7800):189 Attack Submarine (Oil or Uranium)190, Rock'n'Roll (with Arena⁵⁵, power), Eiffel Tower (with Forge), reveal Uranium¹⁹¹; Air Recon can reveal Submarines¹⁹²
- Flight (7000):¹⁹³ Fighter (with Oil), Bomber (with Radio¹⁹⁴, Oil and Aluminum¹⁹⁵), Carrier (with Coal or Oil or Uranium), Paratrooper¹⁹⁶
- Ballistics (5500):197 Battleship (with Coal or Oil or Uranium), Destroyer (with Radio and Coal or Oil), 198 Tank (with Assembly Line, Railroad and Oil)19
- Industrialism (7200):²⁰⁰ Industrial Park (with Factory, power), Marine (with Rapid Fire)²⁰¹, Transport (with Coal or Oil)²⁰², Pentagon²⁰³, Aluminum Co. Executive (with University)²⁰⁴
- Totalitarianism (5500):²⁰⁵ Police State, Permanent Alliance, Intelligence Agency, free Great Spy if first to discover, 206 obs. Parthenon²⁰⁷

- Refrigeration (8000): Supermarket (with power), +1 food from Fishing Boats²⁰⁸, Sid's Sushi Executive (with Corporation,
- Computers (8400):²¹⁰ 100% conversion rate from Processes²¹¹, SS Life Support (with Ecology)²¹²
- Mass Media (9000): United Nations, Hollywood (with Broadcast Tower), Broadcast Tower (with power), Civ. Jewelers Executive (with Corporation, University)²¹³, obs. Apostolic Palace
- Rocketry (8500):²¹⁴ SAM Infantry (with Radio²¹⁵), Anti-Tank²¹⁶, Guided Missile, Nuclear Submarine (with Radio and Uranium)¹⁹⁰, Missile Cruiser (with Radio and Oil or Uranium)²¹⁷
- Plastics (8500):²¹⁸ +1 trade route from Harbor²¹⁹, +3 happiness

in all cities²²⁰, Offshore Platform²²¹, obs. Fur, Silk²²²

Nuclear Plant (with Uranium)

- Fission (9500):²²³ Manhattan Project (with Nuclear Plant), Tactical Nuke (with Rocketry, Uranium and Manhattan Project), ICBM (with Satellites²²⁴, Uranium and Manhattan Project),
- Advanced Flight (11000):²²⁵ Gunship (with Oil); Jet Fighter (with Aluminum, Oil), Airport (with Radio, Oil)²²⁶, obs. Stable and
- Satellites (9000):²²⁸ Apollo Project (with Plastics)²²⁹, reveal map, SDI (with Manhattan Project)²³⁰
- Laser (11000):²³¹ Mobile SAM (with Rocketry, Oil), Howitzer²³² (with Ballistics and Oil), Space Elevator (with Satellites)²³³
- Composites (11000):²³⁴ SS Casing, Mechanized Infantry (with Rapid Fire, Aluminum, Oil)²³⁵, Modern Armor (with Laser Ballistics, Oil)²³⁶
- Superconductors (12000): SS Thrusters, Particle Accelerator (with Computers, Fission and power)²³⁷
- Genetics (12000):²³⁸ SS Stasis Chamber (with Refrigeration)²³⁹, +2 health, +1 food in Grassland tiles with at least 5 food²⁴⁰
- Robotics (10000): SS Docking Bay, +1 free Engineer from Industrial Park²⁴¹
- Stealth (12000):²⁴² Stealth Bomber (with Advanced Flight, Aluminum, Oil), Stealth Destroyer (with Oil or Uranium), Air Recon can reveal stealth ships²⁴
- Fiber Optics (12000):²⁴⁴ SS Cockpit, Internet²⁴⁵
- Future Tech (10000):²⁴⁶ + 1 health, +1 happiness
- Fusion (12000):²⁴⁷ SS Engine, free Great Engineer²⁴⁸ if first to

- 1 Dye seems to refer mostly to indigo, which was cultivated since 2500 BC. Considering that most Dye is blocked by Jungle initially, no additional tech should be required. Silk and frankincense are also preclassical trade commodities and come from simple tree plantations. For silk production, it's not enough to plant mulberry trees; the silkworms also need to be domesticated. Require Animal Husbandry for this. Without ritual uses, incense might not be valuable enough to plant incense trees, so Mysticism is required. To avoid introducing additional Plantation improvements, all early Plantations require Agriculture, and Mysticism and Animal Husbandry reveal Incense and Silk.
- About the other three Plantations, see Guilds. All six at the same tech (as in BtS) gives civs near the equator too many resources at once and allows too much city growth in the early midgame. The additional happiness in the early game is welcome since Slavery can no longer be used to work around unhappiness. None of the three resources are very powerful, and civs need to stretch a little to get them 48
- (remove Jungle or Forest, settle near Jungle or Desert). 2 As in Alpha Centauri, but only for Recon, Melee, Archery and Gunpowder units. Should make Fishing a bit more useful for civs that start with Fishing but not at a coast.
- 3 The BtS requirements for clearing Forest and Jungle suggest that metal tools were necessary, but slash-and-burn doesn't require sophisticated tools. Some tech should be required for slash-and-burn because all other Worker jobs have tech requirements too. Mining somewhat fits because it should comprise fire-setting, another fire-based technique. One could argue that equatorial rainforest is too dense and wet for slash-and-burn, but there is also no incentive to settle deep in the jungle

in the early game, especially since Workers are going to have limited

- Similarly, clearing Forest without yield is usually a bad idea. For a chopping yield, Bronze Working is still required, as metal tools are indeed very helpful for making lumber.
- 4 Masonry is still required for the prerequisite Walls. Moving the Great Wall to Archery makes Masonry look less cluttered and gives players another reason to discover Archery. Barbarian activity increases gradually in AdvCiv, so an additional tech requirement shouldn't hurt
- Historically, one could argue that a large wall with flanking towers needs to be manned by archers to be fully effective. That said, other ranged weapons could also do the job, so this explanation is a bit contrived.
- 5 Earlier access to Stable should boost Chariot but also allows Stables to be constructed while researching Horseback Riding, so Horse Archer 6 Pottery is reachable without Agriculture, but Granary needs to store
- grain, no other kind of food will do. The alternative requirement for Pottery has been changed from Fishing to the Wheel, and the Wheel is no longer a mandatory requirement. That is, the potter's wheel helps, but wheel-less civilizations are also allowed to develop Pottery. 7 Granting +2 production right away because +1 production, -1 food is very rarely worth building. The early Workshops should help convert
- Labor, the replacement for Slavery, also performs this conversion but not nearly as effectively as Slavery. The terrain restriction should make Plains a bit more useful compared with Grassland. The early Workshops could represent brickyards, and Plains are clay-colored.

excess food into production when cities reach the happiness cap. Forced

- 8 Should perhaps rename this to "Penteconter" to make clear how it differs from Trireme. (Triremes are also galleys, just a special type.) 9 Polytheism (instead of Priesthood) as a requirement for Writing makes it easier to put Writing in the third column (where it belongs), and makes Polytheism more useful. In turn, Priesthood replaces Polytheism as the requirement for Monotheism. This way, the great temples unlocked by Theology and Divine Law (a.k.a. Divine Right) automatically 54
- 10 Now a great wonder (see stat-changes-pdf). Replaces Temple of Artemis, which moves to Priesthood. The Moai depict deified (or at least venerated) ancestors, which is close enough to polytheism. As the wonder is (also) supposed to represent the colonization of small islands, 55 Although a Colosseum would fit very well under Republic, it's not a Sailing has to be required in addition.
- 11 Adopted from Drama, which gets merged into Literature, as Polytheism may need another useful ability. Testing will have to show if the slider is indeed useful this early, or perhaps even too useful, in a way that discourages Temples.
- 12 This restriction ensures that Buddhism and Hinduism are founded close to each other. Along with other changes (see Monotheism), the coupling of these two religions should keep several civs without an early religion 57 This is a renamed Heroic Epic though with the 3D model of National and thus make the later religions more useful. Could also give each of the two religions an increased chance of spreading in cities where the other religion is already present. (Same later for Taoism/ Confucianism and perhaps the Abrahamic religions too.)
- 13 Note that the abilities of the following wonders have (essentially) been swapped in a circle: Pyramids \rightarrow Parthenon \rightarrow Statue of Zeus \rightarrow
- 14 Moved from Polytheism because Temple of Artemis shouldn't become available earlier than Temple. 15 Moved into the third column because the second column was too
- crowded. This means that Meditation can't lead to Priesthood. The new link to Monarchy represents Buddhist kingship. For example, in the early Mauryan and Tibetan Empires, priests didn't have a major role. Should perhaps be renamed to "Monasticism" to stress the dichotomic relationship with Priesthood. 16 The change to the ability of Organized Religion (see stat-changes.pdf)
- means that religions cannot be spread deliberately without Meditation, and this should make the tech valuable enough to be discovered eventually. If this takes a while – all the better; then the Medieval religions have an easier time catching up with the earlier religions. 17 Kilns for smelting copper ores arguably (always) developed from pottery kilns, hence the Pottery requirement. Whether this is good for gameplay remains to be seen; it should make Mining a less powerful
- which I'm replacing with Bronze Working and Coinage. 18 A.k.a. nerfed Slavery. Bronze Working isn't a plausible tech requirement for either civic, but I don't see a clearly better alternative. and the Ancient era should, when in doubt, remain as in BtS, so that the mod starts out in a familiar fashion. Or perhaps move it to the new Bookkeeping tech that replaces Calendar?

starting tech if nothing else. BtS requires Pottery for Metal Casting,

- 19 A new tech replacing/ encompassing Calendar. The problem with Calendar is that Plantations and the Mausoleum don't have anything to do with calendars, and, apart from other techs, I don't see anything else in the game that would require calendars. "Bookkeeping" is a very
- broad concept that could include commercial records, star catalogs and 62 basic math, e.g. multiplication tables (leading to Mathematics). 20 Moved from Currency; see Coinage. 21 A.k.a. Chichen Itza. According to Wikipedia, "Kukulkan headed a
- pantheon [...] used to promote the Itza [...] commercial agenda." So Bookkeeping, as a (mainly) commercial tech, somewhat fits. Since it's a temple, Priesthood should be required. 22 This doesn't have any tech requirement in BtS but isn't normally useful
- without the Spy unit. The BtS developers probably wanted the slider on the main interface as early as possible in order to draw attention to their new expansion
- 23 Moved from Military Science (now Military Studies). I'm disabling this promotion for combat units (see "Commando" in stat-changes.pdf), so it's not terribly relevant anymore and might as well become available along with the Spy unit. Should probably not appear as an icon on the tech tree.
- 24 Tech trading with Alphabet would also be acceptable once tech trading is nerfed, but, ideally, tech exchange prior to Scientific Method (q.v.) should happen through automatic diffusion. Historically, alphabetic writing may have accelerated tech diffusion (though it was of course
- 25 Now a Classical-era tech. The other techs in the first Classical column were discovered around 1000 BC, and Judaism should be founded no

