

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

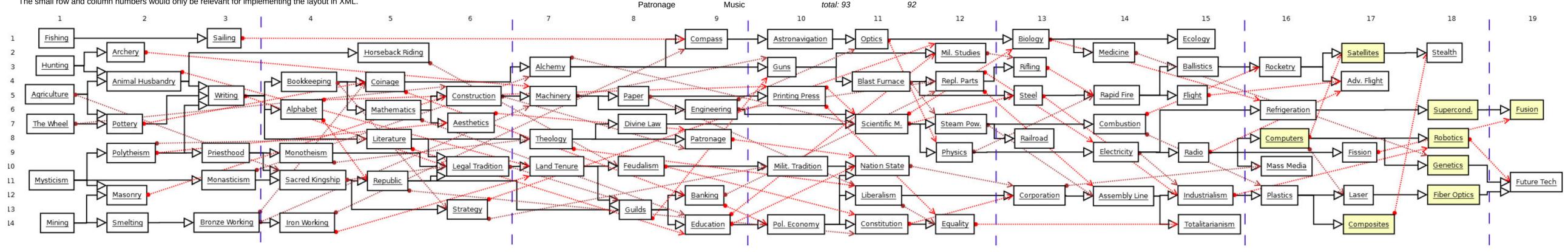
Blue text: Different from BtS. Mere name or research cost changes not highlighted. When a tech name is blue, then almost everything about it is different from BtS.

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.)

The small row and column numbers would only be relevant for implementing the layout in XML



- Fishing (60): can work Coast, Work Boat, faster movement along rivers<sup>1</sup>
- Hunting (60):<sup>2</sup> Scout, Camp
- Agriculture (60): Farm, Tree Plantation<sup>3</sup>
- Wheel (60): Road, Chariot (with Horse)
- Mysticism (60): Monument, Stonehenge, reveal Incense<sup>3</sup>
- Mining (60): Mine, can clear Forest and Jungle for no yield<sup>4</sup>
- Archery (60): Archer, Great Wall (req. Walls)<sup>5</sup>
- Animal Husbandry (100): Pasture, reveal Horse and Silk<sup>3</sup> Stable (with Horse or Ivory)<sup>6</sup>
- Pottery (90): Granary (with Agriculture)<sup>7</sup>, Cottage
- Polytheism (70):8 Temple9, found Hinduism if discoverer has met the founder of Buddhism or if Buddhism not yet founded<sup>10</sup>
- Masonry (60):<sup>5</sup> Quarry, Walls, Pyramids<sup>11</sup>
- Smelting (70):12 reveal Copper13, Spearman (with Hunting, Copper or Iron)<sup>14</sup>, Workshop<sup>15</sup>
- Sailing (120):<sup>16</sup> Galley<sup>17</sup>, Lighthouse, trade along unowned Coast, Moai Statues (with Masonry)
- Writing (160): Library, Open Borders
- Priesthood (80): Temple of Artemis, Oracle,<sup>18</sup> Culture slider<sup>19</sup>
- Monasticism (90):<sup>20</sup> Monastery<sup>21</sup>, found Buddhism if discoverer knows the founder of Hinduism or if Hinduism not yet founded<sup>10</sup> • Legal Tradition (400):<sup>58</sup> Courthouse, Caste System, found
- Bronze Working (80):<sup>22</sup> Axeman (with Copper or Iron), 20 yield from chopping Forest, Trireme (with Sailing)

