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.

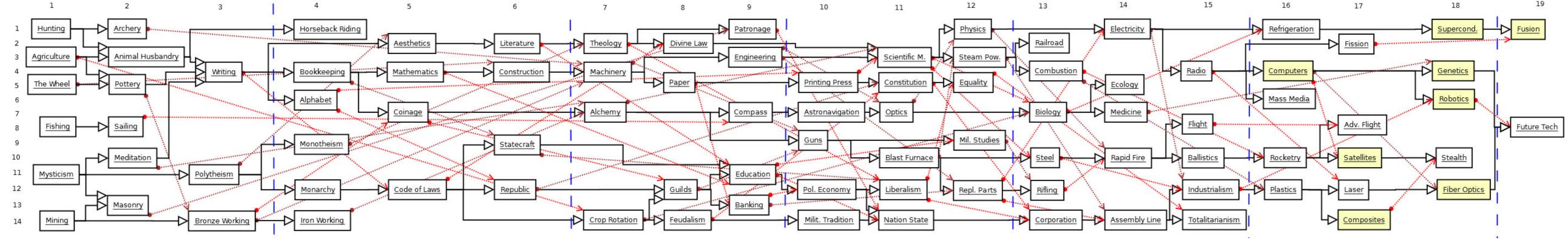
Green text: Difference from BtS that is already implemented in AdvCiv.

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.)



Correspondence between techs:



- Hunting (60): Scout, Camp, Spear (with Copper)
- Agriculture (60): Farm, Plantation (on Silk, Dye, Incense)¹
- Wheel (60): Road, Chariot (with Horse)
- Fishing (60): can work Coast, Workboat, 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)⁴
- 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, Moai Statues, trade along unowned Coast
- Meditation (80): Monastery, found Buddhism if discoverer owns a Hindu city or if Hinduism not yet founded to
- Masonry (60): Quarry, Walls, Great Lighthouse (with Lighthouse), Pyramids¹¹
- Writing (150): Library, Open Borders
- Polytheism (80): Temple,⁹ Oracle¹¹, Temple of Artemis, found Hinduism if discoverer owns a Buddhist city or if Buddhism not yet founded¹⁰
- Bronze Working (120)¹²: Axeman (with Copper or Iron), reveal Copper, 20 yield from chopping Forest, Forced Labor¹³

- Horseback Riding (220): Horse Archer (with Archery, Horse)
- Bookkeeping (160):¹⁴ Market, Gold trading,¹⁵ Temple of Kukulcan (with Polytheism)¹⁶
- Alphabet (200): Spy, Commando promotion, build Research, increases tech diffusion¹⁷
- Monotheism (150):¹⁸ Organized Religion, Winery,¹⁹ unless dicoverer owns a Holy City, found Zoroastrianism; if already founded, found Judaism instead²⁰
- Monarchy (200): Hereditary Rule, Barracks, Fort²¹
- Iron Working (190): Swordsman (with Iron), Forge²², reveal Iron
- Aesthetics (280): Mausoleum of Mausolos²³, Statue of Zeus (req. 2 Monuments), Angkor Wat²⁴
- Mathematics (240):²⁵ Aqueduct (with Mining)²⁶, Hanging Gardens (with Aqueduct), centers the map²⁷, Trireme (with Sailing, Bronze Working)²⁸
- Coinage (320):²⁹ +1 rade route, build Wealth, Shwedagon Paya³⁰ (with Meditation)
- Code of Laws (270):³¹ Courthouse, Caste System, Vassal agreement³², Missionaries can spread to foreign cities³³
- Literature (350): Heroic Epic (with Polytheism, Library), ³⁴ Great Library (with Library), Theater, Culture slider³⁵
- Construction (400):³⁶ Catapult (with Archery³⁷), Harbor³⁸ (with Lighthouse)³⁹, Colossus⁴⁰ (with Forge), Bridge building
- Statecraft (400):⁴¹ War Elephant⁴² (with Horseback Riding, Ivory), Forbidden Palace⁴³ (with Courthouses), Guerilla promotion⁴⁴, found Confucianism if discoverer owns a Taoist city or if Taoism not yet founded⁴⁵
- Republic (420):⁴⁶ Parthenon⁴⁷, Arena (with Masonry)⁴⁸, Academy⁴⁹, Triumphal Arch (with Construction)⁵⁰

- Theology (800):⁵¹ Apostolic Palace, Hagia Sophia, found Christianity if discoverer owns a Jewish or Zoroastrian city⁵²
- Machinery (800):⁵³ Watermill, Lumbermill, +50% chopping yield,⁵⁴ Crossbow (with Iron or Copper)⁵⁵
- Alchemy (700):⁵⁶ Pacifism, +10% research from Monastery,⁵⁷ found Taoism if discoverer owns a Confucian city or if Confucianism not yet founded⁵⁸
- Crop Rotation (800):⁵⁹ Serfdom⁶⁰, can build Farm on Grassland without irrigation⁶¹
- Divine Law (1000):⁶² Theocracy,⁶³ Spiral Minaret, found Islam if discoverer owns a Christian, Jewish or Zoroastrian city⁵²
- Paper (1200):⁶⁴ University of Sankhore, Bureaucracy (with Statecraft)⁶⁵
- Guilds (1300):⁶⁶ Pikeman (with Iron), Maceman (with Machinery, Iron),⁶⁷ Plantation (on Banana, Spice, Sugar)⁶⁸, Workshop on all flat tiles⁶⁹
- Feudalism (800): Longbow (with Archery, Iron Working)⁷⁰, Knight⁷¹ (with Machinery, Horseback Riding, Iron, Horse), Castle⁷², Vassalage civic
- Patronage (1400):⁷³ Sistine Chapel, build Culture, Cathedral, Stupa etc.
- Engineering (1500): Trebuchet, Windmill⁷⁴, Notre Dame (with Theology), Taj Mahal (with Divine Law)⁷⁵
- Compass (1400):⁷⁶ Map trading⁷⁷, Explorer, Grocer (with Guilds)⁷⁸, Whaling Boats⁷⁹
- Education (1500):⁸⁰ University, Oxford University (with University)
- Banking (1500):81 Bank, Great Merchant if first to discover82