My best bet regarding the Masonry requirement in BtS is that it should

- prevent one civ from founding all the early religions; I'm addressing that problem differently (see the footnote about Judaism). The link from Monotheism to Monarchy (one god, one king?) has been replaced with a link to Code of Laws. Laws are central to rabbinic writings. The
- Monarchy tech is more about early imperialism than just kingship, and the Jewish kings weren't emperors, so it seems appropriate to let Monotheism bypass Monarchy. 26 Viticulture is far older, but that's covered by the 1 commerce granted by the bare Wine resource. Wine plays an important role in Judaism, and the Phoenician wine trade picked up around 1000 BC.
- 27 The Holy City restriction ensures that not all the early religions are founded by a single civ. Just as Buddhism and Hinduism are now

coupled with each other (see Meditation), I'd like to make Judaism a

- prerequisite for founding Christianity and Islam (see Theology), but this is too narrow, so Zoroastrianism could be added to the game as an alter- 68 This ability, together with a 1-tile irrigation spread from Aqueduct, native requirement. Neither Judaism nor Zoroastrianism are proselytizing religions, so they should not be allowed to train Missionaries (or no Monasteries). This will leave more room for Christianity and Islam, the most widely practised religions at present. Graphics for Zoroastrianism could be adopted from Realism Invictus,
- and it would be the favorite religion of the Persian AI leaders. 28 At the start of the game, Barracks are a waste of UI space and a trap for
- inexperienced players. Barracks pretty much imply a professional army, and these didn't really exist prior to the Neo-Assyrian Empire. The same goes for Forts as permanently garrisoned outposts. The Monarchy tech can't just represent (hereditary) kingship because that form of government is far older. It has to be something like the
- "Early Empire" civic in Civ 6, and that's just the right place for Barracks and Fort. These two also replace Winery, which moves to Monotheism. Perhaps rename Monarchy to "Empire". 29 Moved from Metal Casting (see Coinage). A forge is normally operated
- by a blacksmith who works wrought iron (not cast iron). 30 Polytheism as a requirement because all three wonders, except possibly the Mausoleum, should require Polytheism
- 31 Previously at Calendar, which doesn't make any sense. The Mausoleum was most famed for the aesthetic value of its sculptures. The Mausoleum replaces the Parthenon, which moves to the new "Republic" tech. 72 Civil Service has been replaced by Statecraft, a Classical-era tech, but
- 32 Moved from Philosophy, which is now named "Alchemy". The actual have much else to do. This also preserves the relationship between construction date is in the 12th century AD; both Aesthetics and Paper and Civil Service (the former requires the latter in BtS). Philosophy appear much earlier in the game than that. This can't be helped. The wonder's ability is pretty narrow, so it's possible that no civ 73 This requires both Machinery and Feudalism in BtS; now it's either will want it before the High Middle Ages. Angor Wat takes the spot of Shwedagon Paya, for which it's easier to find an a new home (Coinage)
- It's important that the wonders unlocked by Aesthetics use different resources, so that the discoverer can likely benefit from at least one production discount. These three resources are Marble, Ivory and Gold 74 in BtS, and now Marble, Ivory and Stone, which is also fine.

than for Angkor Wat.

replaced by Bookkeeping. Bookkeeping could represent ancient (e.g. Babylonian) advances in arithmetics and geometry ("Math I"), and then Mathematics would be about Greek logics, algebra and trigonometry ("Math II"). The construction of long aqueducts required some math, including, arguably, algebra for the proper gradients. Moved elsewhere: Fort (Monarchy), increased chopping yield

33 Mathematics has switched places with Calendar, which was then

- (Machinery).
- 34 Aqueducts can also run underground, and bridge aqueducts often include some tunnels as well. Hence the Mining requirement. 35 Moved from Calendar. The size of the Earth was approximated through
- solar observation and trigonometry. 36 Moved from Metal Casting, which came too late and has been removed (see Coinage); now assumed to be implied by Bronze Working.

Triremes do require cast metal for the ram.

- It's not clear that the construction of triremes required advanced math, but it was apparently an intricate ship design. Wikipedia says that "propulsion, weight and waterline, center of gravity and stability,
- strength [...] are [variables] dependent on one another." 37 This is Currency rethemed as a metallurgic tech to replace Metal Casting as a bridge to the Medieval era. Metal casting (lost-wax casting) is very much a pre-Classical innovation. A civilization that can make bronze also knows how to smelt and cast it. (Metal Casting
- could be placed between Mining and Bronze Working to represent copper smelting, enabling Copper and Spearman, but then the Forced Labor civic would look even more out of place at Bronze Working ...) Bronze Working is required for the coinage metal: Early coins were ores (cupellation) requires similar temperatures as the smelting of
- usually made from silver, copper or bronze, and the refinement of silver copper ores and bronze. (Whereas parting gold from silver requires metallurgic knowledge of salt cementation.)
- Some of the abilities of Currency (Wealth process, Market) have moved to Bookkeeping (the Calendar replacement) to give that tech something to do. The extra trade route should still make Coinage an important
- 38 Moved from Aesthetics. The spot there was needed for Angkor Wat. The real Shwedagon Pagoda was built no earlier than AD 500, but there is no plausible tech requirement to enforce this, and the ability wouldn't work on a Medieval wonder.
- The donated gold (and diamonds) are what make the building special, and Coinage also has to do with gold. The Mon people that built the pagoda also had coins.
- 39 Requires Currency in BtS, which isn't unreasonable, but the authority of a great king (Monarchy) to enforce his law in a large domain seems more crucial to me. This also integrates Monarchy better into the tech
- tree; it only leads to Feudalism in BtS. Monotheism moves in between Priesthood and Code of Laws and thus replaces Priesthood as the alternative requirement.
- 40 I need room at Feudalism, and Code of Laws needs a replacement for Confucianism (now at Statecraft, a. k. a. Civil Service) and Chichen Itza (now "Temple of Kukulcan" at Bookkeeping). Client states have
- existed since the early Mesopotamian empires. 41 That's really National Epic, renamed. The BtS Heroic Epic becomes Triumphal Arch (see Republic).
- 42 Adopted from Drama, which gets replaced by Republic (q.v.). Drama is a form of literature. The culture slider (also at Drama in BtS) gets unlocked by Polytheism now.
- 43 Colosseum moves to Republic under the name "Arena" along with the Masonry requirement. War Elephant moves to Statecraft.

44 Catapults were typically torsion-powered, but developed from primitive

(tension-powered) crossbows.

- 45 Moved from Compass and taking the spot of War Elephant, which moves to Statecraft. The connection between compasses and harbors is a loose one at best. Creating a harbor (or enlarging a natural harbor) through a breakwater or dredging is a construction challenge. Changes to Harbor (flat trade route yield bonus, Merchant slot; see stat-changes.pdf) should make it a somewhat useful building by the
- Sailing needs to be required in some way, and a large (artificial) harbor should be accompanied by a lighthouse. 47 Adopted from Metal Casting, which is no longer a tech (see Coinage), taking the place of Colosseum, which moves to Republic. Some of the plates on the Colossus of Rhodes were of cast metal; this is sufficiently

covered by the Forge requirement. A 15 m high statue is a great con-

time Construction is discovered.

Replacing Civil Service. Maceman (now at Guilds) and irrigation spread (now at Crop Rotation) don't fit well at Civil Service, and it's hard to find Medieval replacements. The name "Statecraft" is supposed to cover the philosophical basis of Chinese civil service, i.e. Confucian governance, particularly meritocracy, as well as Chinese military strategy from the same period (Spring and Autumn). The civil service system (imperial examinations) itself wasn't introduced until AD 600, so the corresponding civic, Bureaucracy, needs to have a Medieval tech requirement. That's Paper, and Statecraft is required in addition. As a Classical-era tech, Statecraft accompanies Republic, the former representing an "Eastern way" and the latter a "Western way". Both are

optional in the sense that they can be avoided until late Renaissance.

Bookkeeping is required because good governance wouldn't be possible

without extensive records. Because of its relation to the Chinese impe-

- rial examinations, Statecraft is a shortcut to Education (avoiding the more costly Guilds and its prerequisites). 49 The saddle (howdah) may have been a significant mechanical development, but that's not really what Construction is about. War Elephant fits with the military aspect of Statecraft and elephants were
- most exploited in Southeast Asia. 50 The Forbidden City was built in AD 1420, but it may well take that long until a civ has enough Courthouses. No tech is required in BtS. 51 This is a new promotion, introduced for the Protective trait. Guerilla
- warfare was pioneered by Sun Tzu. 52 Previously at Code of Laws, a better fit at Statecraft. While not primarily a religion, Confucianism competed with Buddhism and was seen as incompatible with Christianity by the Catholic church, so the representation as a religion has merit. Good relations among Confucian rulers also make sense, and, while non-Confucians weren't regarded as heathens, a small relations penalty doesn't seem inappropriate. (The AI leaders that favor Confucianism have only moderate religion-based relations modifiers.)
- The connection with Taoism mirrors that between Buddhism and Hinduism (see Meditation). Two independent religions aren't needed at this point of the game; perhaps Taoism should be removed entirely (see also Alchemy, the replacement for Philosophy).
- 53 Replacing Democracy (see Equality) and taking the spot of Drama, which has merged into Literature. Drama is kind of a dead end in BtS because all outgoing arrows are optional (to Music and Philosophy, both a bit contrived). It's also a light tech with just three abilities, one of which comes far too early (Globe Theater, now at Nation State), while other late Classical and early Medieval techs are a bit overloaded (Construction, Feudalism, Engineering) and would become even more crowded after the removal of Metal Casting. Therefore a new tech, one for which it's easy to find abilities.
- The Republic tech also integrates Alphabet into the tech tree the arrow to Currency in BtS is dubious. The idea is that a republic requires a certain literacy rate, and that alphabetic writing is easier to learn than Aesthetics is a good fit for the Parthenon ability, which has now moved
- to Statue of Zeus, still at Aesthetics. Parthenon gets the ability of Pyramids instead, which fits very well at Republic. In BtS. Polytheism is the secondary requirement, but, as it's a temple, Priesthood should be
- suitable name for a non-wonder building, and feels out of place for any civ that isn't Rome, and out of time after the Classical era. The Colosseum, with its arcades, would require Construction, but, for a generic arena, Masonry should be enough.
- 56 The Republic tech allows Great Scientists to build Academies. Plato founded his Academy in 387 BC, so Academies shouldn't appear in the Epic (which shows a triumphal arch). Three powerful Marble wonders
- under Republic. See also stat-changes.pdf. 58 Requires Literature instead of Writing mostly because this allows Theology to be placed next to Divine Law (formerly Divine Right) in the tree and still have an incoming arrow. In BtS, Divine Right dangles