- Bookkeeping (160):<sup>23</sup> Market, gold trading,<sup>24</sup> Temple of Kukulcan (with Agriculture)<sup>25</sup>
- Alphabet (200): Spy, Espionage slider<sup>26</sup>, Commando promotion<sup>27</sup>, build Research, increases tech diffusion<sup>28</sup>
- Monotheism (150):<sup>29</sup> Organized Religion, Winery<sup>30</sup>, found Judaism unless<sup>31</sup> discoverer owns a Holy City
- Sacred Kingship (160):32 Forced Labor33, Barracks34, Dynastic Rule (with Writing)<sup>35</sup>
- Iron Working (190): Swordsman (with Iron), reveal Iron, Forge<sup>36</sup>
- Horseback Riding (230):<sup>6</sup> Horse Archer (with Archery, Horse)
- Coinage (320):<sup>37</sup> +1 trade route, build Wealth, Shwedagon Paya<sup>38</sup> (with Monasticism)
- Mathematics (240):<sup>39</sup> Aqueduct (with Mining<sup>40</sup>), Hanging Gardens (with Aqueduct), Great Lighthouse<sup>41</sup> (with Lighthouse), • centers the map<sup>42</sup>
- Literature (350):<sup>43</sup> Heroic Epic (with Library)<sup>44</sup>, Great Library (with Library, Mathematics<sup>45</sup>), Theater<sup>46</sup>
- Republic (360):<sup>47</sup> Parthenon<sup>48</sup>, Arena (with Masonry)<sup>49</sup>, Academy<sup>50</sup>, Triumphal Arch (with Construction)<sup>51</sup>
- Construction (400): Catapult (with Archery<sup>52</sup>), Bridge building, Harbor<sup>53</sup> (Sailing), Colossus (with Harbor, Iron Working)<sup>54</sup>
- Aesthetics (280):<sup>43 55</sup> Mausoleum of Mausolos<sup>56</sup>, Statue of Zeus, Patronage (1300):<sup>95</sup> Sistine Chapel, build Culture, Cathedral Angkor Wat (with Priesthood)<sup>57</sup>
- Confucianism if discoverer owns a Taoist city or if Taoism not vet founded<sup>59</sup>, Vassal agreement<sup>60</sup>
- Strategy (300):<sup>61</sup> War Elephant<sup>62</sup> (with Horseback Riding, Ivory), Guerrilla promotion<sup>63</sup>, free Great General if first to discover<sup>64</sup>,

 Alchemy (700):<sup>66</sup> Pacifism, +10% research from Monastery<sup>67</sup> found Taoism if discoverer owns a Confucian city or if Confucianism not yet founded<sup>59</sup>

Correspondence between techs:

Metal Casting

Monarchy

Calendar

Currency

Drama

Philosophy

Civil Service

Divine Right

**Smelting** 

Coinage

Strategy

Republic

Alchemy

Land Tenure

Divine Law

Sacred Kingship

Bookkeeping

- Machinery (800):<sup>68</sup> Watermill, Lumbermill, +50% chopping yield,<sup>69</sup> Crossbowman (with Iron or Copper)<sup>70</sup>
- Theology (800):<sup>71</sup> Apostolic Palace, Hagia Sophia (with Construction<sup>72</sup>), found Christianity (in a Jewish city if one
- Land Tenure (800):<sup>74</sup> Serfdom<sup>75</sup>, can build Farm on Grassland without irrigation<sup>76</sup>
- Paper (1200):<sup>77</sup> University of Sankore, Bureaucracy (with Legal Tradition)<sup>78</sup>, Forbidden Palace<sup>79</sup> (with Courthouses)
- Divine Law (1000):80 Theocracy81, Spiral Minaret, found Islam (in a Jewish or Christian city if one exists)<sup>73</sup>
- Feudalism (800): Longbow (with Archery)<sup>82</sup>, Knight (with Machinery, Iron, Horse)83, Castle84, Vassalage civic
- Guilds (1100):85 Maceman (with Machinery, Iron)86, Field Plantation<sup>87</sup>, Workshop +1 production<sup>88</sup>
- Guilds)<sup>91</sup>, Whaling Boats<sup>92</sup>

• Compass (1400):89 Map trading90, Explorer, Grocer (with

- Engineering (1500): Windmill<sup>93</sup>, Trebuchet, Notre Dame (with Theology), Taj Mahal (with Divine Law)94
- Banking (1500): Bank, Pikeman<sup>86</sup>, Great Merchant if first to
- Education (1400):<sup>97</sup> University, Oxford University (with University)

- Astronavigation (1900):98 Caravel (with Machinery)99, Navigation II promotion<sup>100</sup>, +1 sight on water<sup>101</sup>
- Guns (2400):102 Musketman, Pinch promotion
- Printing Press (2000): +1 commerce from Village and Town, obs. Great Library<sup>103</sup>