- Printing Press (2000): +1 commerce from Village and Town, obs. Great Library⁸³
- Astronavigation (1900):⁸⁴ Caravel (with Construction)⁸⁵, Navigation II promotion⁸⁶, +1 sight on water⁸⁷
- Guns (2400):88 Musketman, Pinch promotion
- Political Economy (2100):⁸⁹ Mercantilism, +1 production from Lumbermill⁹⁰, Customs House⁹¹ (with Harbor), Versailles⁹²
- Military Tradition (2400):⁹³ Cuirassier (with Guns, Horseback Riding, Horse), Kremlin⁹⁴, Militarism⁹⁵, Defensive Pact
- Scientific Method (2500):⁹⁶ Tech trading⁹⁷, +1 research per specialist⁹⁸, obs. Statue of Zeus, Angkor Wat⁹⁹ and Monastery
- Constitution (2700):¹⁰⁰ Jail, Federation (with Nation State)¹⁰¹, Representation, obs. Monument, Stonehenge¹⁰² and Mausoleum of Mausolos¹⁰³
- Optics (2500):¹⁰⁴ Galleon, Privateer (with Guns and Copper or Iron)¹⁰⁵, trade across Ocean, Lookout promotion for naval units¹⁰⁶, obs. Great Lighthouse¹⁰⁷
- Blast Furnace (2700):¹⁰⁸ Cannon (with Iron)¹⁰⁹, Frigate (with Optics and Iron), Grenadier¹¹⁰, Barrage promotion¹¹¹, obs. Colossus¹¹² and Walls (except defensive effects)¹¹³
- Liberalism (2500): Free Market (with Nation State),¹¹⁴ Free Religion, Statue of Liberty (with Harbor and must be in Emancipation and Free Religion)¹¹⁵, obs. Castle¹¹⁶, Oracle¹¹⁷ and Temple of Artemis¹¹⁸
- Nation State (2600):¹¹⁹ Hermitage, Globe Theater (with Theater)¹²⁰, free Great Artist if first to discover¹²¹
- Physics (2700):¹²² Observatory¹²³, free Great Scientist if first to discover
- Steam Power (3400):¹²⁴ Levee¹²⁵, Workers build improvements faster¹²⁶, Ironclad (with Iron and Coal)¹²⁷, reveal Coal, Farms spread Irrigation¹²⁸
- Equality (3100):¹²⁹ Emancipation, Police Headquarters, Security Bureau,¹³⁰ obs. Deer¹³¹
- Military Studies (2900):¹³² Ship of the Line (with Optics, Blast Furnace and Iron), Military Academy (with Barracks)¹³³,
 +1 movement on Roads¹³⁴, Blitz and Ambush promotions
- Replaceable Parts (3300):¹³⁵ Drydock¹³⁶, +1 production from Windmill. Watermill and Workshop¹³⁷

- Railroad (3700):¹³⁸ Rail Track (with Coal or Oil),
 Public Transportation (with Oil)¹³⁹, can trade Crab¹⁴⁰, Mining Inc.
 Executive (with Corporation, University)
- Combustion (4100):¹⁴¹ reveal Oil¹⁴², Oil Well, Airship (with Physics)¹⁴³, Std. Ethanol Executive (with Corporation, University)¹⁴⁴, obs. Whale, Dye¹⁴⁵
- Biology (4700):¹⁴⁶ +1 food from Farm, can build Farms without irrigation, Cereal Mills Executive (with Corporation, University)¹⁴⁷, obs. Temple of Kukulcan¹⁴⁸
- Steel (4200):¹⁴⁹ Bunker¹⁵⁰, Steelworks (with Iron, Coal, Forge)¹⁵¹, Cristo Redentor (with Theology)¹⁵², faster production of Ancient and Classical buildings¹⁵³, Creative Constructions Executive¹⁵⁴ (with Corporation, University)
- Rifling (4000):¹⁵⁵ Rifleman, Cavalry (with Military Tradition, Horseback Riding, Horse)
- Corporation (4200):¹⁵⁶ Wall Street (with Bank), +1 trade route, State Property (with Equality)¹⁵⁷, can train Executives at Universities¹⁵⁸, obs. Great Wall¹⁵⁹
- Electricity (5000):¹⁶⁰ reveal Aluminium¹⁶¹, Broadway (with Theater), +1 commerce from Watermill¹⁶², Coal Plant (with Coal)¹⁶³, Hydroplant (with Steel), Three Gorges Dam (with Steel)¹⁶⁴
- Ecology (5100): Environmentalism¹⁶⁵, Treatment Plant¹⁶⁶, Preserve Forest, National Park, ¹⁶⁷ obs. Ivory¹⁶⁸
- Medicine (4200): Hospital (with power), Red Cross (with Hospital), Fallout Shelter (with Steel, Manhattan Poject)¹⁶⁹ Medic III promotion¹⁷⁰
- Rapid Fire (4800): Machine Gun,¹⁷¹ Field Gun¹⁷², Infantry (with Assembly Line)¹⁷³, Interception I promotion¹⁷⁴, Mount Rushmore¹⁷⁵
- Assembly Line (5200):¹⁷⁶ Factory (with Coal, Oil or power)¹⁷⁷
 Universal Suffrage (with Equality)¹⁷⁸
- Radio (7800):¹⁷⁹ Attack Submarine (Oil or Uranium)¹⁸⁰, Rock'n'roll (with Arena⁴⁸, power), Eiffel Tower (with Forge), reveal Uranium¹⁸¹; Air Recon can reveal Submarines¹⁸²
- Flight (7000):¹⁸³ Fighter (with Oil), Bomber (with Radio and Oil)¹⁸⁴, Carrier (with Coal or Oil or Uranium), Paratrooper¹⁸⁵
- Ballistics (5500):¹⁸⁶ Battleship (with Coal or Oil or Uranium),
 Destroyer (with Radio and Coal or Oil),¹⁸⁷ Tank (with Assembly
 Line, Railroad and Oil)¹⁸⁸
- Industrialism (7200):¹⁸⁹ Industrial Park (with Factory, power), Marine (with Rapid Fire)¹⁹⁰, Transport (with Coal or Oil)¹⁹¹, Pentagon¹⁹², Aluminium Co. Executive (with University)¹⁹³
- Totalitarianism (5500):¹⁹⁴ Police State, Permanent Alliance, Intelligence Agency, free Great Spy if first to discover,¹⁹⁵ obs. Parthenon¹⁹⁶

- Refrigeration (8000): Supermarket (with power), +1 food from Fishing Boats¹⁹⁷, Sid's Sushi Executive (with Corporation, University)¹⁹⁸
- Computers (8400):¹⁹⁹ 100% conversion rate from Processes²⁰⁰, SS Life Support (with Ecology)²⁰¹
 Mass Media (9000): United Nations, Hollywood (with Broadcast)

Tower), Broadcast Tower (with power), Civ. Jewelers Executive

- (with Corporation, University)²⁰², obs. Apostolic Palace
 Rocketry (8500):²⁰³ SAM Infantry (with Radio²⁰⁴), Anti-Tank²⁰⁵, Guided Missile, Missile Submarine (with Radio and Oil or
- Uranium)¹⁸⁰, Missile Cruiser (with Radio and Oil or Uranium)²⁰⁶
 Plastics (8500):²⁰⁷ +1 trade route from Harbor²⁰⁸, +3 happiness
- in all cities²⁰⁹, Offshore Platform²¹⁰, obs. Fur, Silk²¹¹
 Fission (9500):²¹² Manhattan Project (with Nuclear Plant), Tactical Nuke (with Rocketry, Uranium and Manhattan Project),

ICBM (with Satellites²¹³, Uranium and Manhattan Project),

Nuclear Plant (with Uranium)