at Literature are too many, and the name "Triumphal Arch" makes it fit

- Theocracy moves to Divine Law, but Theology gets to replace Philosophy as the mandatory requirement for Liberalism (Western
- medieval philosophy was largely theology), and the Hagia Sophia gets a more useful ability (see stat-changes.pdf) than in BtS. 59 To capture the connection between the Abrahamic religions. The connection with Zoroastrianism is thin, but Judaism alone would probably be too restrictive. (Or perhaps Hellenism – at Aesthetics? – would be the better choice for an 8th religion. Or Gnosticism, but that can't predate Christianity.) See Meditation, and Monotheism about
- Christianity and Islam more room. 60 Bronze Working and Construction replace the Metal Casting requirement (see Coinage). 61 Lumbermill instead of Windmill (now at Engineering, q.v.). The earliest sawmills appeared during Late Roman times, but that was centuries later than watermills, and the sawmills were not used for sustainable

changes that should hamper the early spread of religions and thus give

- forestry (whereas the Lumbermill improvement sustains the Forest feature). The most appropriate place for Lumbermill would be Economics (now Political Economy). Replaceable Parts as in BtS is a bit late, and Machinery too early. However, the chopping mechanism, even if restricted to buildings and ships as I intend, leads to unrealistically fast deforestation if there is no Medieval Lumbermill. Therefore, Lumbermill appears at Machinery, granting only 1 commerce, and Political Economy adds 1 production. The chopping yield bonus has moved from Mathematics (what does
- that have to do with lumber?) to Machinery, meaning that the maximal chopping yield and Lumbermill become available at the same time. See stat-changes.pdf about the Copper requirement. Archery should be required for Guns (formerly Gunpowder) because there is a spring in a flintlock, and a bow is a primitive spring. However, Guns has two other extra requirements (Machinery and Guilds), and two should be the limit. So Machinery gets the Archery requirement – although a spring is not a machine – and Crossbowman doesn't have to require Archery anymore.
- 63 Replacing Philosophy, which is a too generic name and couldn't lead to any Medieval tech. "Alchemy" is easier to integrate and closely connected to Taoism. Taoism, like all the major Chinese philosophies, had pacifist elements, so there is a remote connection between alchemy and pacifism too. Pacifism would fit better at Meditation or Statecraft, but Alchemy needs to do something.
- The two requirements, Coinage and Iron Working, are both about metallurgy; Coinage could imply knowledge about gold extraction, which relates to the philosopher's stone. The research bonus should give both Monastery and Alchemy a power

boost, and acknowledge the role of Christian monasteries in scholarship

The Angkor Wat had to move in any case (now at Aesthetics).

- and education. 65 Should perhaps be removed in favor of Zoroastrianism (see Monotheism). Taoism didn't really spread outside of China. That said, without Taoism, Pacifism would be difficult to justify at Alchemy, and if Alchemy were removed, it would leave a hole in the Medieval era. So long as Taoism is geographically tied to Confucianism, it shouldn't hurt
- the chances of Christianity and Islam much. 66 New tech that takes over Serfdom from Feudalism and the spreadirrigation ability from Civil Service (now Statecraft). Feudalism was getting too crowded and should really be a high Medieval tech (middle column). Since Metal Casting has been removed (see Coinage), Crop
- Rotation brings the tech count to 92, same as in BtS. Crop rotation has been practised since prehistory, but this tech represents medieval crop rotation systems like the two-field, three-field, open-field or equal-field system (which justify the Code of Laws
- requirement) and possibly iron moldboard plows. 67 Serfdom was introduced in the High Middle Ages as part of the European feudal system along with vassalage, but manorialism, an early form of serfdom, emerged in the Late Roman Empire (which
- belongs to the Medieval era of Civ 4). replaces "Farms spread irrigation"; see stat-changes.pdf.
- 69 The "divine right" of kings was a 16th-century concept; not appropriate for the tech that founds Islam. (And the tech doesn't do anything connected to the Mandate of Heaven, which was an ancient concept
- anyway.) So Versailles moves to Political Economy (formerly Economics) and the link to Nationalism (now Nation State) gets The name "Divine Law" refers to the Islamic belief that the Quran is
- the literal word of Allah, and the sharia thus an immutable divine law. The link to Scientific Method could be justified through the analytical reasoning employed in Islamic jurisprudence (fiqh), or more generally through the scientific advances in the Islamic Golden Age. 70 Divine Law needs this more than Theology does, and a caliphate is very much a theocracy
- 71 Requires Machinery now (instead of Theology or Civil Service), meaning that we're talking about paper mills. It's the cheap manufacture of a writing material that was crucial for further developments. Map trade has moved to Compass. It shouldn't really be much harder to join maps gathered by different civilizations than to join those gathered by one civilization, so it's difficult to argue which tech should be
- required from a historical point of view. Bureaucracy should remain a Medieval-era civic, and Paper doesn't
- Crop Rotation (which replaces Feudalism as an early Medieval tech) or Republic (new tech, taking the spot of Drama). The Republic link allows a direct transition from ancient poleis to medieval towns, sidestepping Crop Rotation and Feudalism. The Currency (now Coinage) requirement has moved up from Banking to Guilds.
- Maceman has moved to Guilds from Civil Service (replaced by Statecraft) and Pikeman from Engineering. These were both rather bizarre tech requirements; the original developers probably just saw no better way to spread the Medieval units out. Knight is now enabled by Feudalism. Guilds is an urban tech, so it gets units that were raised in cities.
- Pikeman is a pretty clear case; the pike was popular among mercenary guilds. I'm treating Maceman as heavy infantry, which also tended to be mercenaries, as peasants were not afforded costly armor. The mace also came in use at about the same time as guilds (AD 900). The pike, that it would've been used earlier if mounted lancers had also appeared earlier; or a Feudalism requirement could be added for Pikeman. For manufacturing their armor, Macemen require Machinery. Pikemen tended to be less heavily armored, though I guess still heavily enough

to make bronze armor unaffordable (Iron required). All this is as in BtS.

Copper as in BtS); instead Crossbow can be trained with Copper now.

The heavier Maceman should then of course also require Iron (not

- 75 About Plantations on Incense, Dye and Silk, see Agriculture. Bananas, spices (e.g. black pepper, cinnamon) and sugarcane had been cultivated long before the Middle Ages, but the cultivated area grew dramatically during the Age of Discovery. Guilds were a part of the trade network that established colonial plantations and delivered the produce to European citizens. Early cultivation is represented by the natural yield bonuses of the three resources. As a high Medieval tech, Guilds comes a bit early for the East Indies
- trade. As a compromise, and because there isn't enough room at Guilds for both Plantation and Grocer, Grocer moves to Compass. 76 In BtS, Guilds gives Workshop +1 production, but now Workshop yields 2 production from the beginning (see Pottery). So, instead of
- increasing the yield, Guilds only lifts the terrain restriction. 77 The English longbow came in use around AD 1000, so Longbowman can't be the first Medieval defender. That role is given to Crossbowman instead, and Longbowman becomes a larger, more flexible unit. Iron Working is required for the arrowheads; see stat-changes.pdf for
- 78 Moved from Guilds (the other requirements are as in BtS; Machinery for manufacturing the armor). Guilds is now for units raised in cities, and Feudalism for units raised in the countryside: peasants (Longbowman) and nobles (Knight).
- Horseback Riding is now required for Feudalism instead of Knight. Arguably, a figher elite on horseback was a prerequisite for feudal societies, and, this way, Knight, Cuirassier and Cavalry are less cluttered with requirements
- 79 Moved from Engineering. A late Medieval tech requirement gives Castle too little time to amortize before its obsoletion (Economics in BtS, now Liberalism). Also, medieval castles had not advanced much technologically from ancient fortifications; the novel thing about castles was their role in the feudal system as the seats of power of feudal lords.
- No need for Masonry: Japanese castles were timbered. In order to make room for Castle and Knight, Serfdom moves to the new Crop Rotation tech and Vassal agreement to Code of Laws. 80 Music renamed. A more specific name like "Art Music" could explain why it's a Medieval tech but still wouldn't match the abilities well. The new name refers to arts patronage, which bloomed in the Late Middle

Ages. In many cases, e.g. the Sistine Chapel and many cathedrals, the

Roman Catholic Church was the patron, which is the reason for the Theology requirement (and it helps integrate Theology into the tech tree). The Culture process – turning production into culture (rather than into gold through the Wealth process) – is also a decent representation of arts patronage. The free Great Artist moves to Nation State (formerly Nationalism), which now requires Patronage. Patronage requires Masonry because Masonry isn't required for Construction anymore. I'm assuming Masonry to represent only stonemasonry, and most buildings in the game could be built with

timber or bricks. But the large temples enabled by Patronage may

- necessitate the grandeur and durability of stone blocks. ved from Machinery because windmills didn't become widesp
- to earlier techs (Guilds, Feudalism). 82 Moved from Nationalism (now Nation State) because that tech requirement made no sense and to replace stuff that was moved away
- from Engineering, in particular the road movement ability (now at Military Studies). Divine Law (a. k. a. Divine Right) is required mostly in order to delay Taj Mahal; the real mausoleum was built in the 17th century. Plus, Divine Law can use a buff. Shah Jahan, who commissioned the Taj
- Mahal, was a Muslim. To be consistent, Notre Dame requires Theology (and so does Cristo Redentor; see Steel). 83 Requires Alchemy now instead of Iron Working (but Alchemy requires Iron Working). Lodestones were of interest to alchemists.
- 84 One can't claim that a compass is necessary in order to exchange maps, but the compass did improve the accuracy of maps (portolan charts) and spurred naval exploration. And Compass needs the ability more than Paper (which now has Bureaucracy). 85 Moved from Guilds, which didn't have enough room and comes a bit

too early (grocers started appearing in the 14th century). Kind of

replacing Harbor, which has moved to Construction.