**BtS** 

Astronomy

Gunpowder

**Economics** 

Nationalism

Democracy+Communism

Fascism+Communism

Chemistry Military Science

Artillery

Astronavigation

Political Economy

Nation State

**Ballistics** 

Equality

Rapid Fire

Blast Furnace

Totalitarianism

Military Studies

- Military Tradition (2400):<sup>104</sup> Cuirassier (with Guns, Horse), Kremlin<sup>105</sup>, Militarism<sup>106</sup>, Defensive Pact<sup>107</sup>
- Political Economy (2100):<sup>108</sup> Mercantilism, +1 production from Lumbermill<sup>109</sup>, Customs House<sup>110</sup> (with Harbor), Versailles<sup>111</sup>
- Optics (2500):<sup>112</sup> Galleon, Privateer (with Guns and Copper or Iron)<sup>113</sup>, trade across Ocean, Lookout promotion for naval units<sup>114</sup>, obs. Great Lighthouse<sup>115</sup>
- Blast Furnace (2700):116 Cannon (with Iron)117, Frigate (with Optics and Iron), Grenadier<sup>118</sup>, Barrage promotion<sup>119</sup>, obs.
- Scientific Method (2500):<sup>121</sup> can impart tech<sup>122</sup>, +1 research per specialist<sup>123</sup>, obs. Statue of Zeus, Angkor Wat<sup>124</sup> and Monastery
- Nation State (2600):125 Hermitage, Globe Theater (with Theater)<sup>126</sup>, free Great Artist if first to discover<sup>127</sup>, Cities don't demand protection<sup>128</sup>
- Liberalism (2500): Free Market, <sup>129</sup> Free Religion, obs. Castle <sup>130</sup> Oracle<sup>131</sup> and Temple of Artemis<sup>132</sup>
- Constitution (2700):<sup>133</sup> Jail, Federation (with Nation State)<sup>134</sup> Representation, obs. Monument, Stonehenge<sup>135</sup> and Mausoleum of Mausolos<sup>136</sup>
- Military Studies (2900):<sup>137</sup> Ship of the Line (with Optics, Blast Furnace and Iron), Military Academy (with Barracks)<sup>138</sup>, +1 movement on Roads<sup>139</sup> and along rivers<sup>140</sup>, Blitz promotion<sup>14</sup>
- Replaceable Parts (3300):<sup>142</sup> Drydock<sup>143</sup>, +1 production from Windmill, Watermill and Workshop<sup>14</sup>
- Steam Power (3400):<sup>145</sup> Levee<sup>146</sup>, Ironclad (with Iron and Coal)<sup>147</sup>, reveal Coal, Farms and (flat) Cities spread Irrigation<sup>148</sup>
- Physics (2700):<sup>149</sup> Observatory<sup>150</sup>, free Great Scientist if first to discover
- Equality (3100):<sup>151</sup> Emancipation, Police Headquarters, Security Bureau, 152 Statue of Liberty (with Harbor, and must be in Emancipation and Free Religion)<sup>153</sup>, obs. Deer<sup>154</sup>