- Advanced Flight (11000):²¹⁴ Gunship (with Oil); Jet Fighter (with Aluminium, Oil), Airport (with Radio, Oil)²¹⁵, obs. Stable and Horse²¹⁶
- Satellites (9000):²¹⁷ Apollo Project (with Plastics)²¹⁸, reveal map, SDI (with Manhattan Project)²¹⁹
- Laser (11000):²²⁰ Mobile SAM (with Rocketry, Oil), Howitzer²²¹ (with Ballistics and Oil), Space Elevator (with Satellites)²²²
- Composites (11000):²²³ SS Casing, Mechanized Infantry (with Rapid Fire, Aluminium, Oil)²²⁴, Modern Armor (with Laser, Ballistics, Oil)²²⁵
- Superconductors (12000): SS Thrusters, Particle Accelerator (with Computers, Fission and power)²²⁶
- Genetics (12000):²²⁷ SS Stasis Chamber (with Refrigeration)²²⁸,
 +2 health, +1 food in Grassland tiles with at least 5 food²²⁹
- Robotics (10000): SS Docking Bay, +1 free Engineer from Industrial Park²³⁰
- Stealth (12000): Stealth Bomber (with Advanced Flight, Aluminium, Oil),²³¹ Stealth Destroyer (with Oil or Uranium), Air Recon can reveal stealthy ships²³²
- Fiber Optics (12000):²³³ SS Cockpit, Internet²³⁴
- Future Tech (10000):²³⁵ + 1 health. +1 happiness
- Fusion (12000):²³⁶ SS Engine, free Great Engineer²³⁷ if first to discover

1 Dye seems to refer mostly to indigo, which was cultivated since 2500 41 Replacing Civil Service. Maceman (now at Guilds) and irrigation 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 too early.

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 (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 may involve 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 bad health is now caused by latitude

not Jungle (i.e. it persists after the Jungle is cleared), and Workers have

limited charges. 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 should benefit as well. 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 excess food into production when cities reach the happiness cap. Forced 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 49 The Republic tech allows Great Scientists to build Academies. Plato with Grassland. The early Workshops could represent brickyards, and Plains are clay-colored.

8 Should perhaps rename this to "Penteconter" to make clear how it differs from Trireme (triremes are also galleys, just a special type).

9 Priesthood has been merged into Polytheism and Meditation. Meditation takes over the arrow to Writing and Polytheism all the rest (Oracle, Temple, arrows to Monarchy and Code of Laws). Mainly because Polytheism and Meditation aren't attractive enough in BtS, especially when Buddhism and Hinduism have already been founded. Other advantages: Makes it easier to put Writing in the third column (where it belongs), and makes the second column less crowded (it's the only one with 7 techs in BtS). Plus, Temple no longer comes later than Temple of Artemis, and by requiring Polytheism for Aesthetics, most of the later great temples also require the Temple tech Polytheism (the remaining great temples get explicit requirements; see Divine Law). Meditation leading to Writing makes some sense if one considers that Meditation also enables Monastery. Polytheism might work better, but Meditation needs this advantage more.

10 This restriction ensures that Buddhism and Hinduism are founded close to each other. Along with other changes (see Monotheism, Code of Laws), the coupling of these two religions should keep several civs without an early religion and thus make the later religions more useful. Additionally, Buddhism and Hinduism should be tolerant toward each other, meaning that there are no relations penalties between Buddhist and Hindu leaders. Religious wars were uncommon between Hindu and

11 Note that the abilities of the following wonders have (essentially) been swapped in a circle: Pyramids \rightarrow Parthenon \rightarrow Statue of Zeus \rightarrow Oracle \rightarrow Pyramids

12 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 starting tech if nothing else. BtS requires Pottery for Metal Casting, which I'm replacing with Bronze Working and Coinage. 13 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 55 mod starts out in a familiar fashion. 14 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 basic math, e.g. multiplication tables (leading to Mathematics). 15 Moved from Currency; see Coinage. 16 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, the tech that enables Temple (now Polytheism) should be required.

17 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 (and Spies for all I care). Historically, Alphabetic writing may have accelerated tech diffusion, but, of course, wasn't a prerequisite. So something else needs to be

enabled by Alphabet, and the Research process somewhat fits (at least not worse than at Mathematics). 18 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; not a problem anymore. Similarly, the link from Monotheism to Monarchy (one god, one king?) may have been an attempt to integrate the religious techs with the others, but it's too contrived, and not necessary either. The Ancient religious techs just need to provide *some* benefit to civs wanting to found the Medieval-era religions. Winery is such a benefit.

19 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. 20 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 alternative 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.

61 This ability, together with a 1-tile irrigation spread from Aqueduct, Graphics for Zoroastrianism could be adopted from Realism Invictus, and it would be the favorite religion of the Persian AI leaders. 21 At the start of the game, Barracks are a waste of UI space and a trap for 62 The divine right of kings was a Renaissance concept; not appropriate 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. 22 Moved from Metal Casting (see Coinage). A forge is normally operated by a blacksmith who works wrought iron (not cast iron).

23 Previously at Calendar, which doesn't make any sense. The Mausoleum was most famed for the aesthetic value of its sculptures. The Mauso-

leum replaces the Parthenon, which moves to the new "Republic" tech. 24 Moved from Philosophy, which is now named "Alchemy". The actual construction date is in the 12th century AD; both Aesthetics and 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 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) than for Angkor Wat. 65 Civil Service has been replaced by Statecraft, a Classical-era tech, but

resources, so that the discoverer can likely benefit from at least one production discount. These three resources are Marble, Ivory and Gold in BtS, and now Marble, Ivory and Stone, which is still fine.

It's important that the wonders unlocked by Aesthetics use different

25 Mathematics has switched places with Calendar, which was then 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. 67 Maceman has moved to Guilds from Civil Service (replaced by Moved elsewhere: Research process (Alphabet), increased chopping yield (Machinery), Fort (Monarchy).

26 Aqueducts can also run underground, and bridge aqueducts often include some tunnels. Hence the Mining requirement.

27 Moved from Calendar. The size of the Earth was approximated through solar observation and trigonometry. 28 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." 68 About Plantations on Incense, Dye and Silk, see Agriculture. Bananas 29 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. Bronze Working is required for the coinage metal: Early coins were usually made from silver, copper or bronze, and the refinement of silver

ores (cupellation) requires similar temperatures as the smelting of 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 and gold trading should still make Coinage an important tech. 70 The English longbow came in use around AD 1000, so Longbowman 30 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. the authority of a great king (Monarchy) to enforce his law in a large 72 Moved from Engineering. A late Medieval tech requirement gives

31 Requires Currency or Priesthood in BtS, which isn't unreasonable, but domain seems more crucial to me. This change also integrates Monarchy better into the tech tree; it only leads to Feudalism in BtS.

32 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.

33 That is, prior to Code of Laws, religions can only spread to foreign cities through the city network. This restriction should reduce the 73 Music renamed. A more specific name like "Art Music" could explain headstart of Buddhism and Hinduism (about Judaism, see Monotheism)

over the other religions toward global dominance. 34 That's really National Epic, renamed. The BtS Heroic Epic becomes

Triumphal Arch (see Republic). 35 Both adopted from Drama, which gets replaced by Republic (q.v.). Drama is a form of literature.

