Legend

Blue dashed lines: Era boundaries

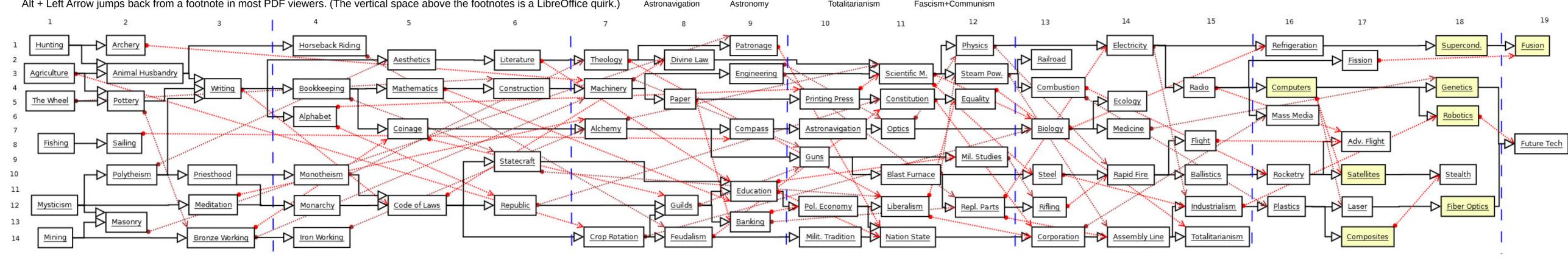
Red dotted arrows: Additional tech requirements (two different shades of red to make them less difficult to trace) Yellow shade: Spaceship (SS) parts

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:

Calendar

Currency

Drama

Civil Service

Philosophy

Metal Casting

Divine Right

Bookkeeping

Coinage

Statecraft

Republic

Alchemy

Crop Rotation

Divine Law

Patronage

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

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

- Theology (800):58 Apostolic Palace, Hagia Sophia, found Christianity if discoverer owns a Jewish or Zoroastrian city⁵⁹
- Machinery (800):⁶⁰ Watermill, Lumbermill, +50% chopping yield, 61 Crossbowman (with Iron or Copper) 62
- Alchemy (700):⁶³ Pacifism, +10% research from Monastery,⁶⁴ found Taoism if discoverer owns a Confucian city or if Confucianism not yet founded⁶⁵
- Crop Rotation (800):66 Serfdom67, can build Farm on Grassland without irrigation⁶⁸
- Divine Law (1000):⁶⁹ Theocracy,⁷⁰ Spiral Minaret, found Islam if discoverer owns a Christian, Jewish or Zoroastrian city⁵⁹
- Paper (1200):⁷¹ University of Sankore, Bureaucracy (with
- Guilds (1300):⁷³ Pikeman (with Iron), Maceman (with Machinery, Iron),74 Plantation (on Banana, Spice, Sugar)75, Workshop on all flat tiles⁷⁶
- Feudalism (800): Longbow (with Archery, Iron Working)⁷⁷ Knight⁷⁸ (with Machinery, Iron, Horse), Castle⁷⁹, Vassalage civic
- Patronage (1400):80 Sistine Chapel, build Culture, Cathedral
- Engineering (1500): Trebuchet, Windmill⁸¹, Notre Dame (with Theology), Taj Mahal (with Divine Law)82
- Compass (1400):⁸³ Map trading⁸⁴, Explorer, Grocer (with Guilds)85, Whaling Boats86
- Education (1500):⁸⁷ University, Oxford University (with University)
- Banking (1500):⁸⁸ Bank, Great Merchant if first to discover⁸⁹

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

BtS

Gunpowder

Economics

Nationalism

Military Science

Democracy+Communism

Chemistry

Artillery

Guns

Political Economy

Nation State

Ballistics

Equality

Rapid Fire

Blast Furnace

Military Studies

- Astronavigation (1900):⁹¹ Caravel (with Construction)⁹², Navigation II promotion⁹³, +1 sight on water⁹⁴
- Guns (2400):95 Musketman, Pinch promotion
- Political Economy (2100):96 Mercantilism, +1 production from Lumbermill⁹⁷, Customs House⁹⁸ (with Harbor), Versailles (Monarchy)⁹⁹
- Military Tradition (2400):¹⁰⁰ Cuirassier (with Guns, Horse), Kremlin¹⁰¹, Militarism¹⁰², Defensive Pact
- Scientific Method (2500):¹⁰³ can impart tech¹⁰⁴, +1 research per specialist¹⁰⁵, obs. Statue of Zeus, Angkor Wat¹⁰⁶ and Monastery
- Constitution (2700):¹⁰⁷ Jail, Federation (with Nation State)¹⁰⁸, Representation, obs. Monument, Stonehenge¹⁰⁹ and Mausoleum of Mausolos¹¹⁰
- Optics (2500):¹¹¹ Galleon, Privateer (with Guns and Copper or Iron)¹¹², trade across Ocean, Lookout promotion for naval units¹¹³, obs. Great Lighthouse¹¹⁴
- Blast Furnace (2700):¹¹⁵ Cannon (with Iron)¹¹⁶, Frigate (with Optics and Iron), Grenadier¹¹⁷, Barrage promotion¹¹⁸, obs.
- Liberalism (2500): Free Market, 120 Free Religion, obs. Castle 121, Oracle¹²² and Temple of Artemis¹²³
- Nation State (2600):124 Hermitage, Globe Theater (with Theater)¹²⁵, free Great Artist if first to discover¹²⁶
- Physics (2700):¹²⁷ Observatory¹²⁸, free Great Scientist if first to
- Steam Power (3400):¹²⁹ Levee¹³⁰, Workers build improvements faster¹³¹, Ironclad (with Iron and Coal)¹³², reveal Coal, Farms spread Irrigation¹³³
- Equality (3100):134 Emancipation, Police Headquarters, Security Bureau, 135 Statue of Liberty (with Harbor and must be in Emancipation and Free Religion)¹³⁶obs. Deer¹³⁷
- Military Studies (2900):¹³⁸ Ship of the Line (with Optics, Blast Furnace and Iron), Military Academy (with Barracks)¹³⁹ +1 movement on Roads¹⁴⁰ and along rivers¹⁴¹, Blitz promotion¹⁴
- Replaceable Parts (3300):¹⁴³ Drydock¹⁴⁴, +1 production from Windmill, Watermill and Workshop 145

- Railroad (3700):¹⁴⁶ Rail Track (with Coal or Oil), Public Transportation (with Oil)¹⁴⁷, can trade Crab¹⁴⁸, Mining Inc. Executive (with Corporation, University), obs. Walls¹⁴⁹
- Combustion (4100):¹⁵⁰ reveal Oil¹⁵¹, Oil Well, Airship (with Physics)¹⁵², Std. Ethanol Executive (with Corporation, University)¹⁵³, obs. Whale, Dye¹⁵⁴
- Biology (4700):155 +1 food from Farm, can build Farms without irrigation, Cereal Mills Executive (with Corporation, University)¹⁵⁶, obs. Temple of Kukulcan¹⁵
- Steel (4200):¹⁵⁸ Bunker¹⁵⁹, Steelworks (with Iron, Coal, Forge)¹⁶⁰, Cristo Redentor (with Theology)¹⁶¹, construct Ancient and Classical buildings faster¹⁶², Creative Constructions Executive¹⁶³ (with Corporation, University)
- Rifling (4000):¹⁶⁴ Rifleman, Cavalry (with Military Tradition,
- Corporation (4200):¹⁶⁵ Wall Street (with Bank), +1 trade route, State Property (with Equality)¹⁶⁶, can train Executives at Universities¹⁶⁷, obs. Great Wall¹⁶⁸
- Electricity (5000):¹⁶⁹ reveal Aluminum¹⁷⁰, Broadway (with Theater), +1 commerce from Watermill¹⁷¹, Coal Plant (with Coal)¹⁷², Hydroplant (with Steel), Three Gorges Dam (with
- Ecology (5100): Environmentalism¹⁷⁴, Treatment Plant¹⁷⁵, Preserve Forest, National Park, 176 obs. Ivory 177
- Medicine (4200): Hospital (with power), Red Cross (with Hospital), Fallout Shelter (with Steel, Manhattan Project)¹⁷⁸ Medic III promotion¹⁷⁹
- Rapid Fire (4800): Machine Gun,¹⁸⁰ Field Gun¹⁸¹, Interception I ¹⁸² and Ambush¹⁸³ promotions, Mount Rushmore¹⁸⁴
- Assembly Line (5200):¹⁸⁵ Factory (with Coal, Oil or power)¹⁸⁶ Infantry (with Rapid Fire)¹⁸⁷, Universal Suffrage (with Equality)¹⁸
- Radio (7800):189 Attack Submarine (Oil or Uranium)190, Rock'n'Roll (with Arena⁵⁵, power), Eiffel Tower (with Forge), reveal Uranium¹⁹¹; Air Recon can reveal Submarines¹⁹²
- Flight (7000):¹⁹³ Fighter (with Oil), Bomber (with Radio¹⁹⁴, Oil and Aluminum¹⁹⁵), Carrier (with Coal or Oil or Uranium), Paratrooper (with Silk or Plastics)¹⁹⁶
- Ballistics (5500):¹⁹⁷ Battleship (with Coal or Oil or Uranium) Destroyer (with Radio and Coal or Oil), 198 Tank (with Assembly Line, Railroad and Oil)199
- Industrialism (7200):²⁰⁰ Industrial Park (with Factory, power), Marine (with Rapid Fire)²⁰¹, Transport (with Coal or Oil)²⁰², Pentagon²⁰³, Aluminum Co. Executive (with University)²⁰⁴
- Totalitarianism (5500):²⁰⁵ Police State, Permanent Alliance, Intelligence Agency, free Great Spy if first to discover, ²⁰⁶ obs. Parthenon²⁰⁷