- Biology (4700):<sup>155</sup> +1 food from Farm, can build Farms without irrigation, Cereal Mills Executive (with Corporation, University)<sup>156</sup>, obs. Temple of Kukulcan<sup>157</sup>
- Rifling (4000):158 Rifleman, Cavalry (with Military Tradition,
- Steel (4200):<sup>159</sup> Bunker<sup>160</sup>, Steelworks (with Iron, Coal, Forge)<sup>161</sup>, Cristo Redentor (with Theology)<sup>162</sup>, construct Ancient and Classical buildings faster<sup>163</sup>, Creative Constructions Executive<sup>164</sup> (with Corporation, University)
- Railroad (3700):165 Rail (with Coal or Oil), Public Transportation (with Oil)<sup>166</sup>, can trade Crab<sup>167</sup>, Mining Inc. Executive (with Corporation, University), obs. Walls<sup>168</sup>
- Corporation (4200):<sup>169</sup> Wall Street (with Bank), +1 trade route, State Property (with Equality)<sup>170</sup>, can train Executives at Universities<sup>171</sup>, obs. Great Wall<sup>172</sup>
- Medicine (4200): Hospital (with power), Red Cross (with Hospital), Fallout Shelter (with Steel, Manhattan Project)<sup>173</sup>,
- Rapid Fire (4800): Machine Gun,<sup>175</sup> Field Gun<sup>176</sup>, Interception I <sup>77</sup> and Ambush<sup>178</sup> promotions, Mount Rushmore<sup>179</sup>
- Combustion (4100):<sup>180</sup> reveal Oil<sup>181</sup>, Oil Well, Airship (with Physics)<sup>182</sup>, Std. Ethanol Executive (with Corporation, University)<sup>183</sup>, obs. Whale, Dye<sup>184</sup>
- Electricity (5000):<sup>185</sup> reveal Aluminum<sup>186</sup>, Broadway (with Theater), +1 commerce from Watermill<sup>187</sup>, Coal Plant (with Coal)<sup>188</sup>, Hydroplant (with Steel), Three Gorges Dam (with
- Assembly Line (5200):190 Factory (with Coal, Oil or power)191 Infantry (with Rapid Fire)<sup>192</sup>, Universal Suffrage (with Equality)<sup>193</sup>
- Ecology (5100): Environmentalism<sup>194</sup>, Treatment Plant<sup>195</sup>, Preserve Forest, National Park. 196 obs. Ivorv197
- Ballistics (5500):198 Battleship (with Coal or Oil or Uranium), Destroyer (with Radio and Coal or Oil), <sup>199</sup> Tank (with Assembly Line, Railroad and Oil)200
- Flight (7000):<sup>201</sup> Fighter (with Oil), Bomber (with Radio<sup>202</sup>, Oil and Aluminum<sup>203</sup>), Carrier (with Coal or Oil or Uranium), Paratrooper (with Silk or Plastics)<sup>204</sup>
- Radio (7800):<sup>205</sup> Attack Submarine (Oil or Uranium)<sup>206</sup>, Rock'n'Roll (with Arena<sup>49</sup>, power), Eiffel Tower (with Forge), reveal Uranium<sup>207</sup>. Air Recon can reveal Submarines<sup>208</sup>
- Industrialism (7200):<sup>209</sup> Industrial Park (with Factory, power), Marine (with Rapid Fire)<sup>210</sup>, Transport (with Coal or Oil)<sup>211</sup>, Pentagon<sup>212</sup>, Aluminum Co. Executive (with University)<sup>213</sup>
- Totalitarianism (5500):<sup>214</sup> Police State, Permanent Alliance, Intelligence Agency, free Great Spy if first to discover<sup>215</sup>, obs. Parthenon<sup>216</sup>

- Rocketry (8500):<sup>217</sup> SAM Infantry (with Radio<sup>218</sup>), Anti-Tank<sup>219</sup> Guided Missile (with Electricity<sup>220</sup>), Nuclear Submarine (with Uranium)<sup>219</sup>, Missile Cruiser (with Computers and Oil or Uranium)<sup>221</sup>
- Refrigeration (8000): Supermarket (with power), +1 food from Fishing Boats<sup>222</sup>, Sid's Sushi Executive (with Corporation, University)<sup>223</sup>
- Computers (8400):<sup>224</sup> 100% conversion rate from Processes<sup>225</sup>, SS Life Support (with Ecology)<sup>226</sup>
- Mass Media (9000)<sup>227</sup>: United Nations, Hollywood (with Broadcast Tower), Broadcast Tower (with power), Jubilant Jewelers Executive (with Corporation, University)<sup>228</sup>, obs. Apostolic Palace
- Plastics (8500):<sup>229</sup> +1 trade route from Harbor<sup>230</sup>, +3 happiness in all cities<sup>231</sup>, Offshore Platform<sup>232</sup>, obs. Fur, Silk<sup>233</sup>
- Satellites (9000):<sup>234</sup> Apollo Project (with Plastics)<sup>235</sup>, reveal map<sup>236</sup>, SDI (with Manhattan Project)<sup>237</sup>
- Advanced Flight (11000):<sup>238</sup> Gunship (with Oil); Jet Fighter (with Aluminum, Oil), Airport (with Oil)<sup>239</sup>, obs. Stable and Horse<sup>240</sup>
- Fission (9500):<sup>241</sup> Manhattan Project (with Nuclear Plant), Tactical Nuke (with Rocketry, Uranium and Manhattan Project), ICBM (with Satellites<sup>242</sup>, Uranium and Manhattan Project), Nuclear Plant (with Uranium)
- Laser (11000):<sup>243</sup> Mobile SAM (with Rocketry, Oil), Howitzer<sup>244</sup> (with Ballistics and Oil), Space Elevator (with Satellites)<sup>245</sup>