36 Colosseum moves to Republic under the name "Arena" along with the Masonry requirement.

(tension-powered) crossbows.

37 Catapults were typically torsion-powered, but developed from primitive 38 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) 74 Moved from Machinery because windmills didn't become widespread

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 time Construction is discovered.

39 Sailing needs to be required in some way, and a large (artificial) harbor should be accompanied by a lighthouse. 40 Adopted from Metal Casting, which is no longer a tech (see Coinage), taking the place of Colosseum, which moves to Republic. Some of the

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

struction effort.

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, plates on the Colossus of Rhodes were of cast metal; this is sufficiently Divine Law can use a buff. Shah Jahan, who comissioned the Taj

(and so does Cristo Redentor; see Steel).

until the 13th century AD. (Although an earlier hill improvement to represent terrace fields would be nice.) Conversely, Pikeman and Castle have moved to earlier techs (Guilds, Feudalism). 75 Moved from Nationalism (now Nation State) because that tech requirement made no sense and to replace stuff that was moved away

Mahal, was a Muslim. To be consistent, Notre Dame requires Theology

wonders obsolete at once. 113 Moved from Rifling because Rifling gets turned into an Industrial-era

tech, and because it's cannons that made medieval fortifications

76 Requires Alchemy now instead of Iron Working (but Alchemy requires 114 Liberalism takes over Free Market from Political Economy (q.v.; for-Iron Working). Lodestones were of interest to alchemists. 77 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).

spread (now at Crop Rotation) don't fit well at Civil Service, and it's

governance, particularly meritocracy, as well as Chinese military

requirement. That's Paper, and Statecraft is required in addition.

hard to find Medieval replacements. The name "Statecraft" is supposed

to cover the philosophical basis of Chinese civil service, i.e. Confucian

strategy from the same period (Spring and Autumn). The civil service

system (imperial examinations) itself wasn't introduced until AD 600,

As a Classical-era tech, Statecraft accompanies Republic, the former

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

development, but that's not really what Construction is about. War

The Forbidden City was built in AD 1420, but it may well take that

44 This is a new promotion, introduced for the Protective trait. Guerilla

45 Previously at Code of Laws, a better fit at Statecraft. While not

long until a civ has enough Courthouses. No tech is required in BtS.

primarily a religion, Confucianism competed with Buddhism and was

seen as incompatible with Christianity by the Catholic church, so the

rulers also make sense, but bad relations with "heathens" are less

The connection with Taoism mirrors that between Buddhism and

also Alchemy, the replacement for Philosophy).

for which it's easy to find abilities.

representation as a religion has merit. Good relations among Confucian

plausible, so Confucian AI leaders should be tolerant toward other state

this point of the game; perhaps Taoism should be removed entirely (see

Replacing Democracy (see Equality) and taking the spot of Drama,

because all outgoing arrows are optional (to Music and Philosophy,

other late Classical and early Medieval techs are a bit overloaded

The Republic tech also integrates Alphabet into the tech tree – the

47 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

48 Although a Colosseum would fit very well under Republic, it's not a

civ that isn't Rome, and out of time after the Classical era. The

Colosseum, with its arcades, would require Construction, but for a

50 This is a renamed Heroic Epic though with the 3D model of National

51 Requires Literature instead of Writing mostly because this allows

Theocracy moves to Divine Law, but Theology gets to replace

a more useful ability (see stat-changes.pdf) than in BtS.

and thus give Christianity and Islam more room.

requirement (see Coinage).

53 Bronze Working and Construction replace the Metal Casting

52 To capture the connection between the Abrahamic religions. The

Philosophy as the mandatory requirement for Liberalism (Western

connection with Zoroastrianism is thin, but Judaism alone would

probably be too restrictive. See Meditation, Monotheism and Code of

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

forestry (whereas the Lumbermill improvement sustains the Forest

Economics (now Political Economy). Replaceable Parts as in BtS is a

bit late, and Machinery too early. However, the chopping mechanism,

unrealistically fast deforestation if there is no Medieval Lumbermill.

The chopping yield bonus has moved from Mathematics (what does

chopping yield and Lumbermill become available at the same time.

that have to do with lumber?) to Machinery, meaning that the maximal

See stat-changes.pdf about the Copper requirement. Archery should

be required for Guns (formerly Gunpowder) because there is a spring in

the limit. So Machinery gets the Archery requirement although a spring

a flintlock, and a bow is a primitive spring. However, Guns has two

other extra requirements (Machinery and Guilds), and two should be

56 Replacing Philosophy, which is a too generic name and couldn't lead to

connected to Taoism. Mohism, which advocated for pacifism, was later

partly absorbed into Taoism, so there is a remote connection between

alchemy and pacifism too. Pacifism would fit better at Statecraft, but

is not a machine, and Crossbow doesn't have to require Archery

any Medieval tech. "Alchemy" is easier to integrate and closely

the Medieval era already has fewer techs than the others.

58 Should perhaps be removed in favor of Zoroastrianism (see

leaders should be tolerant toward other state religions.

which relates to the philosopher's stone.

the chances of Christianity and Islam much.

and education.

than in BtS.

much a theocracy.

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

The two requirements, Coinage and Iron Working, are both about

metalurgy; Coinage could imply knowledge about gold extraction,

The research bonus should give both Monastery and Alchemy a power

boost, and acknowledge the role of Christian monasteries in scholarship

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

If Taoism stays in the game, it should work like Confucianism, i.e. AI

59 New tech that takes over Serfdom (from Feudalism) and the spread-

irrigation ability (from Civil Service). Feudalism was getting too

crowded and should really be a high Medieval tech (middle column).

Since Metal Casting and Priesthood have been removed (see Coinage

and Polytheism), Crop Rotation brings the tech count to 91, one fewer

Crop rotation has been practised since prehistory, but this tech repre-

sents medieval crop rotation systems like the two-field, three-field,

European feudal system along with vassalage, but manorialism, an

early form of serfdom, emerged in the Late Roman Empire (which

open-field or equal-field system (which justify the Code of Laws

60 Serfdom was introduced in the High Middle Ages as part of the

replaces "Farms spread irrigation"; see stat-changes.pdf.

for the tech that founds Islam. (And the tech doesn't do anything

anyway.) So Versailles moves to Political Economy (formerly

through the scientific advances in the Islamic Golden Age.

Economics) and the link to Nationalism (now Nation State) gets

connected to the Mandate of Heaven, which was an ancient concept

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

63 Divine Law needs this more than Theology does, and a caliphate is very

meaning that we're talking about paper mills. It's the cheap manufacture

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

Bureaucracy should remain a Medieval-era civic, and Paper doesn't

Crop Rotation (which replaces Feudalism as an early Medieval tech) or

have much else to do. This also preserves the relationship between

Paper and Civil Service (the former requires the latter in BtS).