86 Optics is too late for gameplay reasons: Whale has to go obsolete with Combustion, and Combustion is quite close to Optics (even more so after I've switched Optics and Astronomy, but also in BtS). Historically, earlier Whaling Boats can be justified through Basque whaling in the 12th century. They did not use compasses, but Compass is the only naval tech at the proper time.

87 Paper became widespread in Europe perhaps around AD 1200; the

- University of Oxford was established around AD 1100. So the Paper requirement in BtS doesn't work. The early European universities emerged from scholastic guilds, so this is the main path, and Statecraft (replacement for Civil Service) offers a shortcut, although Mathematics and Literature are required in any case as essential parts of the curriculum. Obviously, Education has to be a Medieval tech (not Renaissance
- Banking. Banks antedate paper, and even once paper became used for receipts by the 14th century, the material was probably not crucial. Nevertheless, some tech should illustrate the use of paper prior to the printing press, and I don't see a better alternative. The free Great Merchant switches places with Mercantilism because Banking has to be a Medieval tech, while mercantilism emerged in the

88 Instead of being required for Education (q.v.), Paper is now required for

- 16th century. There are some famous bankers like the Medici and Fugger whom the Great Merchant could represent. 90 Too many important buildings go obsolete at Scientific Method in BtS. Obsoletion of the Great Library at Printing Press sounds at least as
- plausible as at Scientific Method. 91 Replacing Optics, which, in turn, replaces Astronomy. The name "Astronomy" has to go because Observatory plays better at Physics. "Astronavigation" does not imply an observatory, or at least not as strongly. The caravel was developed around AD 1450, whereas the telescope (→ Optics) was invented around AD 1600. The Jacob's staff came in use at around the same time as the caravel; the mariner's astrolabe followed around AD 1500. That said, none of these devices were crucial for Magellan's circumnavigation, nor for the discovery of America, so Astronavigation as the Caravel tech is a bit fantastical – but
- better than Optics. Whaling Boats have been moved to Compass as Optics and Astronavigation are too close to Combustion.
- An important innovation behind the caravel was its carvel planking; hence the Construction requirement. (Engineering would make Caravel too difficult to access for civs that start in isolation.)
- 93 This promotion has no tech requirement in BtS. I'm increasing the base speed of Galley and Trireme by one, and Navigation I and II on top of that would make these ships implausibly fast. 94 This might fit better at Optics, but I worry that it would take Caravels too long to discover other continents without the sight bonus. The nor-

mal sight range of ships is just 1.

- 95 New name for Gunpowder. The name "Guns" should make the link to Blast Furnace (previously Chemistry) a bit more convincing, as in "the furnace is for making larger guns, " and it's a bit awkward to have the same name for a tech and a combat class (Gunpowder units). The Education requirement in BtS is dubious; Education helps innovation overall through University but shouldn't lead to concrete inventions. Alchemy is a no-brainer. Guilds is additionally required because Musketman is getting a buff and mustn't be too easy to beeline to; gunsmiths were arguably organized in guilds. Machinery is also
- required because it's no longer implied by Guilds. 96 This tech comes too early for Free Market ("The Wealth of Nations" 1776), and Mercantilism comes too early at Banking. Therefore push Free Market to Liberalism and turn Economics into the Mercantilism tech. Rename it to "Political Economy" because just "Economics" would be strongly associated with market economics, and in order to cover political philosophy as well. In mercantilism, economical policy
- followed power-political aims. This change moves Mercantilism and Free Market closer together, but these two civics need to be properly balanced anyway, so this shouldn't
- be a concern. (In BtS, Free Market is usually preferable to Mercan-Castle still goes obsolete with Free Market (i.e. at Liberalism). This extends the lifespan of Castle a bit further. The free Great Merchant moves to Banking to fill the gap left by Mercantilism.
- 97 To reduce deforestation, Lumbermill becomes available with Machinery but yields only 1 commerce initially. The extra production at Political Economy gives Lumbermill the same yields that it gets in BtS at Replaceable Parts. The proper time for Lumbermill should be around 1500, when forestry became widespread in some parts of the world. Political Economy is about right, and forestry also aligns with the mercantilist view of a state's land as a resource.

98 Changes to Customs House and Mercantilism make the two compa-

tible; see stat-changes.pdf. (In BtS, Customs House has no effect

under Mercantilism unless the owner of Customs House has vassals.)

99 Moved from Divine Right (now Divine Law, q.v.). The Palace of Versailles was a symbol of absolutism, which is covered by the "Political" in Political Economy. Monarchy was previously required by Divine Right. 100 Cuirassiers and the military bands that the Music requirement in BtS hints at came earlier than nation states, not to mention nationalism. Therefore, Nation State (new name for Nationalism) now requires Military Tradition and not vice versa. Military Tradition requires Feudalism because cuirassiers developed from knights and because the

chivalric code also concerns military culture. Music has been renamed

to Patronage and that requirement has moved down to Nation State.

- These changes may seem to make Military Tradition quite a bit faster to beeline to, however, the tech requirements of Guns (a. k. a. Gunpowder) have become stricter. Cavalry still requires Military Tradition but is visually relocated to
- Rifling, the much tougher of the two requirements. 101 Moved from Communism (now called Equality), replacing West Point, which moves to Military Studies (new name for Military Science). The new Kremlin ability, faster Great General birth (see stat-changes. pdf), is unrelated to communism, and fits at Military Tradition. The Moscow Kremlin became a residence of tsars in the 16th century.

102 After a name change from "Nationhood" to "Militarism", Military

early; now requires adopting the Emancipation civic (at Equality) in addition to Militarism. See stat-changes.pdf about this and the name 103 Now also represents early modern chemistry, whereas the Chemistry tech has become Blast Furnace. Early chemists like Boyle were among the pioneers of scientific method. Their writings were published in the middle of the 17th century, as were those of Descartes, Galilei and

Tradition is a natural match. That said, the Draft ability can't come this

- Bacon, so Scientific Method is clearly not an Industrial tech. In BtS, Astronomy is required, but that's unconvincing and not an option after
- replacing Astronomy with Astronavigation and Optics (in the same column as Scientific Method). The new Alchemy tech (replacing Philosophy) is an obvious requirement, the others (Engineering, Printing Press) are as in BtS except that Divine Law (q.v.) can substitute for Engineering
- 104 The earliest example of a deliberate technology transfer between sovereign states that I'm aware of is the industrialization of Japan in the 19th century. There is no science-flavored tech that late in the game though, and Scientific Method needs a strong ability (doesn't do anything valuable in BtS). Scientific Method only allows tech to be imparted; for tech-for-tech trades, both sides need Scientific Method. Otherwise, beelining to Scientific Method might be too powerful. (Perhaps Scientific Method itself should be untradeable.) Tech trading still has to be nerfed, regardless of the required tech.
- Prior to Scientific Method, tech exchange should happen automatically through a tech diffusion system based on tile culture. See also Alphabet 105 K-Mod introduced this ability at Scientific Method but eventually moved it to Computers. I think it is needed earlier because almost all tile improvements get substantial yield bonuses in the Renaissance or Industrial era, while Great Person points from specialists decrease in value, and, after National Epic (now called Heroic Epic), bonuses to specialists come only from civics. On the other hand, the specialist bonus from Representation should be reduced by 1 research. Another measure to make specialists more attractive in the late game: higher initial yields in exchange for fewer Great Person points; see the
- Specialists section in stat-changes.pdf. 106 Since the three wonders obsoleted by Scientific Method in BtS (Great Library, Parthenon and Temple of Artemis) all get a discount from Marble, it's not rare that a civ loses more than one wonder with Scientific Method, which is harsh. Now it's two wonders boosted by different resources. Statue of Zeus gets the ability from Parthenon; so no change there really. (Parthenon gets the ability from Pyramids and goes obsolete with Totalitarianism, a. k. a. Fascism.) Angkor Wat goes obsolete with Computers in BtS, which is strange, and now that Angkor Wat becomes available earlier (Aesthetics instead of Philosophy), it's OK to let it go obsolete earlier. The obsoletion of Temple of Artemis moves to Liberalism, and the Great Library to Printing Press.
- 107 This tech has to refer to constitutions enshrining rights of parliamentarians and the rule of law; otherwise, Constitution would have to be a much earlier tech and wouldn't enable Jail. The earliest examples appear to be Acts of the English parliament (Habeas Corpus, Bill of Rights) in the late 17th century. Constitution requires Nationalism in BtS, but it's hard to say if England was a nation state at that time. Requiring Nation State (new name for Nationalism) would also push Constitution into the third Renaissance column, which is mostly for discoveries at the onset of the Industrial Age (late 18th century). Nation State is instead an additional requirement for the Federation civic replacing Free Speech.
- The Feudalism requirement accounts for the roots of renaissance constitutions in the Magna Carta (cited in the tech quote for Constitution) and, more generally, medieval constitutions determining the relations between king, nobility and clergy. The new rights for the (elected) parliament could be attributed to humanism (Republic required) and the increase in literacy brought about by the printing 108 This civic replaces Free Speech, previously enabled by Liberalism.
- Since this should be a late civic, it only refers to post-feudal federations, the earliest example of which might be the Treaty of Union forming the UK. Early federations are covered by the Vassalage civic. admittedly, only became widely used around AD 1300. One could argue 109 These go obsolete with Astronomy in BtS, but it's doubtful that Stonehenge had an important astronomical function. Hereditary Rule now gives Monument +1 happiness (instead of the military happiness ability), and losing that happiness is painful unless the obsoletion tech provides some remedy – such as the Representation civic. One could imagine that a constitution restricts the king's ability to erect monu-
 - 110 Most other ancient wonders go obsolete, so why not this one? Prolonged Golden Ages in the late game can also lead to a lot of military build-up, overcrowding the map. Could as well make e.g. Equality (replacement for Democracy) the obsoletion tech, but it's tidier to cluster obsoletions a bit. 111 Optics takes over the role of Astronomy; see Astronavigation. Engineering is required because all subsequent techs (Physics and
 - Biology) should require it, and because Galleon should require it for its architecture (naval engineering). All abilities of Optics really have to do 151 Moved from Scientific Method. There are no units that require Oil in with galleons. 112 Early privateers (e.g. Francis Drake's Golden Hind) were galleons outfitted as warships. The Guns (a. k. a. Gunpowder) and metal requirements are for primitive man-killer cannons firing stone balls. Although the 3D animation shows cannon fire, Galleon is assumed to

be lightly armed with whatever ranged weapons are available (no Guns

- The move from Chemistry to an earlier tech should also give Privateer a longer window of opportunity. 113 See stat-changes.pdf about this. It's the Sentry promotion under a 114 Moved from Corporation for balance reasons: the two extra trade routes
- become too powerful with cross-ocean trade. Also, a lighthouse built for trade along the shores of the Mediterranean Sea shouldn't boost trade across the oceans. In turn, the obsoletion of Colossus moves to Blast Furnace (a. k. a. Chemistry), and Monument and Stonehenge to Constitution. 115 New tech replacing Chemistry and, in a way, Metal Casting (see Coinage) as blast furnaces are used for smelting iron ore. Cannon needs to be at the same tech as Frigate, and that tech would be a poor

representation of chemistry as a science. Instead, chemistry is now

represented through Alchemy (replacing Philosophy), Scientific

Method, Steam Power (physical chemistry) and Combustion

hence the need for cast iron.

accordingly; see stat-changes.pdf.