- Refrigeration (8000): Supermarket (with power), +1 food from Fishing Boats²⁰⁸, Sid's Sushi Executive (with Corporation, University)²⁰⁹
- Computers (8400):²¹⁰ 100% conversion rate from Processes²¹¹, SS Life Support (with Ecology)²¹²
- Mass Media (9000)²¹³: United Nations, Hollywood (with Broadcast Tower), Broadcast Tower (with power), Civ. Jewelers Executive (with Corporation, University)²¹⁴, obs. Apostolic
- Rocketry (8500):²¹⁵ SAM Infantry (with Radio²¹⁶), Anti-Tank²¹⁷, Guided Missile (with Electricity²¹⁸), Nuclear Submarine (with Uranium)¹⁹⁰, Missile Cruiser (with Computers and Oil or
- Plastics (8500):²²⁰ +1 trade route from Harbor²²¹, +3 happiness in all cities²²², Offshore Platform²²³, obs. Fur, Silk²²⁴
- Fission (9500):²²⁵ Manhattan Project (with Nuclear Plant), Tactical Nuke (with Rocketry, Uranium and Manhattan Project), ICBM (with Satellites²²⁶, Uranium and Manhattan Project), Nuclear Plant (with Uranium)
- Advanced Flight (11000):²²⁷ Gunship (with Oil); Jet Fighter (with Aluminum, Oil), Airport (with Oil)²²⁸, obs. Stable and Horse²²⁹
- Satellites (9000):²³⁰ Apollo Project (with Plastics)²³¹, reveal map, SDI (with Manhattan Project)²³²
- Laser (11000):²³³ Mobile SAM (with Rocketry, Oil), Howitzer²³⁴ (with Ballistics and Oil), Space Elevator (with Satellites)²³⁵
- Composites (11000):²³⁶ SS Casing, Mechanized Infantry (with Rapid Fire, Aluminum, Oil)²³⁷, Modern Armor (with Laser,
- Superconductors (12000): SS Thrusters, Particle Accelerator (with Computers, Fission and power)²³⁹
- Genetics (12000):²⁴⁰ SS Stasis Chamber (with Refrigeration)²⁴¹, +2 health, +1 food in Grassland tiles with at least 5 food²⁴²
- Robotics (10000): SS Docking Bay, +1 free Engineer from Industrial Park²⁴³
- Aluminum, Oil), Stealth Destroyer (with Oil or Uranium), Air Recon can reveal stealth ships²⁴⁵

Stealth (12000):²⁴⁴ Stealth Bomber (with Advanced Flight,

- Fiber Optics (12000):²⁴⁶ SS Cockpit, Internet²⁴⁷
- Future Tech (10000):²⁴⁸ + 1 health, +1 happiness
- Fusion (12000):²⁴⁹ SS Engine, free Great Engineer²⁵⁰ if first to

1 Dye seems to refer mostly to indigo, which was cultivated since 2500 BC. Considering that most Dye is blocked by Jungle initially, no additional tech should be required. Silk and frankincense are also preclassical trade commodities and come from simple tree plantations. For silk production, it's not enough to plant mulberry trees; the silkworms also need to be domesticated. Require Animal Husbandry for this. Without ritual uses, incense might not be valuable enough to plant incense trees, so Mysticism is required. To avoid introducing additional Plantation improvements, all early Plantations require Agriculture, and Mysticism and Animal Husbandry reveal Incense and Silk.

About the other three Plantations, see Guilds. All six at the same tech (as in BtS) gives civs near the equator too many resources at once and allows too much city growth in the early midgame. The additional happiness in the early game is welcome since Slavery can no longer be used to work around unhappiness. None of the three resources are very powerful, and civs need to stretch a little to get them (remove Jungle or Forest, settle near Jungle or Desert). 2 As in Alpha Centauri, but only for Recon, Melee, Archery and

Gunpowder units. Should make Fishing a bit more useful for civs that start with Fishing but not at a coast. 3 The BtS requirements for clearing Forest and Jungle suggest that metal tools were necessary, but slash-and-burn doesn't require sophisticated tools. Some tech should be required for slash-and-burn because all other Worker jobs have tech requirements too. Mining somewhat fits because it should comprise fire-setting, another fire-based technique. One could argue that equatorial rainforest is too dense and wet for slash-and-burn, but there is also no incentive to settle deep in the jungle

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

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

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

The terrain restriction should make Plains a bit more useful compared with Grassland. The early Workshops could represent brickyards, and Plains are clay-colored.

not nearly as effectively as Slavery.

8 Should perhaps rename this to "Penteconter" to make clear how it differs from Trireme. (Triremes are also galleys, just a special type.) 9 Polytheism (instead of Priesthood) as a requirement for Writing makes it easier to put Writing in the third column (where it belongs), and makes Polytheism more useful. In turn, Priesthood replaces Polytheism 54 as the requirement for Monotheism. This way, the great temples unlocked by Theology and Divine Law (a.k.a. Divine Right) automatically

10 Now a great wonder (see stat-changes-pdf). Replaces Temple of Artemis, which moves to Priesthood. The Moai depict deified (or at least venerated) ancestors, which is close enough to polytheism. As the wonder is (also) supposed to represent the colonization of small islands, Sailing has to be required in addition. 11 Adopted from Drama, which gets merged into Literature, as Polytheism

is indeed useful this early, or perhaps even too useful, in a way that discourages Temples. 12 This restriction ensures that Buddhism and Hinduism are founded close 57 This is a renamed Heroic Epic though with the 3D model of National to each other. Along with other changes (see Monotheism), the coupling

of these two religions should keep several civs without an early religion and thus make the later religions more useful. Could also give each of the two religions an increased chance of spreading in cities where the other religion is already present. (Same later for Taoism/ Confucianism and perhaps the Abrahamic religions too.) 13 Note that the abilities of the following wonders have (essentially) been

swapped in a circle: Pyramids \rightarrow Parthenon \rightarrow Statue of Zeus \rightarrow Oracle \rightarrow Pyramids 14 Moved from Polytheism because Temple of Artemis shouldn't become

available earlier than Temple. 15 Moved into the third column because the second column was too crowded. This means that Meditation can't lead to Priesthood. The new link to Monarchy represents Buddhist kingship. For example, in the early Mauryan and Tibetan Empires, priests didn't have a major role. Should perhaps be renamed to "Monasticism" to stress the dichotomic relationship with Priesthood.

16 The change to the ability of Organized Religion (see stat-changes.pdf) means that religions cannot be spread deliberately without Meditation, 60 Bronze Working and Construction replace the Metal Casting and this should make the tech valuable enough to be discovered eventually. If this takes a while – all the better; then the Medieval religions have an easier time catching up with the earlier religions. 17 Kilns for smelting copper ores arguably (always) developed from pottery kilns, hence the Pottery requirement. Whether this is good for

gameplay remains to be seen; it should make Mining a less powerful starting tech if nothing else. BtS requires Pottery for Metal Casting, which I'm replacing with Bronze Working and Coinage. 18 A.k.a. nerfed Slavery. Bronze Working isn't a plausible tech requirement for either civic, but I don't see a clearly better alternative, and the Ancient era should, when in doubt, remain as in BtS, so that the

mod starts out in a familiar fashion. Or perhaps move it to the new Bookkeeping tech that replaces Calendar? 19 A new tech replacing/ encompassing Calendar. The problem with Calendar is that Plantations and the Mausoleum don't have anything to do with calendars, and, apart from other techs, I don't see anything else 62 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). 20 Moved from Currency; see Coinage. 21 A.k.a. Chichen Itza. According to Wikipedia, "Kukulkan headed a

pantheon [...] used to promote the Itza [...] commercial agenda." So Bookkeeping, as a (mainly) commercial tech, somewhat fits. Since it's a temple, Priesthood should be required. 22 This doesn't have any tech requirement in BtS but isn't normally useful

without the Spy unit. The BtS developers probably wanted the slider on the main interface as early as possible in order to draw attention to their

23 Moved from Military Science (now Military Studies). I'm disabling this promotion for combat units (see "Commando" in stat-changes.pdf), so it's not terribly relevant anymore and might as well become available along with the Spy unit. Should probably not appear as an icon on the tech tree.

24 Tech trading with Alphabet would also be acceptable once tech trading is nerfed, but, ideally, tech exchange prior to Scientific Method (q.v.) should happen through automatic diffusion. Historically, alphabetic writing may have accelerated tech diffusion (though it was of course not a prerequisite).