66 This requires both Machinery and Feudalism in BtS; now it's either

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

Statecraft) and Pikeman from Engineering. These were both rather

Guilds is an urban tech, so it gets units that were raised in cities.

came in use at about the same time as guilds (AD 900).

bizarre tech requirements; the original developers probably just saw no

better way to spread the Medieval units out. Knight is now enabled by

Pikeman is a pretty clear case; the pike was popular among mercenary

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.

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

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

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

European citizens. Early cultivation is represented by the natural yield

As a high Medieval tech, Guilds comes a bit early for the East Indies

In BtS, Guilds gives Workshop +1 production, but now Workshop

yields 2 production from the beginning (see Pottery). So, instead of

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

Moved from Guilds (the other requirements are as in BtS; Machinery

for manufacturing the armor). Guilds is now for units raised in cities,

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.

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 commerce into culture (rather than

into gold) – is also a decent representation of arts patronage. The free

Great Artist moves to Nation State (formerly Nationalism), which now

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.

In order to make room for Castle and Knight, Serfdom moves to the

new Crop Rotation tech and Vassal agreement to Code of Laws.

and Feudalism for units raised in the countryside: peasants

No need for Masonry: Japanese castles were timbered.

(Longbowman) and nobles (Knight).

for both Plantation and Grocer, Grocer moves to Compass.

increasing the yield, Guilds only lifts the terrain restriction.

trade. As a compromise, and because there isn't enough room at Guilds

that established colonial plantations and delivered the produce to

bonuses of the three resources.

guilds. I'm treating Maceman as heavy infantry, which also tended to be

mercenaries, as peasants were not afforded costly armor. The mace also

Coinage) requirement has moved up from Banking to Guilds.

required from a historical point of view.

Requires Machinery now (instead of Theology or Civil Service),

of a writing material that was crucial for further developments.

requirement) and possibly iron moldboard plows.

belongs to the Medieval era of Civ 4).

feature). The most appropriate place for Lumbermill would be

even if restricted to buildings and ships as I intend, leads to

commerce, and Political Economy adds 1 production.

Therefore, Lumbermill appears at Machinery, granting only 1

Laws about changes that should hamper the early spread of religions

medieval philosophy was largely theology), and the Hagia Sophia gets

Epic (which shows a triumphal arch). Three powerful Marble wonders

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

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

suitable name for a non-wonder building, and feels out of place for any

founded his Academy in 387 BC, so Academies shouldn't appear in the

Pyramids instead, which fits very well at Republic.

generic arena, Masonry should be enough.

under Republic. See also stat-changes.pdf.

game long before that.

which has merged into Literature. Drama is kind of a dead end in BtS

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

(Construction, Feudalism, Engineering) and would become even more

crowded after the removal of Metal Casting. Therefore a new tech, one

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

Elephant fits with the military aspect of Statecraft and elephants were

42 The saddle (howdah) may have been a significant mechanical

more costly Guilds and its prerequisites).

most exploited in South East Asia.

warfare was pioneered by Sun Tzu.

religions.

so the corresponding civic, Bureaucracy, needs to have a Medieval tech

78 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. representing an "Eastern way", and the latter a "Western way". Both are 79 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
115 Moved from Democracy, which has been replaced by Republic and tech at the proper time. 80 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 Renaissace as in BtS).

81 Instead of being required for Education (q.v.), Paper is now required for 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. 82 The free Great Merchant switches places with Mercantilism because

Banking has to be a Medieval tech, while mercantilism emerged in the 16th century. There are some famous bankers like the Medici and Fugger whom the Great Merchant could represent Hinduism (see Meditation). Two independent religions aren't needed at 83 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. 84 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

better than Optics. Whaling Boats have been moved to Compass as Optics and

too difficult to access for civs that start in isolation.)

Astronavigation are too close to Combustion. 85 An important innovation behind the caravel was its carvel planking; hence the Construction requirement. (Engineering would make Caravel

America, so Astronavigation as the Caravel tech is a bit fantastical, but

86 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. 87 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. 88 New name for Gunpowder. The tech is now assumed to imply primitive cannons that are only represented by the Privateer unit (see Optics). The name "Guns" should also make the link to Blast Furnace (previously Chemistry) a bit more convincing, as in "the furnace is for making and a combat class (Gunpowder units).

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. 89 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

The Education requirement in BtS is dubious; Education helps

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 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 preferrable to Mercan-

Castle still goes obsolete along 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.

90 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.

91 Changes to Customs House and Mercantilism make the two compatible; see stat-changes.pdf. (In BtS, Customs House has no effect under Mercantilism unless the owner of Customs House has vassals.) 92 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.

93 Cuirassiers and the military bands that the Music requirement hinted 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 make Military Tradition quite a bit faster to beeline to; however, Cuirassier still requires Guns (a. k. a. Gunpowder), whose

Cavalry still requires Military Tradition, but has visually relocated to Rifling, the much tougher of the two requirements. 94 Moved from Communism (now called Equality), replacing West Point,

tech requirements have become stricter.

requiring that tech.

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. 95 After a name change from "Nationhood" to "Militarism", Military Tradition is a natural match. That said, the Draft ability can't come this early; now requires adopting the Emancipation civic (at Equality) in

addition to Militarism. See stat-changes.pdf. about this and the name 96 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 Bacon, so Scientific Method is very much a Renaissance tech, and should be contemporary with Astronomy (now Optics) instead of

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.

97 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). Tech trading still has to be nerfed, regardless of

Prior to Scientific Method, tech exchange should happen automatically through a tech diffusion system based on tile culture. See also Alphabet 98 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 only come 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.

99 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 differing 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.

100 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

101 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. 102 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-

103 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.

104 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 with galleons. 105 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 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 required). The move from Chemistry to an earlier tech should also give Privateer a longer window of opportunity. 106 See stat-changes.pdf about this. It's the Sentry promotion under a

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. 108 New tech replacing Chemistry and, in a way, Metal Casting (see to be at the same tech as Frigate, and that tech would be a poor

107 Moved from Corporation for balance reasons: the two extra trade routes

representation of chemistry as a science. Instead, chemistry is now represented through Alchemy (replacing Philosophy), Scientific Method, Steam Power (physical chemistry) and Combustion (petrochemistry). The production bonus to Workshop moves to Replaceable Parts (q.v.). 109 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; hence the need for cast iron. 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.

excellent fit for this unit. This moves Grenadier one column to the left,

Grenadier is, as it should be, more often contemporary with Musketman

while Rifleman moves two to the right (see Rifling), meaning that

110 Early grenades were made out of cast iron, so Blast Furnace is an

than with Rifleman. The stats and abilities of Grenadier need to change accordingly; see stat-changes.pdf. 111 Catapults and trebuchets aren't supposed to deal collateral damage anymore; see stat-changes.pdf. 112 Moved from Astronomy (now called Optics) to avoid making two naval

merly just Economics), but loses Free Speech (see Constitution) and the free tech. The free-tech ability isn't worth the distortions 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; Guns, Rifling and Drafting. Nation State is an additional requirement for Free Market because market economics emerged about a century later than liberalism as a political philosophy. The requirement should also illustrate the

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 techs) is just for flavor. 116 The obsoletion of Castle has moved from Economics (now Political

in Europe during the 19th century.