Composites (11000):<sup>246</sup> SS Casing, Mechanized Infantry (with

- Rapid Fire, Aluminum, Oil)247, Modern Armor (with Laser, Ballistics, Oil)<sup>248</sup> Stealth (12000):<sup>249</sup> Stealth Bomber (with Advanced Flight,
- Aluminum, Oil), Stealth Destroyer (with Oil or Uranium), Air Recon can reveal stealth ships<sup>25</sup> • Superconductors (12000): SS Thrusters, Particle Accelerator
- Robotics (10000): SS Docking Bay, +1 free Engineer from Industrial Park<sup>252</sup>
- Genetics (12000):<sup>253</sup> SS Stasis Chamber (with Refrigeration)<sup>254</sup>, +2 health, +1 food in Grassland tiles with at least 5 food<sup>255</sup>
- Fiber Optics (12000):<sup>256</sup> SS Cockpit, Internet<sup>257</sup>

(with Fission and power)<sup>251</sup>

- Fusion (12000):<sup>258</sup> SS Engine, free Great Engineer<sup>259</sup> if first to
- Future Tech (10000):<sup>260</sup> +1 health, +1 happiness

1 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. 2 The game's representation of prehistorical exploration is so squarely ahistorical that I think it's best to leave to alone the Hunting tech alone. This also goes for Spearman requiring Hunting – although Smelting is now the primary requirement. 3 Enabling all six plantation resources at the same tech (Calendar in BtS) gives civs near the equator too many resources at once and allows too

much city growth in the early midgame. I'm pushing those resources that are grown in fields back to Guilds (q.v.). Silk, frankincense and spices such as black pepper, long pepper and cinnamon (not: chili, saffron) come from tree plantations and were pre-classical trade commodities. For silk production, it's not enough to plant mulberry trees; the silkworms also need to be domesticated. Require Animal Husbandry for 49

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 Tree Plantations require Agriculture, and Mysticism and Animal Husbandry reveal Incense and Silk. For Spice, the map generator may have to be adjusted so that it appears mostly on Jungle, which also seems more realistic. This way, none of the plantation resources are very powerful, and civs need to stretch a

4 The BtS requirements for clearing Forest and Jungle suggest that metal 51 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. For a chopping yield, Bronze Working is still required, as metal tools are indeed very helpful for making lumber.

little to get them (remove Jungle or Forest, settle near Jungle or Desert).

The BtS designers may have had the expansion of Vedic tribes into the Gangetic plain – then presumably densely forested – in mind, which coincided with the advent of iron metalurgy. However, I find it more plausible to attribute this development to soil conditions and iron plows than to iron axes and the natural vegetation. 5 Masonry is still required for the prerequisite Walls. Moving the Great Wall to Archery makes Masonry look less cluttered and gives players another reason to discover Archery. Barbarian activity increases

gradually in AdvCiv, so an additional tech requirement shouldn't hurt Historically, one could argue that a large wall with flanking towers needs to be manned by archers to be fully effective. That said, other ranged weapons could also do the job, so this explanation is a bit contrived.

6 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. 7 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. 8 Polytheism (instead of Priesthood) as a requirement for Writing makes it easier to put Writing in the third column (where it belongs), and makes Polytheism more useful. In turn, Priesthood replaces Polytheism as the requirement for Monotheism. This way, the great temples unlocked by Theology and Divine Law (a.k.a. Divine Right) automatically 57 Moved from Philosophy, which is now named Alchemy, replacing

9 Switched with the Temple of Artemis, which moves to Priesthood. With Meditation moved to the third column (as Monasticism), the Buddhist Temple would otherwise be too difficult to access.

10 This restriction ensures that Buddhism and Hinduism are founded somewhat close 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

11 The Great Wall moves to Archery (q.v.), but still requires Masonry indirectly. Note that the abilities of the following wonders are (essentially) getting swapped in a circle: Pyramids  $\rightarrow$  Parthenon  $\rightarrow$ Statue of Zeus  $\rightarrow$  Oracle  $\rightarrow$  Pyramids

12 Replacing Metal Casting. Forge fits much better at Iron Working, and, while metal casting is a sensible requirement for certain tools employed in a workshop, such tools would arguably be cast using the lost-wax technique, which, in the Fertile Crescent, was already known before the Bronze Age. So, as a Bronze Age technology representing clay molds, there isn't anything for Metal Casting to do except Trireme (naval ram) and Colossus (bronze plates). About Colossus, see Construction. Trireme should play well – and fits well enough – at Bronze Working, but that tech already does too much in BtS (which is probably why the BtS expansion moved Trireme from Sailing + Bronze Working to Metal Casting + Sailing). Therefore, a tech replacing Metal Casting should be

59 While not primarily a religion, Confucianism competed with Buddhism able to take over some items from Bronze Working. Copper smelting is one possibility (admittedly anachronistic as the Copper Age began before 4000 BC in several regions of the world).