25 Now a Classical-era tech. The other techs in the first Classical column were discovered around 1000 BC, and Judaism should be founded no

My best bet regarding the Masonry requirement in BtS is that it should prevent one civ from founding all the early religions; I'm addressing that problem differently (see the footnote about Judaism). The link from Monotheism to Monarchy (one god, one king?) has been replaced with a link to Code of Laws. Laws are central to rabbinic writings. The Monarchy tech is more about early imperialism than just kingship, and the Jewish kings weren't emperors, so it seems appropriate to let

Monotheism bypass Monarchy. 26 Viticulture is far older, but that's covered by the 1 commerce granted by

the bare Wine resource. Wine plays an important role in Judaism, and the Phoenician wine trade picked up around 1000 BC. 27 The Holy City restriction ensures that not all the early religions are founded by a single civ. Just as Buddhism and Hinduism are now coupled with each other (see Meditation), I'd like to make Judaism a prerequisite for founding Christianity and Islam (see Theology), but this

69 The "divine right" of kings was a 16th-century concept; not appropriate native requirement. Neither Judaism nor Zoroastrianism are proselytizing religions, so they should not be allowed to train Missionaries (or no Monasteries). This will leave more room for Christianity and Islam, the most widely practised religions at present.

is too narrow, so Zoroastrianism could be added to the game as an alter-Graphics for Zoroastrianism could be adopted from Realism Invictus, and it would be the favorite religion of the Persian AI leaders. 28 At the start of the game, Barracks are a waste of UI space and a trap for

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

inexperienced players. Barracks pretty much imply a professional army,

Barracks and Fort. These two also replace Winery, which moves to Monotheism. Perhaps rename Monarchy to "Empire". 29 Moved from Metal Casting (see Coinage). A forge is normally operated by a blacksmith who works wrought iron (not east iron).

"Early Empire" civic in Civ 6, and that's just the right place for

30 Polytheism as a requirement because all three wonders, except possibly the Mausoleum, should require Polytheism.

31 Previously at Calendar, which doesn't make any sense. The Mausoleum 72 Civil Service has been replaced by Statecraft, a Classical-era tech, but was most famed for the aesthetic value of its sculptures. The Mausoleum replaces the Parthenon, which moves to the new "Republic" tech.

32 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.

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 also fine. 33 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

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

("Math II"). The construction of long aqueducts required some math, including, arguably, algebra for the proper gradients. Moved elsewhere: Fort (Monarchy), increased chopping yield 34 Aqueducts can also run underground, and bridge aqueducts often

include some tunnels as well. Hence the Mining requirement. 35 Moved from Calendar. The size of the Earth was approximated through solar observation and trigonometry. 36 Moved from Metal Casting, which came too late and has been removed

(see Coinage); now assumed to be implied by Bronze Working. Triremes do require cast metal for the ram.

It's not clear that the construction of triremes required advanced math, but it was apparently an intricate ship design. Wikipedia says that "propulsion, weight and waterline, center of gravity and stability, strength [...] are [variables] dependent on one another."

37 This is Currency rethemed as a metallurgic tech to replace Metal Casting as a bridge to the Medieval era. Metal casting (lost-wax casting) is very much a pre-Classical innovation. A civilization that can make bronze also knows how to smelt and cast it. (Metal Casting could be placed between Mining and Bronze Working to represent copper smelting, enabling Copper and Spearman, but then the Forced Labor civic would look even more out of place at Bronze Working ...)

Bronze Working is required for the coinage metal: Early coins were 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 78 Moved from Guilds (the other requirements are as in BtS; Machinery

to Bookkeeping (the Calendar replacement) to give that tech something to do. The extra trade route should still make Coinage an important 38 Moved from Aesthetics. The spot there was needed for Angkor Wat. The real Shwedagon Pagoda was built no earlier than AD 500, but there is no plausible tech requirement to enforce this, and the ability wouldn't

work on a Medieval wonder. The donated gold (and diamonds) are what make the building special, and Coinage also has to do with gold. The Mon people that built the

pagoda also had coins. a great king (Monarchy) to enforce his law in a large domain seems more crucial to me. This also integrates Monarchy better into the tech

39 Requires Currency in BtS, which isn't unreasonable, but the authority of tree; it only leads to Feudalism in BtS. Monotheism moves in between

Priesthood and Code of Laws and thus replaces Priesthood as the alternative requirement. 40 I need room at Feudalism, and Code of Laws needs a replacement for Confucianism (now at Statecraft, a. k. a. Civil Service) and Chichen Itza (now "Temple of Kukulcan" at Bookkeeping). Client states have existed since the early Mesopotamian empires.

41 That's really National Epic, renamed. The BtS Heroic Epic becomes Triumphal Arch (see Republic).

42 Adopted from Drama, which gets replaced by Republic (q.v.). Drama is a form of literature. The culture slider (also at Drama in BtS) gets unlocked by Polytheism now.

43 Colosseum moves to Republic under the name "Arena" along with the Masonry requirement. War Elephant moves to Statecraft. 44 Catapults were typically torsion-powered, but developed from primitive

45 Moved from Compass and taking the spot of War Elephant, which

moves to Statecraft. The connection between compasses and harbors is

(tension-powered) crossbows.

time Construction is discovered. should be accompanied by a lighthouse.

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

46 Sailing needs to be required in some way, and a large (artificial) harbor 47 Adopted from Metal Casting, which is no longer a tech (see Coinage), taking the place of Colosseum, which moves to Republic. Some of the

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

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

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 imperial examinations, Statecraft is a shortcut to Education (avoiding the more costly Guilds and its prerequisites).

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

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

representing an "Eastern way" and the latter a "Western way". Both are

Elephant fits with the military aspect of Statecraft and elephants were most exploited in Southeast Asia. 50 The Forbidden City was built in AD 1420, but it may well take that long until a civ has enough Courthouses. No tech is required in BtS. This is a new promotion, introduced for the Protective trait. Guerilla

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

warfare was pioneered by Sun Tzu. 52 Previously at Code of Laws, a better fit at Statecraft. While not primarily a religion, Confucianism competed with Buddhism and was seen as incompatible with Christianity by the Catholic church, so the representation as a religion has merit. Good relations among Confucian rulers also make sense, and, while non-Confucians weren't regarded as heathens, a small relations penalty doesn't seem inappropriate. (The AI leaders that favor Confucianism have only moderate religion-based

relations modifiers.) The connection with Taoism mirrors that between Buddhism and Hinduism (see Meditation). Two independent religions aren't needed at this point of the game; perhaps Taoism should be removed entirely (see also Alchemy, the replacement for Philosophy).

53 Replacing Democracy (see Equality) and taking the spot of Drama, which has merged into Literature. Drama is kind of a dead end in BtS because all outgoing arrows are optional (to Music and Philosophy, both a bit contrived). It's also a light tech with just three abilities, one of which comes far too early (Globe Theater, now at Nation State), while other late Classical and early Medieval techs are a bit overloaded (Construction, Feudalism, Engineering) and would become even more crowded after the removal of Metal Casting. Therefore a new tech, one

The Republic tech also integrates Alphabet into the tech tree – the arrow to Currency in BtS is dubious. The idea is that a republic requires a certain literacy rate, and that alphabetic writing is easier to learn than 93 This promotion has no tech requirement in BtS. I'm increasing the base Aesthetics is a good fit for the Parthenon ability, which has now moved

for which it's easy to find abilities.

to Statue of Zeus, still at Aesthetics. Parthenon gets the ability of Pyramids instead, which fits very well at Republic. In BtS. Polytheism is the secondary requirement, but, as it's a temple, Priesthood should be 55 Although a Colosseum would fit very well under Republic, it's not a suitable name for a non-wonder building, and feels out of place for any civ that isn't Rome, and out of time after the Classical era. The

generic arena, Masonry should be enough may need another useful ability. Testing will have to show if the slider 56 The Republic tech allows Great Scientists to build Academies. Plato founded his Academy in 387 BC, so Academies shouldn't appear in the game long before that.

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

Epic (which shows a triumphal arch). Three powerful Marble wonders at Literature are too many, and the name "Triumphal Arch" makes it fit under Republic. See also stat-changes.pdf.

58 Requires Literature instead of Writing mostly because this allows Theology to be placed next to Divine Law (formerly Divine Right) in the tree and still have an incoming arrow. In BtS, Divine Right dangles

Philosophy as the mandatory requirement for Liberalism (Western medieval philosophy was largely theology), and the Hagia Sophia gets a more useful ability (see stat-changes.pdf) than in BtS. 59 To capture the connection between the Abrahamic religions. The connection with Zoroastrianism is thin, but Judaism alone would probably be too restrictive. (Or perhaps Hellenism – at Aesthetics? – would be the better choice for an 8th religion. Or Gnosticism, but that can't predate Christianity.) See Meditation, and Monotheism about changes that should hamper the early spread of religions and thus give

Theocracy moves to Divine Law, but Theology gets to replace

Christianity and Islam more room. requirement (see Coinage).