- (petrochemistry). The production bonus to Workshop moves to Replaceable Parts (q.v.). 116 Moved from Steel. It's very strange to have such a long gap between Musketman and Cannon, when the two actually appeared in history at the same time. Guns (formerly Gunpowder) is still assumed to enable an early cannon firing gunstones that is only used by Privateer (see Optics). The Frigate and Cannon units at Blast Furnace fire iron balls;
- Of course, this earlier Cannon, just one tech after Gunpowder/Guns, not requiring Engineering, needs to be smaller and weaker than the Steel Cannon in BtS; see stat-changes.pdf. 117 Early grenades were made out of cast iron, so Blast Furnace is an excellent fit for this unit. This moves Grenadier one column to the left, while Rifleman moves two to the right (see Rifling), meaning that Grenadier is, as it should be, more often contemporary with Musketman

than with Rifleman. The stats and abilities of Grenadier need to change

- 118 Catapults and trebuchets aren't supposed to deal collateral damage anymore; see stat-changes.pdf.
- until the 13th century AD. Conversely, Pikeman and Castle have moved 119 Moved from Astronomy (now called Optics) to avoid making two naval wonders obsolete at once. 120 Liberalism takes over Free Market from Political Economy (q.v.; formerly just Economics) but loses Free Speech (see Constitution) and the free tech. The free-tech ability isn't worth the distortions that it causes in BtS (players always beelining to Liberalism and all techs near it). It also (probably) overstates the importance of liberalism for the increase of power and wealth in the West (i.e. the Great Divergence). There are still many powerful rewards for early discoverers of techs in the Renaissance era or one of the adjoining columns: tech trading; a free Great Merchant, Artist and Scientist; gunpowder units; and Drafting. Nation State is an additional requirement for Free Market because
 - in Europe during the 19th century. 121 Moved from Democracy, which has been replaced by Republic and Equality (q.v.). These two techs are still indirectly required through the Emancipation civic (now at Equality). Liberalism should be the main requirement because it's the Statue of *Liberty*. The requirement to actually run liberal civics (rather than just knowing their prerequisite

a political philosophy. The requirement should also illustrate the

market economics only emerged about a century later than liberalism as

connection between liberalism and the national unification movements

- techs) is just for flavor. 122 The obsoletion of Castle has moved from Economics (now Political Economy) together with Free Market. It's not clear why an understanding of liberal economics (without adopting Free Market) should eliminate the economical benefits of castles, but at least it's a graceful obsoletion insofar as switching to Free Market makes up for the lost trade routes from Castles. Alternatively, one could tie the trade
- 123 See stat-changes.pdf about the new ability for Oracle, loosely based on the BtS ability of Statue of Zeus. This ability needs to go obsolete when Free Religion becomes available. 124 Moved from Scientific Method, where too many (Marble) wonders

route bonus from Castle to certain civics and choose a different

went obsolete. Religious wonders might as well go obsolete with Liberalism instead of Scientific Method, and Temple of Artemis is even 125 Nationalism arose in the 19th century; can't be a Renaissance tech. Even after renaming the tech to "Nation State" (and the Nationhood civic to "Militarism"), it has to be switched with Military Tradition, which takes over the Militarism civic, making Nation State entirely a cultural tech. The Dutch Republic around 1600 and the restored Kingdom of Portugal (1650) could be seen as early examples of nation states.

Require Education because an education system needs to be required at

some point on the path to a modern state. Patronage corresponds to

ment has moved one column down the tech tree. It's needed for the

nation's cultural identity. The Political Economy requirement (alter-

Music in BtS, which was required for Military Tradition; that require-

native to Military Tradition) alludes to theories that attribute the emergence of nation states more to economical developments than to national sentiment. 126 Moved from Drama, which got merged into Literature. Makes sense for a tech called "Nation State" to enable more than one national wonder. 127 Moved from the Medieval tech Music (now called Patronage) and replacing the Taj Mahal (moved to Engineering). The free Great Artist

should really appear in Renaissance, and famous compatriots help

shape a nation (e.g. national poets).

- 128 Newton's laws, pivotal for modern physics and paraphrased in the tech quote (though that quote will have to move to the new Rapid Fire tech), were published in the 1680s, so Physics should be a pre-Industrial tech. Newtonian physics can't be lumped together with the discovery of Uranium (around 1900) though; this moves to Radio. Airship moves to Combustion (q.v.) 129 Moved from Astronomy, which was renamed to "Astronavigation" in
- order to allow Observatory to move. The telescope (1608) very much belongs at Optics, but the first large observatory (Greenwich) did not open until 1676, and Physics needs this building much more than Optics does. This also moves Observatory farther away from University – cities don't need two buildings that boost research in a row. 130 The Watt steam engine went into production in 1776, but steam engine parts were not interchangeable until 1880. Therefore Steam Power
- addition to Blast Furnace (which replaces Chemistry) to account for prerequisites in early chemistry, e.g. gas laws and pneumatics. Blast furnaces are needed for the cast iron parts of the engine I'm drawing the line between Renaissance and Industrial era in the early 19th century. This neatly includes the entire Age of Enlightenment in Renaissance, and, otherwise, there are too many techs for the Industrial

shouldn't require Replaceable Parts. Scientific Method is required in

and Modern era. I also don't want to push Railroad into the middle Industrial column. Let's look at the steam engine as a catalyst of the Industrial Age rather than a part of it. The Hagia Sophia gets a different ability and no longer goes obsolete (BtS: obsolete with Steam Power).

131 Levee at Steam Power (same as in BtS) makes sense to me because

river transportation on steamboats increased the need for river engineering. 132 Same as in BtS. Makes some sense because steam engines were used in mines and, to an extent, as traction engines on farms. They didn't exactly help constructing houses, roads or railroads though. Steel would fit better but doesn't have room.

133 Moved from Steel to give Ironclad a longer window of utility. Also, the

first ironclads, produced in 1862 for the US Civil War, were not clad in modern steel; the first steel mill in the US based on the Bessemer process was set up in 1865. 134 This ability represents the large American aqueducts that stretch across hundreds of miles. Steam Power is needed for the pumping stations. 135 Replacing Democracy. The name "Equality" allows the tech to become an additional requirement for the State Property civic (main requirement: Corporation, q.v.), and then the rest of Communism can be merged with Fascism into "Totalitarianism". Regarding Emancipation at Equality, the notion that "all men are created equal" (Thomas Jefferson, 1776) is, in my mind, the most important difference between the USA

century, many of which had practically abandoned serfdom – but had

not renounced it. Similarly, suffrage existed e.g. in medieval England

- but wasn't universal. Universal Suffrage moves to Assembly Line (q.v.), with Equality as an additional requirement. Assembly Line can explain the production bonus better. The Statue of Liberty moves to Liberalism (q.v.), though Equality is indirectly required. Liberalism is, strangely, not required for Democracy in BtS, but was a major influence on the revolutions in France and America. 136 Scotland Yard, renamed as Police Headquarters, takes over the role of Security Bureau as a regular building, while Security Bureau becomes the special building that a Great Spy can construct; see stat-
- changes.pdf about this. Police agencies were restructured in the early Industrial Age due to population growth in metropolitan areas and legal and philosophical changes regarding the role of police. There are several other techs where Police Headquarters would also make some sense (e.g. Railroad); Equality has room and partly replaces Communism, so, in a way, the building stays where it was. A similar case can be made for Security Bureau at Equality. The FBI and MI5 were only founded in the early 20th century, but that's OK: after discovering Equality, it may still take a civ quite some time to get a
- Great Spy for building a Security Bureau. 137 Part of an effort to make resources less decisive for city growth in the late game. In Europe, and perhaps elsewhere, game populations shrunk once hunting stopped being a privilege of the nobility. 138 "Military science" is the more commonly used term, but would suggest that Scientific Method is required. Scientific Method is directly required for four other techs, which should be the maximum, and military science is (mostly) not science in a strict sense. Requires Education for the "studies" part (and in turn Statecraft, the Sun Tzu
- tech), and Blast Furnace (previously Chemistry) only for Ship of the Line. The other unit that requires cast iron, Grenadier, has moved directly to Blast Furnace (q.v.). The Commando promotion has moved to Alphabet (q.v.). 139 This is West Point, moved from Military Tradition and renamed to something less US-centric (it gets pretty bad in the second half of the
- gameplay reasons (military production too fast in the late game). 140 Moved from Engineering. A rather major change that should extend the mobility advantage of ships over land units. It's also a big boost for Military Studies (even though Railroad in the next column somewhat obsoletes the road bonus). The bonus is supposed to represent advances in logistics (e.g. supply depots) and operational warfare. 141 See Fishing.

tech tree). The Military Academy special building gets removed for

much later and get Blitz for free. To my knowledge, early modern ships didn't carry out any tactics resembling tank warfare; especially not ships of the line. So the name of the promotion is problematic, but the ability is fine (see "Blitz" in stat-changes.pdf). If there was a Blitz promotion for ships with a different name, then which tech would enable Blitz for Armored units?