13 To make Copper Mines less powerful for pre-bronze warfare, the yields

can be changed by -1 production, +2 commerce. This also captures the uses of copper (and its alloys) in works of art and as a currency. 14 This makes the weaker city attacker of the two Copper units, Axeman and Spearman, available earlier. (Problem however: it'll hurt Chariot.) 15 Granting +1 production, +1 commerce because +1 production, -1 food is very rarely worth building. (+2 production, on the other hand, would make hills too unimportant for city placement too early.) Early

Workshops should help players deal with excess food and thus cushion

16 Moved into the third column in order to make room for Smelting. 17 Should perhaps rename this to "Penteconter" to make clear how it differs from Trireme. (Triremes are also galleys, just a special type.)

changes to the Slavery civic.

18 This tech will have to represent a higher level of cultic organization than just priests and temples – because, without those basic elements, there isn't much that Polytheism could do. Both the temple at Delphi and the one at Ephesos were sanctuaries (temenoi) and had high priestesses. 19 Adopted from Drama, which gets merged into Literature, as Priesthood

needs a non-wonder ability. Could represent tithing. Testing will have to show if the slider is indeed useful this early, or perhaps even too useful, in a way that discourages Temples. 20 Moved into the third column because the second column was too

crowded (already before the addition of Smelting). This means that Meditation can't lead to Priesthood. The new link to Sacred Kingship (a.k.a. Monarchy) represents Buddhist kingship. For example, in the early Mauryan and Tibetan Empires, priests didn't have a major role. Renamed to "Monasticism" to make this connection sound less far-21 The change to the ability of Organized Religion (see stat-changes.pdf)

means that religions cannot be spread deliberately without Meditation, and this should make the tech valuable enough to be discovered eventually. If this takes a while – all the better; then the Medieval religions have an easier time catching up with the earlier religions.

22 See also Smelting about Trireme, Copper and Spearman. As important as bronze was historically, the Bronze Working tech was too overpowered in BtS; moving the powerful reveal-Copper ability should help. Another move (and maybe this is going too far in nerfing Bronze Working): Forced Labor (a.k.a. nerfed Slavery) at Sacred Kingship (a.k.a. Monarchy). It's a big stretch to connect that civic somehow with Bronze Working, and I think it'll also play better at a Classical tech. Trireme would also fit better in that era, but becomes much more useful when it's available earlier.

23 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 and maybe Chichen Itza, I don't see anything else in the game that would require calendars. "Bookkeeping" is a very broad concept that could include commercial records, star catalogs and basic math, e.g. multiplication tables (leading

to Mathematics). 24 Moved from Currency; see Coinage. 25 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. The pyramid also has a particular alignment informed by the Maya calendar A Priesthood requirement could be justified, or also Sacred Kingship (other Maya step pyramids served as tombs for great rulers), but, since the wonder is gaining a new, agricultural ability, Agriculture takes the 26 This doesn't have any tech requirement in BtS but isn't normally useful

without the Spy unit. The BtS developers probably wanted the slider on the main interface as early as possible in order to draw attention to their new expansion 27 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 71 along with the Spy unit. Should probably not appear as an icon on the tech tree. 28 Tech trading with Alphabet would also be acceptable if tech trading can be nerfed, but, ideally, tech exchange prior to Scientific Method (q.v.)

should happen through automatic diffusion. Historically, alphabetic writing may have accelerated tech diffusion. 29 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; the Priesthood requirement will serve that purpose just as well (see also the footnote

about Judaism). The link from Monotheism to Monarchy (one god, one king?) has been replaced with a link to Legal Tradition (replacement for Code of Laws). The Halakha constitutes an early legal tradition. 30 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. 31 The Holy City restriction ensures that not all the early religions are

founded by a single civ. kingship because that form of government is far older. A sacred king

32 New name for Monarchy. This tech can't just represent hereditary serves as a mediator between the gods (or some particular tutelary deity) and his people. This type of kingship already existed in the Old