61 Lumbermill instead of Windmill (now at Engineering, q.v.). The earliest sawmills appeared during Late Roman times, but that was centuries later than watermills, and the sawmills were not used for sustainable forestry (whereas the Lumbermill improvement sustains the Forest feature). The most appropriate place for Lumbermill would be Economics (now Political Economy). Replaceable Parts as in BtS is a bit late, and Machinery too early. However, the chopping mechanism, even if restricted to buildings and ships as I intend, leads to unrealistically fast deforestation if there is no Medieval Lumbermill. Therefore, Lumbermill appears at Machinery, granting only 1

commerce, and Political Economy adds 1 production. The chopping yield bonus has moved from Mathematics (what does that have to do with lumber?) to Machinery, meaning that the maximal chopping yield and Lumbermill become available at the same time.

See stat-changes.pdf about the Copper requirement. Archery should be required for Guns (formerly Gunpowder) because there is a spring in a flintlock, and a bow is a primitive spring. However, Guns has two other extra requirements (Machinery and Guilds), and two should be the limit. So Machinery gets the Archery requirement – although a spring is not a machine – and Crossbowman doesn't have to require

63 Replacing Philosophy, which is a too generic name and couldn't lead to any Medieval tech. "Alchemy" is easier to integrate and closely connected to Taoism. Taoism, like all the major Chinese philosophies, had pacifist elements, so there is a remote connection between alchemy and pacifism too. Pacifism would fit better at Meditation or Statecraft, but Alchemy needs to do *something*.

The Angkor Wat had to move in any case (now at Aesthetics). The two requirements, Coinage and Iron Working, are both about metallurgy; Coinage could imply knowledge about gold extraction,

which relates to the philosopher's stone. 64 The research bonus should give both Monastery and Alchemy a power boost, and acknowledge the role of Christian monasteries in scholarship

and education.

65 Should perhaps be removed in favor of Zoroastrianism (see Monotheism). Taoism didn't really spread outside of China. That said, without Taoism, Pacifism would be difficult to justify at Alchemy, and if Alchemy were removed, it would leave a hole in the Medieval era. So long as Taoism is geographically tied to Confucianism, it shouldn't hurt the chances of Christianity and Islam much.

66 New tech that takes over Serfdom from Feudalism and the spreadirrigation ability from Civil Service (now Statecraft). Feudalism was getting too crowded and should really be a high Medieval tech (middle lumn). Since Metal Casting has been removed (see Coinage), Crop Rotation brings the tech count to 92, same as in BtS.

Crop rotation has been practised since prehistory, but this tech represents medieval crop rotation systems like the two-field, three-field, open-field or equal-field system (which justify the Code of Laws requirement) and possibly iron moldboard plows. Serfdom was introduced in the High Middle Ages as part of the

European feudal system along with vassalage, but manorialism, an early form of serfdom, emerged in the Late Roman Empire (which belongs to the Medieval era of Civ 4). 68 This ability, together with a 1-tile irrigation spread from Aqueduct, replaces "Farms spread irrigation"; see stat-changes.pdf.

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

connected to the Mandate of Heaven, which was an ancient concept anyway.) So Versailles moves to Political Economy (formerly Economics) and the link to Nationalism (now Nation State) gets The name "Divine Law" refers to the Islamic belief that the Quran is the literal word of Allah, and the sharia thus an immutable divine law. The link to Scientific Method could be justified through the analytical

reasoning employed in Islamic jurisprudence (fiqh), or more generally through the scientific advances in the Islamic Golden Age. 70 Divine Law needs this more than Theology does, and a caliphate is very much a theocracy 71 Requires Machinery now (instead of Theology or Civil Service),

meaning that we're talking about paper mills. It's the cheap manufacture of a writing material that was crucial for further developments Map trade has moved to Compass. It shouldn't really be much harder to join maps gathered by different civilizations than to join those gathered by one civilization, so it's difficult to argue which tech should be required from a historical point of view.

Bureaucracy should remain a Medieval-era civic, and Paper doesn't have much else to do. This also preserves the relationship between Paper and Civil Service (the former requires the latter in BtS).

73 This requires both Machinery and Feudalism in BtS; now it's either Crop Rotation (which replaces Feudalism as an early Medieval tech) or Republic (new tech, taking the spot of Drama). The Republic link allows a direct transition from ancient poleis to medieval towns, sidestepping Crop Rotation and Feudalism. The Currency (now

Coinage) requirement has moved up from Banking to Guilds. 74 Maceman has moved to Guilds from Civil Service (replaced by Statecraft) and Pikeman from Engineering. These were both rather bizarre tech requirements; the original developers probably just saw no better way to spread the Medieval units out. Knight is now enabled by

Guilds is an urban tech, so it gets units that were raised in cities. Pikeman is a pretty clear case; the pike was popular among mercenary guilds. I'm treating Maceman as heavy infantry, which also tended to be 109 These go obsolete with Astronomy in BtS, but it's doubtful that Stonemercenaries, as peasants were not afforded costly armor. The mace also came in use at about the same time as guilds (AD 900). The pike, admittedly, only became widely used around AD 1300. One could argue that it would've been used earlier if mounted lancers had also appeared earlier; or a Feudalism requirement could be added for Pikeman

For manufacturing their armor, Macemen require Machinery. Pikemen tended to be less heavily armored, though I guess still heavily enough to make bronze armor unaffordable (Iron required). All this is as in BtS. The heavier Maceman should then of course also require Iron (not Copper as in BtS); instead Crossbow can be trained with Copper now. 75 About Plantations on Incense, Dye and Silk, see Agriculture. Bananas spices (e.g. black pepper, cinnamon) and sugarcane had been cultivated

long before the Middle Ages, but the cultivated area grew dramatically during the Age of Discovery. Guilds were a part of the trade network that established colonial plantations and delivered the produce to European citizens. Early cultivation is represented by the natural yield bonuses of the three resources. As a high Medieval tech, Guilds comes a bit early for the East Indies trade. As a compromise, and because there isn't enough room at Guilds

for both Plantation and Grocer, Grocer moves to Compass. 76 In BtS, Guilds gives Workshop +1 production, but now Workshop yields 2 production from the beginning (see Pottery). So, instead of increasing the yield, Guilds only lifts the terrain restriction.

77 The English longbow came in use around AD 1000, so Longbowman can't be the first Medieval defender. That role is given to Crossbowman instead, and Longbowman becomes a larger, more flexible unit. Iron

Working is required for the arrowheads; see stat-changes.pdf for for manufacturing the armor). Guilds is now for units raised in cities, and Feudalism for units raised in the countryside: peasants (Longbowman) and nobles (Knight).

Horseback Riding is now required for Feudalism instead of Knight. Arguably, a figher elite on horseback was a prerequisite for feudal societies, and, this way, Knight, Cuirassier and Cavalry are less cluttered with requirements 79 Moved from Engineering. A late Medieval tech requirement gives Castle too little time to amortize before its obsoletion (Economics in

BtS, now Liberalism). Also, medieval castles had not advanced much technologically from ancient fortifications; the novel thing about castles was their role in the feudal system as the seats of power of feudal lords. No need for Masonry: Japanese castles were timbered. In order to make room for Castle and Knight, Serfdom moves to the new Crop Rotation tech and Vassal agreement to Code of Laws. 80 Music renamed. A more specific name like "Art Music" could explain

why it's a Medieval tech but still wouldn't match the abilities well. The new name refers to arts patronage, which bloomed in the Late Middle Ages. In many cases, e.g. the Sistine Chapel and many cathedrals, the Roman Catholic Church was the patron, which is the reason for the Theology requirement (and it helps integrate Theology into the tech tree). The Culture process – turning production into culture (rather than into gold through the Wealth process) – is also a decent representation of arts patronage. The free Great Artist moves to Nation State (formerly Nationalism), which now requires Patronage. Patronage requires Masonry because Masonry isn't required for

Construction anymore. I'm assuming Masonry to represent only stonemasonry, and most buildings in the game could be built with timber or bricks. But the large temples enabled by Patronage may necessitate the grandeur and durability of stone blocks. 81 Moved from Machinery because windmills didn't become widespread until the 13th century AD. Conversely, Pikeman and Castle have moved to earlier techs (Guilds, Feudalism).

a loose one at best. Creating a harbor (or enlarging a natural harbor) 82 Moved from Nationalism (now Nation State) because that tech requirement made no sense and to replace stuff that was moved away from Engineering, in particular the road movement ability (now at Military Studies).

> Divine Law (a. k. a. Divine Right) is required mostly in order to delay Taj Mahal; the real mausoleum was built in the 17th century. Plus, Divine Law can use a buff. Shah Jahan, who commissioned the Taj Mahal, was a Muslim. To be consistent, Notre Dame requires Theology

(and so does Cristo Redentor; see Steel). 83 Requires Alchemy now instead of Iron Working (but Alchemy requires plates on the Colossus of Rhodes were of cast metal; this is sufficiently Iron Working). Lodestones were of interest to alchemists. 84 One can't claim that a compass is necessary in order to exchange maps,

but the compass did improve the accuracy of maps (portolan charts) and

12th century. They did not use compasses, but Compass is the only naval

spurred naval exploration. And Compass needs the ability more than

Moved from Guilds, which didn't have enough room and comes a bit too early (grocers started appearing in the 14th century). Kind of replacing Harbor, which has moved to Construction. 86 Optics is too late for gameplay reasons: Whale has to go obsolete with Combustion, and Combustion is quite close to Optics (even more so after I've switched Optics and Astronomy, but also in BtS). Historically, earlier Whaling Boats can be justified through Basque whaling in the

Paper (which now has Bureaucracy).