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 route bonus from Castle to certain civics and choose a different

117 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. 118 Moved from Scientific Method, where too many (Marble) wonders

went obsolete. Religious wonders might as well go obsolete with

Liberalism instead of Scientific Method, and Temple of Artemis is even a mercantile wonder. 119 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 Music in BtS, which was required for Military Tradition; that requirement has moved one column down the tech tree. It's needed for the nation's cultural identity. The Political Economy requirement (alternative to Military Tradition) alludes to theories that attribute the emergence of nation states more to economical developments than to national sentiment.

120 Moved from Drama, which got merged into Literature. Makes sense for a tech called "Nation State" to enable more than one national wonder. 121 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).

quote (though that quote will have to move to the new Rapid Fire tech) were published in the 1680s, so Physics should be a Renaissance 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.). larger guns". Lastly, it's a bit awkward to have the same name for a tech 123 Moved from Astronomy, which was renamed to "Astronavigation" in order to allow Observatory to move. The telescope (1608) very much

122 Newton's laws, pivotal for modern physics and paraphrased in the tech

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. 124 The Watt steam engine went into production in 1776, but steam engine parts were not interchangeable until 1880. Therefore Steam Power shouldn't require Replaceable Parts. Scientific Method is required in

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; otherwise, there are too many techs for the Industrial 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). 125 Levee at Steam Power (same as in BtS) makes sense to me because

river transportation on steamboats increased the need for river engineering. 126 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. 127 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. 128 This ability represents the large American aqueducts that stretch across hundreds of miles. Steam Power is needed for the pumping stations. 129 Replacing Democracy. The name "Equality" allows the tech to become

an additional requirement for the State Property civic (main require-

ment: Corporation, q.v.), and then the rest of Communism can be merged with Fascism into "Totalitarianism". Also, the notion that "all men are created equal" (Thomas Jefferson, 1776) is, in my mind, the most important difference between the USA (or the First French Republic) and the European monarchies of the 18th 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 Suffrage moves to Assembly Line (q.v.), with Equality as an

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. 130 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 statchanges.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; 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

additional requirement. Assembly Line can explain the production

bonus better. The Statue of Liberty moves to Liberalism (q.v.), though

civ quite some time to get a Great Spy for building a Security Bureau. 131 Part of an effort to make resources less crucial for city growth in the late game. In Europe, and perhaps elsewhere, game populations shrunk once hunting stopped being a privilege of the nobility. 132 "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

20th century, but that's OK: after discovering Equality, it may still take a

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

gameplay reasons (military porduction too fast in the late game). 34 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. The bonus could represent advances in logistics and operational warfare.

35 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. 136 Moved from Steel in order to boost Ironclad and especially Ship of the

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. 137 The bonus to Workshop has moved from Chemistry (now called Blast Furnace) and replaces Lumbermill, which is now enabled by Machinery

Line, which has to cost more than Frigate, but isn't a lot more useful.

and boosted by Political Economy. Blast Furnace does other things, and it's neater to have all the improvement bonuses at one tech. 138 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.). 139 Moved from Combustion because Combustion no longer requires Railroad. The Oil requirement implies Combustion, so there is no real

140 Prior to Railroad only a local health bonus because crabs are difficult to conserve (more so than fish). Transportation on rail made food from crustaceans available farther inland. Full availability should realistically require Refrigeration, but, that late in the game, +1 health might be 141 Requires Railroad and, indirectly, Steel in BtS. Steel made sense for the ships (Destroyer, Transport) enabled by Combustion in BtS, but these

have moved 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

meaning that Combustion also remains required. 142 Moved from Scientific Method. There are no units that require Oil in 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, not in Renaissance. 143 Moved from Physics. Airships are dirigible, and for that they require an

Public Transportation moves to Railroad, additionally requiring Oil,

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. 144 Moved from Plastics and taking the spot of Creative Constructions, which moves to Steel. Combustion is the most straightfoward

requirement for a fuel company. (Standard Ethanol isn't primarily about biofuel anymore; more like Standard Oil. See stat-changes.pdf.) 145 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 146 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.). 147 Moved from Refrigeration – grains benefit from refrigeration less than

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 the Cereal Mills shouldn't be a game balance problem; the numbers just need to be tweaked accordingly. 148 This obsoletion only makes sense because of the new agricultural ability for the Temple of Kukulcan (called Chichen Itza in BtS). Cf.

stat-changes.pdf. 149 Cannon has moved to Blast Furnace (replacement for Chemistry), 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 earlier techs. Instead, the Steel tech focuses on uses of steel in construction, especially in reinforced concrete and steel beams. 150 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 shouldn't require electrification. 151 "Steelworks" is a more common (or at least more specific) term for a modern steel mill than "ironworks," which sounds like it should be at Blast Furnace. See stat-changes.pdf about the resource requirements.

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

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

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

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

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

already been proposed in the 1850s. Theology is required in order to be

Creative Constructions. 155 The Rifleman 3D model appears to show a soldier from the Napoleonic latter makes more sense because rifles didn't supplant muskets until

midgame, especially on land discovered through Caravels. Improved

154 Moved from Combustion; Combustion gets Standard Ethanol instead.

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

construction methods seem like the best historical explanation.

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

193 Moved from Rocketry, mostly, because that tech doesn't have room

194 Replacement for Fascism, also taking over parts of Communism (which

the element of collectivism (perhaps debatable). As "Fascism", there

was too little that the tech could plausibly do, considering that it's a

195 The spy stuff is a pretty silly way to represent communism in the game;

The free Great General is, for now, entirely removed. There's also no

"Statecraft" tech (replacing Civil Service) is a good candidate for a free

tech granting a free Great Prophet, so I think this is fine. The new

Great General and could even be renamed to "Strategy", but would

96 For consistency, all pre-Medieval wonders should go obsolete at some

point if there isn't a special reason against obsoletion. At Totalitarian-

ism, all government civics are guaranteed to be unlocked, and obso-

197 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.

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

conservation, the bonus could also represent trawling, fish farms and

in the early game is highly unrealistic. That food output needs to be

reduced by 1 (see also stat-changes.pdf), and then Refrigeration

other developments in commercial fishing that BtS fails to capture.