142 Blitz is really only enabled for ships here because Armored units appear

143 Replaceable Parts can be dated no earlier than 1800, but I'm still leaving it in the Renaissance era (along with Steam Power) so that Rifling can be in the first Industrial-era column. Also, the first machine tools were developed in the late 18th century. About the Banking requirement (same as in BtS), one could argue that loans are required for large-scale manufacturing, which benefits most from interchangeable parts. Blast Furnace (replacing Chemistry) is required for cast iron parts. Engineering is required for Chemistry in BtS; this requirement

moves one column down the tree to Replaceable Parts.

- 144 Moved from Steel in order to boost Ironclad and especially Ship of the Line, which has to cost more than Frigate but isn't a lot more useful. Drydocks have antecedents in the Chinese Song dynasty and were widely used in England since about 1600. I see no direct relation between drydocks and replaceable parts, but the other techs in the same column would fit even worse or do too much.
- 145 The bonus to Workshop has moved from Chemistry (now called Blast Furnace) and replaces Lumbermill, which is now enabled by Machinery and boosted by Political Economy. Blast Furnace does other things, and it's neater to have all the improvement bonuses at one tech. 146 Doesn't require Steel because railroads were already widely used (e.g. the First Transcontinental Railroad in the US) prior to modern

Machine Gun has moved to the new Rapid Fire tech (q.v.).

that late in the game, +1 health might be insignificant.

- 147 Moved from Combustion because Combustion no longer requires Railroad. The Oil requirement implies Combustion, so there is no real 148 Prior to Railroad only a local health bonus (or, easier to implement: none) because crabs are difficult to conserve (more so than certain fish). Transportation on rail made food from crustaceans available farther inland. Full availability should realistically require Refrigeration, but,
- 149 Moved from Rifling. Firearms didn't make city walls completely obsolete, and the effect of firearms is already captured by the high bombard rate of Cannon (which I intend to increase further). The German Wikipedia cites a German author, Jürgen Osterhammel, stating that "if anything made walls obsolete, it was the railroad," and argues that city growth (urban sprawl?) caused walls to be abandoned. This line of reasoning makes it unnecessary to exempt the "defensive abilities" of Walls from obsoletion. Simpler is better, and that exception is confusing because *all* abilities of Walls are defensive.
- ships (Destroyer, Transport) enabled by Combustion in BtS, but these move to Ballistics and Industrialism. Just for the engine, Steel shouldn't be required, just as it isn't required for Steam Power. Railroads don't seem to have had a strong impact on the development of internal combustion engines. One could argue that it was mostly the availability of coal in England that let external combustion engines (steam engines) mature earlier than internal ones, and that Combustion

shouldn't even require Steam Power. This would add another outgoing

arrow to Scientific Method though, which is already required for four

150 Requires Railroad and, indirectly, Steel in BtS. Steel made sense for the

Public Transportation moves to Railroad, additionally requiring Oil, meaning that Combustion also remains required. the first two Industrial-era columns, so Combustion (in the first column) is early enough, and systematic oil exploration only began in the second half of the 19th century. 152 Moved from Physics. Airships are dirigible, and for that they require an

internal combustion engine. Physics is still an additional requirement

for Airship, representing aerostatics. Hydrogen production (late 18th

- century) is, I guess, implied by either Scientific Method or Combustion. Electricity should perhaps also be required because of the aluminium frame of zeppelins, but this might shorten the time during which Airship is useful for air attacks too much. 153 Moved from Plastics and taking the spot of Creative Constructions, which moves to Steel. Combustion is the most straightforward requirement for a fuel company. (Standard Ethanol isn't primarily about
- biofuel anymore; more like Standard Oil. See stat-changes.pdf.) 154 Part of an effort to make resources less crucial for city growth in the late game; no obsoletion in BtS. The production of indigo nowadays often involves petrochemical cracking, but it seems that no petrochemistry was involved when the synthesis of indigo first became commercially viable around 1900. So the obsoletion doesn't quite fit at Combustion, but Industrialism would be a bit late and already has a lot of ability icons.

155 The Chemistry requirement is gone because Chemistry has been

- replaced by Blast Furnace, which doesn't work as a requirement for Biology. Early modern chemistry is instead represented by Scientific Crop Rotation is required because the food bonus to Farms should, among other agricultural innovations, represent four-field crop rotation (although this technique was not developed by biologists). National Park moves to Ecology (q.v.).
- just about any other foodstuffs I can think of. Grain corporations began to form in the 1850s, toward the end of the British Agricultural Revolution. Earlier access to Cereal Mills shouldn't be a game balance problem; the numbers just need to be tweaked accordingly. 157 This obsoletion only makes sense because of the new agricultural ability for the Temple of Kukulcan (called Chichen Itza in BtS). Cf.

Ironclad to Steam Power and Drydock to Replaceable Parts. For all of

these, Steel could be justified as a requirement, but they'll play better at

158 Cannon has moved to Blast Furnace (replacement for Chemistry),

earlier techs. Instead, the Steel tech focuses on uses of steel in

stat-changes.pdf.

156 Moved from Refrigeration – grains benefit from refrigeration less than

BtS, is the only building that benefits from electrical power. Now there are some buildings, e.g. Broadcast Tower and Hospital, that also require power but don't require Assembly Line. Electricity should be required for all power plants in any case. 173 Both moved from Plastics because hydroplants were the earliest power plants, in use long before the discovery of synthetic polymers. Steel is required for the reinforced concrete. The power plants take the place of Bunker and Bomb Shelter (now called Fallout Shelter), which move to

construction, especially in beams and reinforced concrete

shouldn't require electrification.

Creative Constructions.

159 Moved from Electricity. Bunkers are built in reinforced concrete. It's

not clear if Bunker is supposed to represent bomb shelters (as the

Civilopedia text suggests) or actual bunkers; I'm assuming that it's both,

and that the Bomb Shelter building is really a fallout and blast shelter

against nuclear attacks (see Medicine). Bunkers and air raid shelters

160 "Ironworks" sounds like it should be at Blast Furnace. For a modern

steel mill, "steelworks" is the more common term (or at least more

specific). See stat-changes.pdf about the resource requirements.

161 Moved from Radio; I'm not seeing the connection. The statue is built in

reinforced concrete. Steel is a bit early considering that the statue was

finished in 1931; however, a similar statue on the same mountain had

consistent with Notre Dame requiring Theology (see Divine Law).

162 This ability should make it more worthwhile to found cities past the

construction methods seem like the best historical explanation.

midgame, especially on land discovered through Caravels. Improved

163 Moved from Combustion; Combustion gets Standard Ethanol instead.

As the modern construction tech, Steel is the most natural place for

164 The Rifleman 3D model appears to show a soldier from the Napoleonic

latter makes more sense because rifles didn't supplant muskets until

about 1850 (Minié rifle). This interpretation also gives Musketman

more time to shine. Consequently, Rifling becomes an Industrial-era

The Military Studies (formerly Military Science) requirement should

additional requirement represents advances in logistics more than in

165 Requires Liberalism instead of Economics (now Political Economy) in

order to integrate Liberalism better into the tech tree, and because Free

clear that market economics are a prerequisite for limited liability and

should be required in addition because the concept of social ownership

developed in response to capitalism. Corporations were only beginning

to spread in Marx's time, but the (new) abilities of the State Property

spreading a corporation, allowing corporation yields to be reduced

168 Because the new ability of the Great Wall grants an extra trade route,

and too many extra trade routes could encourage city spam. The

169 Requires Replaceable Parts for mass-manufacturing electrical

170 Moved from Industrialism. Electricity makes more sense because

electrolysis (Hall-Héroult process, 1886) is needed in order to process

bauxite ores into aluminium. Now that Bomber requires Aluminium,

171 See stat-changes.pdf about the Watermill commerce and the Theater

commerce, 1 production (from Replaceable Parts) is good enough

172 Moved from Assembly Line. The Assembly Line requirement makes

some sense in BtS because Assembly Line enables Factory, which, in

requirement for Broadway. No commerce bonus to Windmill. 1 food, 1

compared with Mine (2 production, 3 with Railroad). Wind turbines are

better represented by the bonus from Environmentalism; didn't become

obsoletion of the Great Lighthouse moves to Optics.

equipment like light bulbs, resistors and switches.

Industrialism is also a bit late (same column as Flight).

make much sense to allow the civic before the Corporation tech.

166 Communism has (in part) been replaced by Equality, and Equality is

still required for State Property. Either Corporation or Liberalism

other aspects of modern corporations.)

stat-changes.pdf.

widespread until the Oil Crisis.

Steel and Medicine

make it harder to beeline from Guns (formerly Gunpowder) to Rifling,

Wars, but the Civilopedia text talks about the American Civil War. The

ism civic is rarely useful that late in the game. For that reason, presumably, Environmentalism was moved to Medicine in patch 1.52. Better to 216 Civilopedia talks about "high-velocity cannons," but the combat keep it at Ecology and move Ecology into the Industrial era. Biology covers the technological prerequisites for ecology as a science. The motivation for this science (nuclear or plastic pollution in BtS) is captured by whatever health problems civs experience in the game; civs that don't need more health aren't going to research Ecology.