87 Paper became widespread in Europe perhaps around AD 1200; the University of Oxford was established around AD 1100. So the Paper requirement in BtS doesn't work. The early European universities emerged from scholastic guilds, so this is the main path, and Statecraft (replacement for Civil Service) offers a shortcut, although Mathematics and Literature are required in any case as essential parts of the curriculum. Obviously, Education has to be a Medieval tech (not Renaissance as in BtS).

88 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. 89 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. 90 Too many important buildings go obsolete at Scientific Method in BtS. Obsoletion of the Great Library at Printing Press sounds at least as plausible as at Scientific Method.

91 Replacing Optics, which, in turn, replaces Astronomy. The name "Astronomy" has to go because Observatory plays better at Physics. "Astronavigation" does not imply an observatory, or at least not as strongly. The caravel was developed around AD 1450, whereas the telescope (→ Optics) was invented around AD 1600. The Jacob's staff came in use at around the same time as the caravel; the mariner's astrolabe followed around AD 1500. That said, none of these devices were crucial for Magellan's circumnavigation, nor for the discovery of America, so Astronavigation as the Caravel tech is a bit fantastical – but better than Optics.

Whaling Boats have been moved to Compass as Optics and Astronavigation are too close to Combustion.

92 An important innovation behind the caravel was its carvel planking; hence the Construction requirement. (Engineering would make Caravel too difficult to access for civs that start in isolation.)

speed of Galley and Trireme by one, and Navigation I and II on top of that would make these ships implausibly fast. 94 This might fit better at Optics, but I worry that it would take Caravels too long to discover other continents without the sight bonus. The normal sight range of ships is just 1.

95 New name for Gunpowder. The name "Guns" should make the link to

Blast Furnace (previously Chemistry) a bit more convincing, as in "the

furnace is for making larger guns, " and it's a bit awkward to have the same name for a tech and a combat class (Gunpowder units). The Education requirement in BtS is dubious; Education helps innovation overall through University but shouldn't lead to concrete inventions. Alchemy is a no-brainer. Guilds is additionally required because Musketman is getting a buff and mustn't be too easy to beeline to; gunsmiths were arguably organized in guilds. Machinery is also

required because it's no longer implied by Guilds. 96 This tech comes too early for Free Market ("The Wealth of Nations": 1776), and Mercantilism comes too early at Banking. Therefore push Free Market to Liberalism and turn Economics into the Mercantilism tech. Rename it to "Political Economy" because just "Economics" would be strongly associated with market economics, and in order to cover political philosophy as well. In mercantilism, economical policy

followed power-political aims. This change moves Mercantilism and Free Market closer together, but these two civics need to be properly balanced anyway, so this shouldn't be a concern. (In BtS, Free Market is usually preferable to Mercan-

tilism.) Castle still goes obsolete with Free Market (i.e. at Liberalism). This extends the lifespan of Castle a bit further. The free Great Merchant moves to Banking to fill the gap left by Mercantilism. To reduce deforestation, Lumbermill becomes available with

at Replaceable Parts. The proper time for Lumbermill should be around 1500, when forestry became widespread in some parts of the world. Political Economy is about right, and forestry also aligns with the mercantilist view of a state's land as a resource. 98 Changes to Customs House and Mercantilism make the two compatible; see stat-changes.pdf. (In BtS, Customs House has no effect under Mercantilism unless the owner of Customs House has vassals.)

Machinery but yields only 1 commerce initially. The extra production at

Political Economy gives Lumbermill the same yields that it gets in BtS

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

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

beeline to, however, the tech requirements of Guns (a. k. a.

Gunpowder) have become stricter.

These changes may seem to make Military Tradition quite a bit faster to

Cavalry still requires Military Tradition but is visually relocated to Rifling, the much tougher of the two requirements. 101 Moved from Communism (now called Equality), replacing West Point, which moves to Military Studies (new name for Military Science). The new Kremlin ability, faster Great General birth (see stat-changes. pdf), is unrelated to communism, and fits at Military Tradition. The Moscow Kremlin became a residence of tsars in the 16th century. 102 After a name change from "Nationhood" to "Militarism", Military 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 103 Now also represents early modern chemistry, whereas the Chemistry tech has become Blast Furnace. Early chemists like Boyle were among the pioneers of scientific method. Their writings were published in the middle of the 17th century, as were those of Descartes, Galilei and Bacon, so Scientific Method is clearly not an Industrial tech. In BtS, Astronomy is required, but that's unconvincing and not an option after

replacing Astronomy with Astronavigation and Optics (in the same column as Scientific Method). The new Alchemy tech (replacing Philosophy) is an obvious requirement, the others (Engineering, Printing Press) are as in BtS except that Divine Law (q.v.) can substitute for Engineering

104 The earliest example of a deliberate technology transfer between sovereign states that I'm aware of is the industrialization of Japan in the 19th century. There is no science-flavored tech that late in the game though, and Scientific Method needs a strong ability (doesn't do anything valuable in BtS). Scientific Method only allows tech to be imparted; for tech-for-tech trades, both sides need Scientific Method. Otherwise, beelining to Scientific Method might be too powerful. (Perhaps Scientific Method itself should be untradeable.) Tech trading still has to be nerfed, regardless of the required tech.

Prior to Scientific Method, tech exchange should happen automatically through a tech diffusion system based on tile culture. See also Alphabet 105 K-Mod introduced this ability at Scientific Method but eventually moved it to Computers. I think it is needed earlier because almost all tile improvements get substantial yield bonuses in the Renaissance or Industrial era, while Great Person points from specialists decrease in value, and, after National Epic (now called Heroic Epic), bonuses to specialists come only from civics. On the other hand, the specialist bonus from Representation should be reduced by 1 research. Another measure to make specialists more attractive in the late game: higher initial yields in exchange for fewer Great Person points; see the Specialists section in stat-changes.pdf.

106 Since the three wonders obsoleted by Scientific Method in BtS (Great Library, Parthenon and Temple of Artemis) all get a discount from Marble, it's not rare that a civ loses more than one wonder with Scientific Method, which is harsh. Now it's two wonders boosted by different resources. Statue of Zeus gets the ability from Parthenon; so no change there really. (Parthenon gets the ability from Pyramids and goes obsolete with Totalitarianism, a. k. a. Fascism.) Angkor Wat goes obsolete with Computers in BtS, which is strange, and now that Angkor Wat becomes available earlier (Aesthetics instead of Philosophy), it's OK to let it go obsolete earlier. The obsoletion of Temple of Artemis moves to Liberalism, and the Great Library to Printing Press.

107 This tech has to refer to constitutions enshrining rights of parliamentarians and the rule of law; otherwise, Constitution would have to be a much earlier tech and wouldn't enable Jail. The earliest examples appear to be Acts of the English parliament (Habeas Corpus, Bill of Rights) in the late 17th century. Constitution requires Nationalism in BtS, but it's hard to say if England was a nation state at that time. Requiring Nation State (new name for Nationalism) would also push Constitution into the third Renaissance column, which is mostly for discoveries at the onset of the Industrial Age (late 18th century). Nation State is instead an additional requirement for the Federation civic replacing Free Speech.

The Feudalism requirement accounts for the roots of renaissance constitutions in the Magna Carta (cited in the tech quote for Constitution) and, more generally, medieval constitutions determining the relations between king, nobility and clergy. The new rights for the (elected) parliament could be attributed to humanism (Republic required) and the increase in literacy brought about by the printing

108 This civic replaces Free Speech, previously enabled by Liberalism. Since this should be a late civic, it only refers to post-feudal federations, the earliest example of which might be the Treaty of Union forming the UK. Early federations are covered by the Vassalage civic. henge had an important astronomical function. Hereditary Rule now gives Monument +1 happiness (instead of the military happiness ability), and losing that happiness is painful unless the obsoletion tech provides some remedy – such as the Representation civic. One could imagine that a constitution restricts the king's ability to erect monu-

110 Most other ancient wonders go obsolete, so why not this one?

Prolonged Golden Ages in the late game can also lead to a lot of

military build-up, overcrowding the map. Could as well make e.g. Equality (replacement for Democracy) the obsoletion tech, but it's tidier to cluster obsoletions a bit. 111 Optics takes over the role of Astronomy; see Astronavigation. Engineering is required because all subsequent techs (Physics and Biology) should require it, and because Galleon should require it for its

architecture (naval engineering). All abilities of Optics really have to do 112 Early privateers (e.g. Francis Drake's Golden Hind) were galleons outfitted as warships. The Guns (a. k. a. Gunpowder) and metal requirements are for primitive man-killer cannons firing stone balls. Although the 3D animation shows cannon fire, Galleon is assumed to be lightly armed with whatever ranged weapons are available (no Guns

The move from Chemistry to an earlier tech should also give Privateer a longer window of opportunity. 113 See stat-changes.pdf about this. It's the Sentry promotion under a 114 Moved from Corporation for balance reasons: the two extra trade routes become too powerful with cross-ocean trade. Also, a lighthouse built

for trade along the shores of the Mediterranean Sea shouldn't boost

trade across the oceans. In turn, the obsoletion of Colossus moves to Blast Furnace (a. k. a. Chemistry), and Monument and Stonehenge to 115 New tech replacing Chemistry and, in a way, Metal Casting (see Coinage) as blast furnaces are used for smelting iron ore. Cannon needs to be at the same tech as Frigate, and that tech would be a poor representation of chemistry as a science. Instead, chemistry is now represented through Alchemy (replacing Philosophy), Scientific Method, Steam Power (physical chemistry) and Combustion

The production bonus to Workshop moves to Replaceable Parts (q.v.). 116 Moved from Steel. It's very strange to have such a long gap between Musketman and Cannon, when the two actually appeared in history at the same time. Guns (formerly Gunpowder) is still assumed to enable an early cannon firing gunstones that is only used by Privateer (see Optics). The Frigate and Cannon units at Blast Furnace fire iron balls;

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. 117 Early grenades were made out of cast iron, so Blast Furnace is an excellent fit for this unit. This moves Grenadier one column to the left, while Rifleman moves two to the right (see Rifling), meaning that

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

accordingly; see stat-changes.pdf.