198 Moved from Medicine and replacing Cereal Mills, which moves to

Biology (q.v.). Refrigeration is a better explanation for a seafood

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; now

200 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

tency, the main tech requirements of SS parts should be Modern or

Artillery. Rocketry is a subfield of ballistics, so Ballistics has to be

subsonic aerodynamics relevant for constructing planes. Only

required. Perhaps Flight should be required in addition, but supersonic

aerodynamics seem to be quite different from (and less tricky than) the

Combustion is required instead; rocket engines are normally internal

Aluminium Co. has moved to Industrialism in order to make room at

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

206 Moved from Robotics. Not much of a point in such a late unit, and I

remain without a replacement for so long. Radio as an additional

207 Apart from the obsoletion of Fur, all BtS abilities have been relocated;

requirement because just Rocketry would be a bit too early. I'm also

adding an air interception chance (missile cruisers developed from anti-

air cruisers and continued to have air defenses); Radio could be needed

see the notes at the respective techs: Hydroplant and Three Gorges Dam

to Electricity, Standard Ethanol to Combustion, Offshore Platform to

208 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

209 This bonus mirrors the health bonus at Genetics and should make up for

the resource obsoletions at Plastics and in the Industrial era (Whale,

0 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.

late game. The importance of silk declined after the development of

down the tree to Stealth; instead require only Rocketry for Advanced

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

(landing guidance) was important for flight safety in passenger aviation

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 in order to tidy up

Now requires Computers (only Radio in BtS). It might be possible to

computers at the Baikonur Cosmodrome when Sputnik 1 was launched.

launch a satellite without (electronic) computers, but there were

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

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

1957) is a much greater technological achievement than a guided

Plastics is required for e.g. insulation. One could also argue for

be a third requirement not indicated by arrows in the tech tree (in

addition to Plastics and the hidden Computers requirement for the

19 Moved from Laser. Don't want to require the combination of Satellites

and Laser for both SDI and Space Elevator (moved to Laser from

(successor of the SDI) don't seem to rely on lasers, although lasers

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

might be incorporated within the next decade. The BtS expansion had

requirements, but Satellites should only be required for SDI, not the

Refrigeration because of heat exchangers in space suits, but that would

Robotics. Rocketry should not include spaceflight because this

The Apollo Project is inconceivable without computers

missile staying within the Earth's atmosphere.

Satellites tech).

added the Laser requirement.

enables Anti-Tank). But there is only enough room left for either Stable

Flight. That's for the advanced engines (turbojet, turboshaft).

215 Moved from Flight. Strategic airlift without jet aircraft is difficult to

216 This should really happen at Rocketry because Cavalry upgrades to

Dye, Ivory). Plastics have improved numerous consumer goods or made

convenient to assume that Rocketry covers this because Rocketry is

doubt that robotics has anything to do with missile cruisers. Practically

no Battleships were commissioned after WW2, so Battleship should not

204 MANPADS only became effective in the 60s through infrared homing.

Require Radio for that. (Infrared is a type of radiation.) The first

Modern column would otherwise be a bit early for such a unit.

205 Civilopedia talks about "high-velocity cannons", but the combat

techs to beeline to when aiming at a Space victory.

brings the output to the same level as in BtS. Apart from food

(This change is inspired by the Civ 4 Reimagined mod.)

company than healthy diets.

presumably for balance reasons.

happens at Scientific Method.

diamond is forever" by De Beers.

combustion engines.

required for nukes anyway.

Composites.

spaceflight tech now.

leting a symbol of democracy boosts the evil image of Totalitarianism.

Moreover, the speed bonus makes it harder for players to keep track of

dead end in the tech tree. Paratrooper has moved to Flight and Mount

is otherwise replaced by Equality). Totalitarianism requires Equality for

military-industrial complex

Rushmore to the new Rapid Fire tech.

arguably become too powerful that way.

fits much better under the label "Totalitarianism".

Wars, but the Civilopedia text talks about the American Civil War. The about 1850 (Minié rifle). This interpretation also gives Musketman more time to shine. Consequently, Rifling becomes an Industrial-era connection between liberalism and the national unification movements The Military Studies (formerly Military Science) requirement should make it harder to beeline from Guns (formerly Gunpowder) to Rifling,

> and integrates Military Studies better into the tech tree. I doubt that rifles were employed by 19th-century military commanders in fundamentally different ways than muskets during the Napoleonic Wars. So, as far as historicity is concerned, Military Studies perhaps shouldn't be required until Tank (i.e. Ballistics). 156 Requires Liberalism instead of Economics (now Political Economy) in order to integrate Liberalism better into the tech tree, and because Free

Market has moved from Economics to Liberalism. (That said, it's not so

clear that market economics are a prerequisite for limited liability and

other aspects of modern corporations.) 157 Communism has (in part) been replaced by Equality, and Equality is still required for State Property. Either Corporation or Liberalism 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 civic (see stat-changes.pdf) are focused on corporations, so it doesn't make much sense to allow the civic before the Corporation tech. 158 That is, no HQ is required. This change lowers the initial investment for spreading a corporation, allowing corporation yields to be reduced

159 Because the new ability of the Great Wall grants an extra trade route, and too many extra trade routes could encourage city spam. The obsoletion of the Great Lighthouse moves to Optics.

substantially, which should improve the pace of the late game. See also

199 The nonsensical Plastics requirement was added by the BtS expansion, 160 Requires Replaceable Parts for mass-manufacturing electrical equipment like light bulbs, resistors and switches. 161 Moved from Industrialism. Industrialism is early enough as far as game balance is concerned, but Electricity fits better historically. The Hall-Héroult process (1886) for smelting aluminium ore involves electrical current. The discovery of this process made aluminium viable as a construction material.

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

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

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

widespread until the Oil Crisis. 201 Moved from Ecology, which is no longer a Modern tech. For consis-163 Moved from Assembly Line. The Assembly Line requirement makes some sense in BtS because Assembly Line enables Factory, which, in BtS, is the only building that benefits from electrical power. Now there 202 Same as in BtS. Could be explained with advertisements, particularly "a are some buildings, e.g. Broadcast Tower and Hospital, that also require power, but don't require Assembly Line. Electricity should be required 203 Requires Ballistics (replacement for Artillery) instead of Flight or for all power plants in any case.

164 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 Steel and Medicine. 165 Ecology is a Modern tech in BtS, requiring Fission or Plastics. This fits with the post-WW2 environmental movement, but the Environmentalism civic is rarely useful that late in the game. For that reason, presumably, Environmentalism was moved to Medicine in patch 1.52. Better to 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

166 New name for Recycling Center; see stat-changes.pdf. 167 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 ecological preservation. Perhaps the BtS developers felt that Ecology came too late, but that isn't an issue

that don't need more health aren't going to research Ecology.

captured by whatever health problems civs experience in the game; civs

Exclusion Zone (new name for the Fallout feature) in stat-168 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.