175 New name for Recycling Center; see stat-changes.pdf.

with the post-WW2 environmental movement, but the Environmental-

176 Forest Preserve has moved from Scientific Method and National Park from Biology. These techs have enough other things to do, and Ecology is the most natural fit for environmental preservation. Perhaps the BtS developers felt that Ecology came too late, but that isn't an issue

Ecology is still required for SS Life Support, but Computers (q.v.) is

now the main requirement. The Scrub action has been removed; see

- Exclusion Zone (new name for the Fallout feature) in stat-177 Moved from Industrialism because that tech looked too crowded in BtS. and because synthetic substitutes have not diminished the monetary value of ivory that much. 178 Moved from Electricity and renamed from "Bomb Shelter" to "Fallout
- damage. Therefore, Bunker (now at Steel) is assumed to represent both bunkers and air raid shelters, and Bomb Shelter is renamed. Steel is required for blast doors; if not in civil defense shelters, then in shelters for military equipment (the building also reduces damage to (or the First French Republic) and the European monarchies of the 18th military units). Medicine could be needed for understanding the impact of radiation on the human body, and the tech has room. 179 This has no tech requirement in BtS but is only available for Great

Warlords. Quick free healing shouldn't be available in the early game,

and the first couple of Great Generals shouldn't always be used for

- 'super medics". See also stat-changes.pdf. Plus, the Medicine tech 180 Merging Democracy, Communism and Fascism into just two techs (Equality and Totalitarianism) opens up room for a new tech. It's a military tech because there are so many military units in the Industrial era, and several of them with unrealistic tech requirements; Machine Gun at Railroad even seems completely nonsensical. The "Rapid Fire" tech represents advances in firearms from the late 19th century, especially smokeless powder and mechanisms for absorb-
- for the smokeless powder, but that would be one tech requirement too

ing or redirecting recoil. Physics is required for the recoil handling

- I've got the name "Rapid Fire" from the American Revolution Mod; the tech icon would also come from there. 81 New name for the Artillery unit to allow me to move it to Rapid Fire. Several WW2 units move to the Artillery tech, and the Artillery unit should come earlier than these units. The Canon de 75, regarded as the first modern artillery piece, was a quick-firing field gun with a hydropneumatic recoil mechanism, so Rapid Fire is a suitable requirement. (Machine guns and field guns developed alongside each other, differing in caliber and fire rate.) The name "Ballistics" for the Artillery tech
- should make clear why Field Gun comes earlier: field guns were not designed for indirect fire. Accordingly, Mobile Artillery gets named "Howitzer". 182 No tech required in BtS. Apart from Air units, Gunpowder units can get this promotion in BtS, and I'm also allowing it for Siege and Naval units (see stat-changes.pdf). Not plausible to hit aircraft with slowfiring guns. And I don't want the promotion to show up on the UI long
- before it is needed. 183 No tech requirement in BtS. Don't want this to show up on the UI long before Armored units become available. Military Studies could be an alternative, but comes a bit too early. 184 Moved from Fascism (now called Totalitarianism). The developers may
- have seen the memorial as a response to fascism, but that can be misconstrued. The synthesis of nitroglycerine (1847) was important for both the development of smokeless powder for firearms, and dynamite, which was used extensively in the construction of the Mount Rushmore 185 Coal Plant moves to Electricity and Pentagon to Industrialism.
- 186 See stat-changes.pdf about these requirements for Factory. 187 The 3D model, apparently, shows a WW2 US soldier with an M1 rifle (in service since 1936). This kind of unit comes a bit too early in BtS; the Rapid Fire requirement delays it. The Infantry unit would otherwise also replace Rifleman too soon now that Rifling is an Industrial-era tech. The M1 is a semi-automatic (gas-operated) rifle, so requiring Rapid Fire is also historically sound.
- 188 Equality replaces Democracy. Assembly Line becomes an additional requirement because this makes it easier to explain the production bonus for Towns: an increase of female participation in the industrial workforce tended to precede female suffrage. 189 Cristo Redentor moves to Steel (q.v.) and Bomber to Flight with Radio as an additional requirement instead of vice versa.
- An Industrial-era tech because submarines were already deployed in WW1, and the Eiffel Tower was completed in 1889. 190 Attack Submarine and Nuclear Submarine (previously just called "Submarine") have switched places. Attack Submarine was introduced in BtS as a counter against the vanilla Submarine unit, probably representing early Cold War hunter-killer designs. This role is too narrow. Instead, Attack Submarine becomes the ordinary submarine unit for the

World Wars, and Nuclear Submarine a more expensive unit repre-

191 Moved from Physics, which is now a Renaissance tech and thus way

senting the cruise missile and ballistic missile subs of the Cold War.

- were discovered in 1898, and, around that time, uranium began to be mined for extracting radium. Radio directly leads to Fission now (not required for Fission in BtS), meaning that Uranium becomes useful shortly after it is revealed, which could be unfair to civs without Uranium. That said, Uranium only becomes crucial once and if the Manhattan Project is built. 192 Radio is also required for all naval units that detect Submarines. This
- Recon should only reveal Submarines that are adjacent to another ship. (A submarine spotted on the surface by aircraft will dive and change its position if it isn't promptly engaged.) Too easy in BtS to spot Submarines with air units. 193 Requires Rapid Fire for the machine guns mounted on Fighter. No Carrier without Fighter, and Paratrooper also carries an automatic rifle. The Rapid Fire tech covers nitroglycerine and other high explosives, so

Bomber needs it too. No need to require Combustion as Fighter and

I'm drawing the line between Industrial and Modern era in the late

Bomber require Oil. Airport moves to Advanced Flight (q.v.).

should make early Submarines more dangerous. Even with Radio, Air

1930s. This yields a pretty even distribution of techs. Flight could really go either way: The 3D models appear to show planes introduced in the 30s (Spitfire, B-17). 194 Still requires Radio (for search radar) and Flight, but since both are in the same column now, Flight as the more obvious requirement becomes 240 Three health would exaggerate the effects of genetics on human health the main requirement. (Radio is also pretty crowded.)

Aluminum (or just Electricity) should then also be required for Fighter.

without Fighter would be without any adequate air defense; this might

195 By the 1930s, when bombers became potent, practically all military

aircraft had aluminium in their airframes. One could argue that

be too punishing.

British WW1 fighters and also the WW2 "Mosquito" had wooden

fuselages but also included aluminium components. However, a civ

- 196 Moved from Fascism (now called Totalitarianism). Fascist Italy and Germany were early adopters of airborne infantry, but parachuting is hardly a matter of ideology. 197 New name for the Artillery tech; see Field Gun (new name for the Artillery unit) at Rapid Fire about the name change. One could also look at Rapid Fire as "Artillery I" and Ballistics as "Artillery II". One
- Three units move to Ballistics that don't require Artillery in BtS but represent artillery platforms: Tank, Destroyer and Battleship. Anti-Tank moves from Artillery to Rocketry (q.v.). 198 Destroyer is at Combustion in BtS and Battleship at Industrialism. The former is too early, leaving too little time for Ironclad, and the latter rather too late, skipping the Dreadnought era. Radio is required for spotting Submarines. I don't see a problem with Destroyer coming later

important advancement at Ballistics is indirect fire.

more vulnerable to aircraft and subs; see stat-changes.pdf). As for the resource requirements, Industrial-era ships are allowed to run on Coal but move faster with Oil. This should fill a gap between coalfueled (early) ironclads and oil-fueled WW2 navies, and make early access to Oil less crucial. This, in turn, should allow for a more realistic, namely clustered, placement of Oil resources during map

(or at least no earlier) than Battleship; Destroyer has a distinct role as

an anti-Air, anti-Submarine unit. (I'm intending to make Battleship a bit

- 199 Moved from Industrialism as that would be a bit much on top of Ballistics; the manufacturing process is covered by requiring Assembly Line instead of Industrialism. Railroad is needed for the vehicle's continuous tracks, a crucial innovation that was inspired by railroads. (An early patent was named "endless railway.") 200 Look at this tech as the last stage of the Second Industrial Revolution, combining assembly lines with electrification and steelmaking. Steel
- (not required in BtS) should perhaps already be required for Assembly Line – but certainly for Industrialism. One could also argue for Combustion as a requirement (petrochemistry, chemical industry), but it 247 Requires Superconductors instead of Fiber Optics because would be one requirement too many, and is required for Plastics in the next column anyway (also in BtS). Tank and Battleship have moved to Ballistics (q.v.; formerly Artillery). Aluminum is revealed by Electricity instead of Industrialism. Ivory goes obsolete with Ecology instead of Industrialism.

appears to show an AK-47.

- 201 Requires the new Rapid Fire tech instead of just Rifling. The 3D model
 - Great Engineer in stat-changes.pdf).
- 248 That Engineer is fairly useless in BtS as there are few if any worthwhile wonders this late in the game. Can now also be used on SS parts (see

- point if there isn't a special reason against obsoletion. At Totalitarianism, all government civics are guaranteed to be unlocked, and obsoleting a symbol of democracy boosts the evil image of Totalitarianism. 208 Replacing the speed bonus for ships. A big speed boost came from steam turbines, but I don't think refrigeration had any part in this. Moreover, the speed bonus makes it harder for players to keep track of how far each ship can move in one turn. (For the same reason, the circumnavigation bonus should be replaced with some other perk.) As for the new ability: The amount of food provided by Fishing Boats in the early game is highly unrealistic. That food output needs to be reduced by 1 (see stat-changes.pdf), and then Refrigeration brings the output to the same level as in BtS. Apart from food conservation, the bonus could also represent trawling, fish farms and other
- developments in commercial fishing that BtS fails to capture. (This civic (see stat-changes.pdf) are focused on corporations, so it doesn't change is inspired by the Civ 4 Reimagined mod.) 167 That is, no HQ is required. This change lowers the initial investment for 209 Moved from Medicine and replacing Cereal Mills, which moves to Biology (q.v.). Refrigeration is a better explanation for a seafood
- substantially, which should improve the pace of the late game. See also company than healthy diets. 210 The nonsensical Plastics requirement was added by the BtS expansion, presumably for balance reasons. Not much of a point in obsoletions this late in the game, and the Medieval wonders University of Sankore and Spiral Minaret come so late that they don't need to go obsolete at all. Angkor Wat has moved to Aesthetics though, and most Classical-era wonders do go obsolete; that

now happens at Scientific Method.

- 1 Internet moves to Fiber Optics (q.v.), so Computers needs a new ability. The processes, Research, Wealth and Culture, are too powerful in BtS. Set the conversion rate to 80% initially, and to 100% (as in BtS) only with Computers. This ability could make Computers one of several techs to beeline to when aiming at a Space victory.
- 213 Same as in BtS. Could be explained with advertisements, particularly "a diamond is forever" by De Beers. 4 Requires Ballistics (replacement for Artillery) instead of Flight or Artillery. Rocketry is a subfield of ballistics, so Ballistics has to be required. Perhaps Flight should be required in addition, but supersonic aerodynamics seem to be quite different from (and less tricky than) the subsonic aerodynamics relevant for constructing planes. Only
- Modern column would otherwise be a bit early for such a unit. animations show a shaped-charge warhead fired from a recoilless gun. Recoilless guns exhaust gas like rocket launchers. Shaped charges are also needed for initiating nuclear explosions (explosive lens). It's convenient to assume that Rocketry covers this because Rocketry is required for nukes anyway.
- no Battleships were commissioned after WW2, so Battleship should not remain without a replacement for so long. Radio as an additional requirement because just Rocketry would be a bit too early. I'm also adding an air interception chance (missile cruisers developed from antiair cruisers and continued to have air defenses); Radio could be needed
- 218 Hydroplant and Three Gorges Dam move to Electricity and Standard 219 This ability should represent containerization, and help coastal cities in the late game. BtS gives coastal cities practically no bonuses during the Industrial and Modern era. This really has nothing to do with synthetic

materials, but Plastics comes at the right time and otherwise does too

21 Oil appears only on Ocean tiles, so this tile improvement should really be about deep-sea drilling. Synthetic materials are probably used for this, e.g. for tubes and pontoons, but I doubt that they're really needed. Hard to find a more plausible place for Offshore Platform though.