118 Catapults and trebuchets aren't supposed to deal collateral damage anymore; see stat-changes.pdf. 119 Moved from Astronomy (now called Optics) to avoid making two naval wonders obsolete at once.

already been proposed in the 1850s. Theology is required in order to be consistent with Notre Dame requiring Theology (see Divine Law). 120 Liberalism takes over Free Market from Political Economy (q.v.; formerly just Economics) but loses Free Speech (see Constitution) and the

free tech. The free-tech ability isn't worth the distortions that it causes 162 This ability should make it more worthwhile to found cities past the 204 Moved from Rocketry, mostly, because that tech doesn't have room also (probably) overstates the importance of liberalism for the increase of power and wealth in the West (i.e. the Great Divergence). There are still many powerful rewards for early discoverers of techs in the Renaissance era or one of the adjoining columns: tech trading; a free Great Merchant, Artist and Scientist; gunpowder units; and Drafting. 121 The obsoletion of Castle has moved from Economics (now Political Economy) together with Free Market. It's not clear why an understanding of liberal economics (without adopting Free Market) should eliminate the economical benefits of castles, but at least it's a graceful obsoletion insofar as switching to Free Market makes up for the lost trade routes from Castles. Alternatively, one could tie the trade route bonus from Castle to certain civics and choose a different obsoletion tech

122 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. 123 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

124 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 require-

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

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

native to Military Tradition) alludes to theories that attribute the

a mercantile wonder.

emergence of nation states more to economical developments than to national sentiment. 125 Moved from Drama, which got merged into Literature. Makes sense for a tech called "Nation State" to enable more than one national wonder. 126 Moved from the Medieval tech Music (now called Patronage) and replacing the Taj Mahal (moved to Engineering). The free Great Artist

shape a nation (e.g. national poets). 127 Newton's laws, pivotal for modern physics and paraphrased in the tech quote (though that quote will have to move to the new Rapid Fire tech), were published in the 1680s, so Physics should be a pre-Industrial tech. Newtonian physics can't be lumped together with the discovery of Uranium (around 1900) though; this moves to Radio. Airship moves to Combustion (q.v.).

128 Moved from Astronomy, which was renamed to "Astronavigation" in

order to allow Observatory to move. The telescope (1608) very much

belongs at Optics, but the first large observatory (Greenwich) did not

should really appear in Renaissance, and famous compatriots help

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. 129 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

(BtS: obsolete with Steam Power).

19th century. This neatly includes the entire Age of Enlightenment in Renaissance, and, 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

river transportation on steamboats increased the need for river 131 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.

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

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

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. 133 This ability represents the large American aqueducts that stretch across hundreds of miles. Steam Power is needed for the pumping stations. 134 Replacing Democracy. The name "Equality" allows the tech to become an additional requirement for the State Property civic (main requirement: Corporation, q.v.), and then the rest of Communism can be merged with Fascism into "Totalitarianism". Regarding Emancipation at

Equality, the notion that "all men are created equal" (Thomas Jefferson,

1776) is, in my mind, the most important difference between the USA

(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. Universal Suffrage moves to Assembly Line (q.v.), with Equality as an additional requirement. Assembly Line can explain the production bonus better. The Statue of Liberty moves to Liberalism (q.v.), though Equality is indirectly required. Liberalism is, strangely, not required for

Democracy in BtS, but was a major influence on the revolutions in

France and America. 135 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 (e.g. Railroad); Equality has room and partly replaces Communism, so, in a way, the building stays where it was. A similar case can be made for Security Bureau at Equality. The FBI and MI5 were only founded in the early 20th century, but that's OK: after discovering Equality, it may still take a civ quite some time to get a Great Spy for building a Security Bureau.

late game. In Europe, and perhaps elsewhere, game populations shrunk once hunting stopped being a privilege of the nobility. 138 "Military science" is the more commonly used term, but would suggest that Scientific Method is required. Scientific Method is directly required for four other techs, which should be the maximum, and military science is (mostly) not science in a strict sense. Requires Education for the "studies" part (and in turn Statecraft, the Sun Tzu tech), and Blast Furnace (previously Chemistry) only for Ship of the Line. The other unit that requires cast iron, Grenadier, has moved

directly to Blast Furnace (q.v.). The Commando promotion has moved

something less US-centric (it gets pretty bad in the second half of the

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

139 This is West Point, moved from Military Tradition and renamed to

gameplay reasons (military production too fast in the late game).

136 The requirement to actually run liberal civics (rather than just knowing

137 Part of an effort to make resources less decisive for city growth in the

their prerequisite techs) is just for flavor.

to Alphabet (q.v.).

140 Moved from Engineering. A rather major change that should extend the mobility advantage of ships over land units. It's also a big boost for Military Studies (even though Railroad in the next column somewhat obsoletes the road bonus). The bonus is supposed to represent advances in logistics (e.g. supply depots) and operational warfare. 141 See Fishing. 142 Blitz is really only enabled for ships here because Armored units appear much later and get Blitz for free. To my knowledge, early modern ships didn't carry out any tactics resembling tank warfare; especially not

ships of the line. So the name of the promotion is problematic, but the ability is fine (see "Blitz" in stat-changes.pdf). If there was a Blitz promotion for ships with a different name, then which tech would enable Blitz for Armored units? 143 Replaceable Parts can be dated no earlier than 1800, but I'm still leaving it in the Renaissance era (along with Steam Power) so that Rifling can be in the first Industrial-era column. Also, the first machine tools were developed in the late 18th century. About the Banking requirement (same as in BtS), one could argue that loans are required for large-scale manufacturing, which benefits most from interchange-

able parts. Blast Furnace (replacing Chemistry) is required for cast iron parts. Engineering is required for Chemistry in BtS; this requirement moves one column down the tree to Replaceable Parts. 144 Moved from Steel in order to boost Ironclad and especially Ship of the Line, which has to cost more than Frigate but isn't a lot more useful. Drydocks have antecedents in the Chinese Song dynasty and were widely used in England since about 1600. I see no direct relation

between drydocks and replaceable parts, but the other techs in the same

column would fit even worse or do too much. 145 The bonus to Workshop has moved from Chemistry (now called Blast Furnace) and replaces Lumbermill, which is now enabled by Machinery and boosted by Political Economy. Blast Furnace does other things, and it's neater to have all the improvement bonuses at one tech. 146 Doesn't require Steel because railroads were already widely used (e.g.

the First Transcontinental Railroad in the US) prior to modern steelmaking. Machine Gun has moved to the new Rapid Fire tech (q.v.). 147 Moved from Combustion because Combustion no longer requires Railroad. The Oil requirement implies Combustion, so there is no real

148 Prior to Railroad only a local health bonus (or, easier to implement:

none) because crabs are difficult to conserve (more so than certain fish).

Transportation on rail made food from crustaceans available farther inland. Full availability should realistically require Refrigeration, but, that late in the game, +1 health might be insignificant. 149 Moved from Rifling. Firearms didn't make city walls completely obsolete, and the effect of firearms is already captured by the high bombard rate of Cannon (which I intend to increase further). The German Wikipedia cites a German author, Jürgen Osterhammel, stating that "if anything made walls obsolete, it was the railroad," and argues that city growth (urban sprawl?) caused walls to be abandoned. This line of reasoning makes it unnecessary to exempt the "defensive

150 Requires Railroad and, indirectly, Steel in BtS. Steel made sense for the ships (Destroyer, Transport) enabled by Combustion in BtS, but these move to Ballistics and Industrialism. Just for the engine, Steel shouldn't be required, just as it isn't required for Steam Power. Railroads don't seem to have had a strong impact on the development of internal combustion engines. One could argue that it was mostly the availability of coal in England that let external combustion engines (steam engines) mature earlier than internal ones, and that Combustion shouldn't even require Steam Power. This would add another outgoing

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

abilities" of Walls from obsoletion. Simpler is better, and that exception

is confusing because *all* abilities of Walls are defensive.

Public Transportation moves to Railroad, additionally requiring Oil, meaning that Combustion also remains required. 151 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. 152 Moved from Physics. Airships are dirigible, and for that they require an

internal combustion engine. Physics is still an additional requirement

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

century) is, I guess, implied by either Scientific Method or Combustion.