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

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

169 Moved from Electricity and renamed from "Bomb Shelter" to "Fallout Shelter". A bomb shelter is also a protection against air raids, but the building only protects against nukes, whereas Bunker does reduce air 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 military units). Medicine could be needed for understanding the impact of radiation on the human body, and the tech has room. 170 This has no tech requirement in BtS, but is only available for Great

171 Merging Democracy, Communism and Fascism into just two techs 211 Part of an effort to make resources less crucial for city growth in the (Equality and Totalitarianism) opens up room for a new technology. It's a military technology because there are so many military units in the Industrial era, and several of them with unrealistic tech requirements: 212 Requires Radio for the radioactivity (only Electricity in BtS). Machine Gun at Railroad even seems completely nonsensical. 213 Requires Satellites instead of just Rocketry because Satellites is the The "Rapid Fire" tech represents advances in firearms from the late 19th century, especially smokeless powder and mechanisms for absorbing or redirecting recoil. Physics is required for the recoil handling 214 The Satellites requirement (supposedly for satellite guidance) moves (Newton's laws of motion), and Steel because all the firearms in ques-

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

"super medics". See also stat-changes.pdf. Plus, the Medicine tech

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

tion were mass-produced in steel. (Ideally, Biology should be required for the smokeless powder, but that would be one tech requirement too I've got the name "Rapid Fire" from the American Revolution Mod; the tech icon would also come from there. 72 New name for the Artillery unit. The Rapid Fire tech pushes the Artillery tech out of the WW1 column. Since artillery was used extensively in WW1, the Artillery tech gets a new name ("Ballistics"), and the Artillery unit moves to Rapid Fire. The Canon de 75, regarded as the first modern artillery piece, was a quick-firing field gun with a

requirement. (Machine guns and field guns developed alongside each other, differing in caliber and fire rate.) The name "Field Gun" should make clear why it's not at Ballistics: field guns were not designed for indirect fire. Accordingly, Mobile Artillery gets named "Howitzer". 173 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

hydro-pneumatic recoil mechanism, so Rapid Fire is a very suitable

tech. The M1 is a semi-automatic (gas-operated) rifle, so requiring Rapid Fire is also historically sound. 174 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

175 Moved from Fascism (now called Totalitarianism). The developers may 21 have seen the memorial as a response to fascism, but that's easy to 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

176 Coal Plant moves to Electricity, Pentagon to Industrialism and Infantry to Rapid Fire (new tech), though Assembly Line remains required. 7 See stat-changes.pdf about these resource requirements. 178 Equality replaces Democracy. Assembly Line becomes an additional requirement because this makes it easier to explain the production bonus to Towns: an increase of female participation in the industrial workforce tended to precede female suffrage.

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. 180 Attack Submarine and Missile Submarine (previously just called "Submarine") have switched places. Attack Submarine was introduced in BtS as a counter against the vanilla Submarine unit, probably repre-

senting early Cold War hunter-killer designs. This role is too narrow. Instead, Attack Submarine becomes the ordinary submarine unit for the World Wars, and Missile Submarine a more expensive unit representing the cruise missile and ballistic missile subs of the Cold War. 181 Moved from Physics, which is now a Renaissance tech and thus way too early for revealing Uranium. The radioactive properties of uranium 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. The short time between revealing Uranium and Fission means that Uranium can be made tradeable at Radio; Uranium Mines not granting the strategic resource is a source of confusion in BtS. 182 Radio is also required for all naval units that detect Submarines. This

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

Recon should only reveal Submarines that are adjacent to another ship.

(A submarine spotted on the surface by an aircraft will dive and change its position if it isn't promptly engaged.) Too easy in BtS to spot Submarines with air units. 83 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

Bomber require Oil. Airport moves to Advanced Flight (q.v.). I'm drawing the line between Industrial and Modern era in the late 1930s. This yields a pretty even distribution of techs. Flight could go either way: The 3D models appear to show planes introduced in the 30s (Spitfire, B-17). Fighter aircraft already played a prominent role in WW1 though, so the Fighter unit should be in the Industrial era. 184 Still requires Radio (for search radar) and Flight, but since both are in

the same column now, Flight as the more obvious requirement becomes the main requirement. (Radio is also pretty crowded.) 185 Moved from Fascism (now called Totalitarianism). Fascist Italy and Germany were early adopters of airborne infantry, but parachuting is hardly a matter of ideology. 186 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 important advancement at Ballistics is indirect fire. 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.). 187 Destroyer is at Combustion in BtS and Battleship at Industrialism. The

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

Ballistics, and 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".) 189 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 233 No obsoletion of Kremlin; pointless this late. 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). Aluminium is revealed by Electricity instead of Industrialism. Ivory goes obsolete with Ecology instead of Industrialism.

190 Requires the new Rapid Fire tech instead of just Rifling. The 3D model appears to show an AK-47. 191 Moved from Combustion. This change should help Ironclad and Ship of the Line (which can't take down Transports). The 3D model shows a WW2 landing craft. These aren't oceangoing, but the unit could represent the contemporary Liberty and Victory ships, which according to

ing that Industrialism is a good match. It's also nice to have Marine and Transport at the same tech. Uranium is no longer an alternative requirement; nuclear reactors in troop transports wouldn't be economical. Same for Destroyer (at Ballistics).

happiness and health. 236 Requires Superconductors instead of Fiber Optics because Wikipedia, "came to symbolize U.S. wartime industrial output", mean-

Great Engineer in stat-changes.pdf).

military units enabled by Laser. Neither the Avenger described in the 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 rangerfinders, and the M109 can also fire a laser-guided shell. 221 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 179 Cristo Redentor moves to Steel (q.v.) and Bomber to Flight with Radio 222 Moved from Robotics, and taking the spot of SDI, which moves to

220 Removed the Satellites requirement. Radio (for stimulating the

emission) and Plastics (for synthetic crystals) are reasonable

Satellites. Perhaps the climber component could be a robot, but I doubt it. Laser could be needed for powering the elevator and for producing nanomaterials for the cable. 223 Removed the Satellites requirement. Probably a remnant from when Jet Fighter and Stealth Bomber were at Composites (prior to the BtS expansion)

224 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 composite material, but an aluminium alloy. That said, later infantry vehicles, like the Humvee, do have composite armor, and some infantry rifles from the 60s have fiberglass stocks (e.g. M14, M16). The new Rapid Fire tech is required for the select-fire rifles. 225 The 3D model shows an M60. That's an early second-generation tank 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 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. 226 New name for Laboratory. The BtS expansion moved this building from 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 physics justify Fission as an additional requirement. I'm requiring

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 227 Replacing the Superconductors requirement with Computers because I see no connection between genetics and superconductors. If the Genetics tech covers recent advances like genetical engineering, gene therapy and the Human Genome Project, then computers are needed for DNA sequence assembly.

228 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. 229 Three health would exaggerate the effects of genetics on human health

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 230 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 statchanges.pdf for details. This is part of an effort to reduce the production output of industrialized cities. 231 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

(BtS requires Satellites already for Advanced Flight.) 232 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 aircraft (and on other ships, but let's keep it simple).

234 Moved from Computers in order to make Fiber Optics more attractive. Had already been at Fiber Optics prior to the BtS expansion. 235 Requires Fiber Optics instead of Stealth because Fiber Optics would otherwise be a dead end (no longer required for Fusion), and because fiber optics (with its uses in computer networks) seems more likely than

fusion energy, though the magnets probably don't have to be 237 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

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

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

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

188 Moved from Industrialism; that would be a bit much on top of want Satellites to be a dead end (no longer leads to Laser), and geolocation through satellites should have *some* military benefit in the game.

stealth technology to lead to future innovations that increase people's Superconductors would otherwise be a dead end (no longer required for Genetics). Also, magnetic confinement is the main approach toward