222 Part of an effort to make resources less crucial for city growth in the

- late game. The importance of silk declined after the development of 223 Requires Radio for the radioactivity (only Electricity in BtS). 224 Requires Satellites instead of just Rocketry because Satellites is the spaceflight tech now.
- imagine. The commercial use of planes was also too small prior to jets to justify an extra trade route from Airport. Radio navigation and radar (Newton's laws of motion) and Steel because all the firearms in ques-(landing guidance) was important for flight safety in passenger aviation tion were mass-produced in steel. (Ideally, Biology should be required 227 This should really happen at Rocketry because Cavalry upgrades to Tank and Anti-Tank now instead of Gunship (see stat-changes.pdf), meaning that Cavalry is normally obsoleted by Rocketry (which now
 - or Horse at Rocketry, and both should go obsolete together in order to tidy up the UI. 228 Now requires Computers (only Radio in BtS). It might be possible to launch a satellite without (electronic) computers, but there were computers at the Baikonur Cosmodrome when Sputnik 1 was launched. The Apollo Project is inconceivable without computers
 - 1957) is a much greater technological achievement than a guided missile staying within the Earth's atmosphere. Plastics is required for e.g. insulation. One could also argue for Refrigeration because of heat exchangers in space suits, but that would be a third requirement not indicated by arrows in the tech tree (in addition to Plastics and the hidden Computers requirement for the

229 Moved from Rocketry and replacing Docking Bay, which moves to

Robotics. Rocketry should not include spaceflight because this

overloads the Rocketry tech, and because an ICBM (first launched

(successor of the SDI) don't seem to rely on lasers, although lasers might be incorporated within the next decade. The BtS expansion had added the Laser requirement. 231 Removed the Satellites requirement. Radio (for stimulating the emission) and Plastics (for synthetic crystals) are reasonable requirements, but Satellites should only be required for SDI, which moves directly to Satellites. Neither the Avenger described in the

Robotics). The present-day measures of the Missile Defense Agency

32 New name for the Mobile Artillery; see "Field Gun" at the new "Rapid Fire" tech about the name change. The 3D model shows a self-propelled 233 Moved from Robotics, and taking the spot of SDI, which moves to Satellites. Perhaps the climber component could be a robot, but I doubt

it. Laser could be needed for powering the elevator and for producing

234 Removed the Satellites requirement. Probably a remnant from when Jet Fighter and Stealth Bomber were at Composites (prior to the BtS expansion). 235 Moved from Robotics because I don't see any connection between Mechanized Infantry and Robotics. The 3D model shows an M113; these first entered service in 1960. The armor is not made from a

nanomaterials for the cable.

- without composite armor (just steel). It's also not ideal to have Modern Armor and Mechanized Infantry at the same tech. Hard to find a different place for either unit though. The additional requirement of Laser for Modern Armor should help a bit. The M60, or at least many too early for revealing Uranium. The radioactive properties of uranium variants of it, had a laser rangefinder. Also, the T64 tank, contemporary with the M60, did have composite armor, and so do all third-generation tanks. Ballistics (replacement for Artillery) is required for the tank gun. Certainly no Aluminum resource should be required for a heavy tank 237 New name for Laboratory. The BtS expansion moved this building from
 - Computers only for Particle Accelerator, not for Superconductors, because the important theoretical discoveries about superconductivity in the 50s and 60s did not hinge on computers. 38 Replacing the Superconductors requirement with Computers because I see no connection between genetics and superconductors. If the Genetics tech covers recent advances like genetic engineering, gene therapy and the Human Genome Project, then computers are needed for

physics justify Fission as an additional requirement. I'm requiring

compared with other 20th century advances like vaccination or antibiotics that are, supposedly, represented by the three health from Hospital. Instead, give Genetics a food bonus representing highyielding crop varieties and gene food. One extra food for all Farms would be way too much, hence the restriction to high-food tiles like

Corn (\rightarrow gene maize). The food bonus should also make the health

bonus more valuable: it counters the bad health from population

241 Neither Mechanized Infantry nor Missile Cruiser have a plausible connection with robotics; moved to Composites and Rocketry. The Space Elevator also doesn't make much sense at Robotics; moved to Laser. Rather give Robotics a SS part. Since the Apollo Project moves to Satellites, the Docking Bay is available. I'm sure there is some way in which e.g. robotic arms could be useful in a docking bay. Prior to the BtS expansion, Docking Bay was also at Robotics. The bonus to Industrial Park represents industrial robots; hence also the Industrialism requirement for Robotics. Prior to Robotics, Industrial

Park mostly gets the abilities of an electrified Factory; see stat-

changes.pdf for details. This is part of an effort to reduce the

production output of industrialized cities.

- 242 Requires Satellites instead of Advanced Flight; the latter shouldn't be required for Stealth Destroyer. The B-2 shown in the Stealth Bomber 3D model can drop satellite-guided bombs, and there are probably other ways too in which these high-tech units use satellite navigation. Don't want Satellites to be a dead end (no longer leads to Laser), and geolocation through satellites should have *some* military benefit in the game. (BtS requires Satellites already for Advanced Flight.)
- aircraft (and on other ships, but let's keep it simple). 244 No obsoletion of Kremlin; pointless this late. 245 Moved from Computers in order to make Fiber Optics more attractive. Had already been at Fiber Optics prior to the BtS expansion. 246 Requires Fiber Optics instead of Stealth because Fiber Optics would otherwise be a dead end (no longer required for Fusion), and because
- Superconductors would otherwise be a dead end (no longer required for Genetics). Also, magnetic confinement is the main approach toward fusion energy, though the magnets probably don't have to be

205 Replacement for Fascism, also taking over parts of Communism (which is otherwise replaced by Equality). Totalitarianism requires Equality for the element of collectivism (perhaps debatable). As "Fascism," there was too little that the tech could plausibly do, considering that it's a dead end in the tech tree. Paratrooper has moved to Flight and Mount Rushmore to the new Rapid Fire tech.

the Line (which can't take down Transports). The 3D model shows a

WW2 landing craft. These aren't oceangoing, but the unit could repre-

sent the contemporary Liberty and Victory ships, which according to

Uranium is no longer an alternative requirement; nuclear reactors in

completed in 1941, so Assembly Line is a bit early, and there isn't much

troop transports wouldn't be economical. Same for Destroyer (at

203 Moved from Assembly Line. The construction of the Pentagon was

of a connection. At Industrialism, the Pentagon can represent the

Transport at the same tech.

military-industrial complex

Ballistics).

already been proposed in the 1850s. Theology is required in order to be 204 Moved from Rocketry, mostly, because that tech doesn't have room

Wikipedia, "came to symbolize U.S. wartime industrial output," mean-

ing that Industrialism is a good match. It's also nice to have Marine and

- 206 The spy stuff is a pretty silly way to represent communism in the game; fits much better under the label "Totalitarianism". The free Great General is, for now, entirely removed. There's also no tech granting a free Great Prophet, so I think this is fine. The new "Statecraft" tech (replacing Civil Service) is a good candidate for a free
- Great General and could even be renamed to "Strategy" but would arguably become too powerful that way. 207 For consistency, all pre-Medieval wonders should go obsolete at some and integrates Military Studies better into the tech tree. Historically, this
- Market has moved from Economics to Liberalism. (That said, it's not so
 - 212 Moved from Ecology, which is no longer a Modern tech. For consistency, the main tech requirements of SS parts should be Modern or Future techs.
- Combustion is required instead; rocket engines are normally internal combustion engines. Aluminum Co. has moved to Industrialism in order to make room at 215 MANPADS only became effective in the 60s through infrared homing. 174 Ecology is a Modern tech in BtS, requiring Fission or Plastics. This fits Require Radio for that. (Infrared is a type of radiation.) The first
 - 217 Moved from Robotics. Not much of a point in such a late unit, and I doubt that robotics has anything to do with missile cruisers. Practically
- Shelter". A bomb shelter is also a protection against air raids, but the 220 This bonus mirrors the health bonus at Genetics and should make up for building only protects against nukes, whereas Bunker does reduce air the resource obsoletions at Plastics and in the Industrial era (Whale, Dye, Ivory). Plastics have improved numerous consumer goods or made
 - 225 The Satellites requirement (supposedly for satellite guidance) moves down the tree to Stealth; instead require only Rocketry for Advanced Flight. That's for the advanced engines (turbojet, turboshaft). 226 Moved from Flight. Strategic airlift without jet aircraft is difficult to
 - enables Anti-Tank). But there is only enough room left for either Stable
 - 230 Moved from Laser. Don't want to require the combination of Satellites and Laser for both SDI and Space Elevator (moved to Laser from
 - Civilopedia entry for Mobile SAM, nor the Patriot that the 3D model resembles, nor the M109 howitzer shown by the Mobile Artillery model appear to rely on satellites for aim or homing. They do employ lasers as rangefinders, and the M109 can also fire a laser-guided shell.
 - composite material but an aluminium alloy. Some infantry rifles from the 60s have fiberglass stocks (e.g. M14, M16), and the Humvee has

The new Rapid Fire tech is required for the select-fire rifles.

236 The 3D model shows an M60. That's an early second-generation tank

- Computers to Superconductors. It's still too easy to access, making Superconductors a beeline target for a Space victory too often, and the name "Laboratory" doesn't explain the Superconductors requirement well. Particle accelerators use superconducting magnets, and particle
- DNA sequence assembly. 239 A stasis chamber should be based on cryonics, i.e. Refrigeration (also required in BtS via Superconductors) plus Medicine. But I guess Genetics should be a SS tech, so let's imagine that only genetically engineered humans can endure cryostasis.
- 43 As with Submarines (see Radio), the Recon mission should only reveal stealth ships adjacent to another ship. Allowing only Stealth Destroyers to detect Stealth Destroyers is pretty silly. Surely, the Stealth Destroyer's (phased-array?) radar system can also be installed on
- fiber optics (with its uses in computer networks) seems more likely than stealth technology to lead to future innovations that increase people's happiness and health.
- 202 Moved from Combustion. This change should help Ironclad and Ship of