Electricity should perhaps also be required because of the aluminium

frame of zeppelins, but this might shorten the time during which Airship is useful for air attacks too much. Could instead let Aluminum provide a production discount; see also Fighter (Flight). 153 Moved from Plastics and taking the spot of Creative Constructions, which moves to Steel. Combustion is the most straightforward requirement for a fuel company. (Standard Ethanol isn't primarily about biofuel anymore; more like Standard Oil. See stat-changes.pdf.)

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

late game; no obsoletion in BtS. The production of indigo nowadays

often involves petrochemical cracking, but it seems that no petrochemistry was involved when the synthesis of indigo first became commercially viable around 1900. So the obsoletion doesn't quite fit at Combustion, but Industrialism would be a bit late and already has a lot of ability icons. 155 The Chemistry requirement is gone because Chemistry has been replaced by Blast Furnace, which doesn't work as a requirement for Biology. Early modern chemistry is instead represented by Scientific

Crop Rotation is required because the food bonus to Farms should, among other agricultural innovations, represent four-field crop rotation (although this technique was not developed by biologists). National Park moves to Ecology (q.v.). 156 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 Revo-

lution. Earlier access to Cereal Mills shouldn't be a game balance

problem; the numbers just need to be tweaked accordingly.

157 This obsoletion only makes sense because of the new agricultural

ability for the Temple of Kukulcan (called Chichen Itza in BtS). Cf. 158 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 beams and reinforced concrete.

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

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

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

and that the Bomb Shelter building is really a fallout and blast shelter against nuclear attacks (see Medicine). Bunkers and air raid shelters shouldn't require electrification. than with Rifleman. The stats and abilities of Grenadier need to change 160 "Ironworks" sounds like it should be at Blast Furnace. For a modern steel mill, "steelworks" is the more common term (or at least more specific). See stat-changes.pdf about the resource requirements. 161 Moved from Radio; I'm not seeing the connection. The statue is built in reinforced concrete. Steel is a bit early considering that the statue was finished in 1931; however, a similar statue on the same mountain had

in BtS (players always beelining to Liberalism and all techs near it). It midgame, especially on land discovered through Caravels. Improved construction methods seem like the best historical explanation. 163 Moved from Combustion; Combustion gets Standard Ethanol instead. As the modern construction tech, Steel is the most natural place for Creative Constructions.

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

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

and integrates Military Studies better into the tech tree. Historically, this

additional requirement represents advances in logistics more than in

205 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

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

206 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

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

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

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

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

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

208 Replacing the speed bonus for ships. A big speed boost came from

steam turbines, but I don't think refrigeration had any part in this.

how far each ship can move in one turn. (For the same reason, the

circumnavigation bonus should be replaced with some other perk.)

As for the new ability: The amount of food provided by Fishing Boats

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

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

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

developments in commercial fishing that BtS fails to capture. (This

the bonus could also represent trawling, fish farms and other

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

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

210 The nonsensical Plastics requirement was added by the BtS expansion,

Not much of a point in obsoletions this late in the game, and the

Medieval wonders University of Sankore and Spiral Minaret come so

late that they don't need to go obsolete at all. Angkor Wat has moved to

Aesthetics though, and most Classical-era wonders do go obsolete; that

211 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

212 Moved from Ecology, which is no longer a Modern tech. For consis-

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

3 Corporation requirement added (idea from Mongoose Mod). Mass-

And Mass Media might be a bit too easy to beeline to in BtS

215 Requires Ballistics (replacement for Artillery) instead of Flight or

subsonic aerodynamics relevant for constructing planes. Only

manufactured television sets should have some economic requirement.

214 Same as in BtS. Could be explained with advertisements, particularly "a

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

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

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

Combustion is required instead; rocket engines are normally internal

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

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

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

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

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

remain without a replacement for so long. Rocketry alone would be a

too early though. I'm adding a high air interception chance because

air defenses; Computers are needed for the ballistics computer. (In

no Battleships were commissioned after WW2, so Battleship should not

missile cruisers developed from anti-air cruisers and continued to have

particular, a tracking and guidance system such as Aegis would not be

1 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

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

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

223 Oil appears only on Ocean tiles, so this tile improvement should really

Hard to find a more plausible place for Offshore Platform though.

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

226 Requires Satellites instead of just Rocketry because Satellites is the

227 The Satellites requirement (supposedly for satellite guidance) moves

down the tree to Stealth; instead require Rocketry for the advanced

engines (turbojet, turboshaft) and Radio for radar homing (air-to-

surface and air-to-air missiles) and safe air traffic control (radio

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

229 This should really happen at Rocketry because Cavalry upgrades to

imagine. The commercial use of planes was also too small prior to jets

Tank and Anti-Tank now instead of Gunship (see stat-changes.pdf),

meaning that Cavalry is normally obsoleted by Rocketry (which now

or Horse at Rocketry, and both should go obsolete together in order to

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

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

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

Robotics. Rocketry should not include spaceflight because this

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

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

232 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

for SDI, which moves directly to Satellites. Neither the Avenger

233 Removed the Satellites requirement. Plastics is a reasonable

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

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

requirement for synthetic crystals, but Satellites should only be required

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

shell. Laser rangefinders are electronic devices, hence the Computers

requirement. At least Mobile SAM should also require a ballistics

234 New name for the Mobile Artillery; see "Field Gun" at the new "Rapid

5 Moved from Robotics, and taking the spot of SDI, which moves to

Fire" tech about the name change. The 3D model shows a self-propelled

Satellites. Perhaps the climber component could be a robot, but I doubt

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

236 Removed the Satellites requirement. Probably a remnant from when Jet

Fighter and Stealth Bomber were at Composites (prior to the BtS

237 Moved from Robotics because I don't see any connection between

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

Mechanized Infantry and Robotics. The 3D model shows an M113;

composite material but an aluminium alloy. Some infantry rifles from

the 60s have fiberglass stocks (e.g. M14, M16), and the Humvee has

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

Armor and Mechanized Infantry at the same tech. Hard to find a

different place for either unit though. The additional requirement of

without composite armor (just steel). It's also not ideal to have Modern

these first entered service in 1960. The armor is not made from a

employ laser for rangefinders, and the M109 can also fire a laser-guided

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

The Apollo Project is inconceivable without computers

missile staying within the Earth's atmosphere.

added the Laser requirement.

computer to be able to hit jet aircraft.

nanomaterials for the cable

expansion).

growth.

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

computers at the Baikonur Cosmodrome when Sputnik 1 was launched.

225 Requires Radio for the radioactivity (only Electricity in BtS).

be about deep-sea drilling. Synthetic materials are probably used for

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

this, e.g. for tubes and pontoons, but I doubt that they're really needed.

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

convenient to assume that Rocketry covers this because Rocketry is

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

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

218 An electro motor is required for inertial guidance (gyroscope).

techs to beeline to when aiming at a Space victory.

considering that it unlocks a victory condition.

diamond is forever" by De Beers.

combustion engines.

required for nukes anyway.

possible without electronic computers.)

Ethanol to Combustion

spaceflight tech now.

tidy up the UI.

navigation, landing guidance).

to justify an extra trade route from Airport.

Rocketry.

captured by whatever health problems civs experience in the game; civs 216 MANPADS only became effective in the 60s through infrared homing.

change is inspired by the Civ 4 Reimagined mod.)

company than healthy diets.

presumably for balance reasons.

now happens at Scientific Method.

Rushmore to the new Rapid Fire tech.

arguably become too powerful that way.

fits much better under the label "Totalitarianism".

is otherwise replaced by Equality). Totalitarianism requires Equality for

latter makes more sense because rifles didn't supplant muskets until about 1850 (Minié rifle). This interpretation also gives Musketman more time to shine. Consequently, Rifling becomes an Industrial-era The Military Studies (formerly Military Science) requirement should make it harder to beeline from Guns (formerly Gunpowder) to Rifling,

165 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.) 6 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. 167 That is, no HQ is required. This change lowers the initial investment for spreading a corporation, allowing corporation yields to be reduced substantially, which should improve the pace of the late game. See also

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

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

obsoletion of the Great Lighthouse moves to Optics.

equipment like light bulbs, resistors and switches.

for all power plants in any case.

169 Requires Replaceable Parts for mass-manufacturing electrical

170 Moved from Industrialism. Electricity makes more sense because electrolysis (Hall-Héroult process, 1886) is needed in order to process bauxite ores into aluminium. Now that Bomber requires Aluminium, Industrialism is also a bit late (same column as Flight). 171 See stat-changes.pdf about the Watermill commerce and the Theater requirement for Broadway. No commerce bonus to Windmill. 1 food, 1 commerce, 1 production (from Replaceable Parts) is good enough

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. 172 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 are some buildings, e.g. Broadcast Tower and Hospital, that also require power but don't require Assembly Line. Electricity should be required

173 Both moved from Plastics because hydroplants were the earliest power

plants, in use long before the discovery of synthetic polymers. Steel is

required for the reinforced concrete. The power plants take the place of

Bunker and Bomb Shelter (now called Fallout Shelter), which move to Steel and Medicine. I'm drawing the line between Renaissance and Industrial era in the early 4 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

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

175 New name for Recycling Center; see stat-changes.pdf. 176 Forest Preserve has moved from Scientific Method and National Park from Biology. These techs have enough other things to do, and Ecology is the most natural fit for environmental preservation. Perhaps the BtS developers felt that Ecology came too late, but that isn't an issue Ecology is still required for SS Life Support, but Computers (q.v.) is

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

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

177 Moved from Industrialism because that tech looked too crowded in BtS, and because synthetic substitutes have not diminished the monetary 178 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 220 Hydroplant and Three Gorges Dam move to Electricity and Standard bunkers and air raid shelters, and Bomb Shelter is renamed.

Steel is required for blast doors; if not in civil defense shelters, then in

military units). Medicine could be needed for understanding the impact

shelters for military equipment (the building also reduces damage to

of radiation on the human body, and the tech has room.

Gun at Railroad even seems completely nonsensical.

Warlords. Quick free healing shouldn't be available in the early game, and the first couple of Great Generals shouldn't always be used for "super medics". See also stat-changes.pdf. Plus, the Medicine tech needs a buff. 180 Merging Democracy, Communism and Fascism into just two techs (Equality and Totalitarianism) opens up room for a new tech. It's a military tech because there are so many military units in the Industrial era, and several of them with unrealistic tech requirements; Machine

The "Rapid Fire" tech represents advances in firearms from the late

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

19th century, especially smokeless powder and mechanisms for absorb-

179 This has no tech requirement in BtS but is only available for Great

(Newton's laws of motion) and Steel because all the firearms in question 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. 181 New name for the Artillery unit to allow me to move it to Rapid Fire. Several WW2 units move to the Artillery tech, and the Artillery unit should come earlier than these units. The Canon de 75, regarded as the

first modern artillery piece, was a quick-firing field gun with a hydropneumatic recoil mechanism, so Rapid Fire is a suitable requirement. (Machine guns and field guns developed alongside each other, differing in caliber and fire rate.) The name "Ballistics" for the Artillery tech should make clear why Field Gun comes earlier: field guns were not designed for indirect fire. Accordingly, Mobile Artillery gets named "Howitzer" 182 No tech required in BtS. Apart from Air units, Gunpowder units can get this promotion in BtS, and I'm also allowing it for Siege and Naval

units (see stat-changes.pdf). Not plausible to hit aircraft with slowfiring guns. And I don't want the promotion to show up on the UI long before it is needed. 183 No tech requirement in BtS. Don't want this to show up on the UI long before Armored units become available. Military Studies could be an alternative, but comes a bit too early. 184 Moved from Fascism (now called Totalitarianism). The developers may

have seen the memorial as a response to fascism, but that can be

The synthesis of nitroglycerine (1847) was important for both the development of smokeless powder for firearms, and dynamite, which was used extensively in the construction of the Mount Rushmore 185 Coal Plant moves to Electricity and Pentagon to Industrialism. 186 See stat-changes.pdf about these requirements for Factory. 187 The 3D model, apparently, shows a WW2 US soldier with an M1 rifle (in service since 1936). This kind of unit comes a bit too early in BtS: the Rapid Fire requirement delays it. The Infantry unit would otherwise also replace Rifleman too soon now that Rifling is an Industrial-era

Rapid Fire is also historically sound. 188 Equality replaces Democracy. Assembly Line becomes an additional requirement because this makes it easier to explain the production bonus for Towns: an increase of female participation in the industrial workforce tended to precede female suffrage. 189 Cristo Redentor moves to Steel (q.v.) and Bomber to Flight with Radio as an additional requirement instead of vice versa.

tech. The M1 is a semi-automatic (gas-operated) rifle, so requiring

An Industrial-era tech because submarines were already deployed in WW1, and the Eiffel Tower was completed in 1889. 190 Attack Submarine and Nuclear Submarine (previously just called "Submarine") have switched places. Attack Submarine was introduced in BtS as a counter against the vanilla Submarine unit, probably representing early Cold War hunter-killer designs. This role is too narrow. Instead, Attack Submarine becomes the ordinary submarine unit for the World Wars, and Nuclear Submarine a more expensive unit representing the cruise missile and ballistic missile subs of the Cold War. As for requring Radio (as in BtS): Electricity is more crucial (motor, gyroscope, sonar), but that tech comes a bit too early and doesn't have room. Radio can be justified for wolf pack tactics.

191 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

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 aircraft will dive and change its position if it isn't promptly engaged.) Too easy in BtS to spot Submarines with air units. 193 Requires Rapid Fire for the machine guns mounted on Fighter. No Carrier without Fighter, and Paratrooper also carries an automatic rifle. The Rapid Fire tech covers nitroglycerine and other high explosives, so

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

1930s. This yields a pretty even distribution of techs. Flight could really

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

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

could be unfair to civs without Uranium. That said, Uranium only be-

192 Radio is also required for all naval units that detect Submarines. This

comes crucial once and if the Manhattan Project is built.

go either way: The 3D models appear to show planes introduced in the 194 Still requires Radio (for search radar) and Flight, but since both are in the same column now, Flight as the more obvious requirement becomes the main requirement. (Radio is also pretty crowded.) 195 By the 1930s, when bombers became potent, practically all military

aircraft had aluminium in their airframes. One could argue that

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

fuselages but also included aluminium components. However, a civ without Fighter would be without any adequate air defense; this might be too punishing. (One could grant Fighter a production discount from 196 Moved from Fascism (now called Totalitarianism). Fascist Italy and Germany were early adopters of airborne infantry, but parachuting is hardly a matter of ideology. Early parachutes were made of silk, later

197 New name for the Artillery tech; see Field Gun (new name for the

Artillery unit) at Rapid Fire about the name change. One could also

look at Rapid Fire as "Artillery I" and Ballistics as "Artillery II". One

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

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.). 198 Destroyer is at Combustion in BtS and Battleship at Industrialism. The former is too early, leaving too little time for Ironclad, and the latter rather too late, skipping the Dreadnought era. Radio is required for

spotting Submarines. I don't see a problem with Destroyer coming later

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

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

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 199 Moved from Industrialism as that would be a bit much on top of Ballistics; the manufacturing process is covered by requiring Assembly

continuous tracks, a crucial innovation that was inspired by railroads. (An early patent was named "endless railway.") 200 Look at this tech as the last stage of the Second Industrial Revolution combining assembly lines with electrification and steelmaking. Steel (not required in BtS) should perhaps already be required for Assembly Line – but certainly for Industrialism. One could also argue for Combustion as a requirement (petrochemistry, chemical industry), but it would be one requirement too many, and is required for Plastics in the

Line instead of Industrialism. Railroad is needed for the vehicle's

next column anyway (also in BtS). Tank and Battleship have moved to Ballistics (q.v.; formerly Artillery). Aluminum is revealed by Electricity instead of Industrialism. Ivory goes obsolete with Ecology instead of Industrialism. 201 Requires the new Rapid Fire tech instead of just Rifling. The 3D model 249 Requires Superconductors instead of Fiber Optics because appears to show an AK-47. 202 Moved from Combustion. This change should help Ironclad and Ship of

Uranium is no longer an alternative requirement; nuclear reactors in troop transports wouldn't be economical. Same for Destroyer (at

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

Transport at the same tech.

military-industrial complex

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. Certainly no Aluminum resource should be required for a heavy tank 9 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

Genetics tech covers recent advances like genetic engineering, gene therapy and the Human Genome Project, then computers are needed for DNA sequence assembly. 241 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.

240 Replacing the Superconductors requirement with Computers because I

see no connection between genetics and superconductors. If the

the 50s and 60s did not hinge on computers.

242 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

243 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. 244 Requires Satellites instead of Advanced Flight; the latter shouldn't be required for Stealth Destroyer. The B-2 shown in the Stealth Bomber 3D model can drop satellite-guided bombs, and there are probably other ways too in which these high-tech units use satellite navigation. Don't want Satellites to be a dead end (no longer leads to Laser), and geolocation through satellites should have *some* military benefit in the game. (BtS requires Satellites already for Advanced Flight.)

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). 246 No obsoletion of Kremlin; pointless this late. 247 Moved from Computers in order to make Fiber Optics more attractive. Had already been at Fiber Optics prior to the BtS expansion. 248 Requires Fiber Optics instead of Stealth because Fiber Optics would otherwise be a dead end (no longer required for Fusion), and because

5 As with Submarines (see Radio), the Recon mission should only reveal

fiber optics (with its uses in computer networks) seems more likely than stealth technology to lead to future innovations that increase people's happiness and health. fusion energy, though the magnets probably don't have to be

Superconductors would otherwise be a dead end (no longer required for Genetics). Also, magnetic confinement is the main approach toward the Line (which can't take down Transports). The 3D model shows a WW2 landing craft. These aren't oceangoing, but the unit could repre-250 That Engineer is fairly useless in BtS as there are few if any worthwhile sent the contemporary Liberty and Victory ships, which according to wonders this late in the game. Can now also be used on SS parts (see Great Engineer in stat-changes.pdf).

203 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

Wikipedia, "came to symbolize U.S. wartime industrial output," meaning that Industrialism is a good match. It's also nice to have Marine and