Kingdom of Egypt, but at least the new name explains why Priesthood is a prerequisite. "Empire" would be an alternative name (that can mean many things). 33 A.k.a. nerfed Slavery, moved from Bronze Working, which isn't a plausible tech requirement for either name. Corvee labor imposed as a tax is a type of forced labor. Such an intrusive tax arguably required a

ruler with expansive authority, so I feel that it somewhat fits at Sacred Kingship, and an early Classical tech should work best gameplay-wise. 34 At the start of the game, Barracks are mostly a trap for inexperienced players. Barracks pretty much imply a professional army, and these didn't really exist prior to the Neo-Assyrian Empire. Sacred Kingship therefore fits reasonably well – although it might play better at a

slightly earlier tech. Replaces Winery, which moves to Monotheism. 35 New name for the Hereditary Rule civic. Dynasties imply a degree of stability that early hereditary monarchies did not possess (e.g. the

Akkadian empire collapsed after one dynasty lasting 180 years). I don't like that Sacred Kingship now enables two powerful civics. The Writing requirement for Dynastic Rule should make it more difficult to beeline to those civics. Still, it might be better to introduce a separate tech "Empire" (replacing either Smelting or Strategy) for Dynastic Rule. Sacred Kingship could then perhaps revive the name "Code of

36 Moved from Metal Casting (see Smelting). A forge is normally operated by a blacksmith who works wrought iron (not cast iron). Replacing the clear-Jungle ability, which moves to Mining (q.v.). 37 New name for Currency, so that the Gold trading ability can be moved That tech needs something to do while Currency was doing too much The extra trade route and Wealth process alone should still make Currency an important tech. The new name also makes clearer why a

to Bookkeeping (the Calendar replacement). Market also moves there. metallurgic tech is required: A proper currency has to be based on some metal, copper being the easiest candidate, but arguably not valuable enough. Hence the Bronze Working requirement. One may argue that the Currency tech itself comprises e.g. cupellation (refinement of silver ores) or salt cementation (parting of gold from electrum), but those

fairly advanced processes couldn't have been developed without prior 82 The English longbow came in use around AD 1000, so Longbowman metallurgic knowledge. The Pottery requirement has moved from Metal Casting (replaced by Smelting) – to ensure that Pottery becomes required at some point of the Classical era.

38 Moved from Aesthetics; the spot there is needed more by Angkor Wat. The pagoda was built no earlier than AD 500, but the ability wouldn't work at that point of the game, so I think it's best not to worry much

about the date and rather look at the wonder as a representation of the diverse philosophical traditions in early Buddhism. the Mon people that built the pagoda also had coins.

For what it's worth, the donated gold somewhat fits with Coinage, and 39 Mathematics has switched places with Calendar, which was then replaced by Bookkeeping. Bookkeeping could represent ancient (e.g. Babylonian) advances in arithmetics and geometry ("Math I"), and then

Mathematics would be about Greek logics, algebra and trigonometry ("Math II"). The construction of long aqueducts required some math, including, arguably, algebra for the proper gradients. Moved elsewhere: Fort (Strategy), increased chopping yield (Machinery).

40 Aqueducts can also run underground, and bridge aqueducts often include some tunnels as well. Hence the Mining requirement. 41 The construction such an extraordinarily high building probably

large, advanced harbor, so it might make the most sense to require Construction (now the Harbor tech); however, Construction already

involved some non-trivial geometry or algebra. Alexandria also had a enables Colossus and does rather too much in general, and such a late requirement would be too big a balance change. 42 Moved from Calendar. The size of the Earth was approximated through solar observation and trigonometry.

43 Sort of switched the position of Literature and Aesthetics. Greek aesthetics had a mathematical basis and the famous treatises (Polykleitos, Plato) were written no earlier than the 5<sup>th</sup> century BC. The archetypal heroic epic, the Odyssey, was written a couple of centuries earlier (and also attained its importance in Hellenism earlier).

44 That's really National Epic, renamed. The BtS Heroic Epic becomes Triumphal Arch (see Republic). 45 An extra requirement so that this powerful wonder doesn't become and central to the scholarship of the Musaeum.

available too early. Mathematics was an important part of the collection 46 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. 47 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

Construction is a bit overloaded and gets even more crowded after the

removal of Metal Casting. Therefore a new tech, one for which it's easy 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

logographic writing.

48 Aesthetics is a good fit for the Parthenon ability, which has now moved to Statue of Zeus, still at Aesthetics. Parthenon gets the ability of Pyramids instead, which fits very well at Republic. In BtS. Polytheism is an additional requirement, but, since the Parthenon didn't really function as a temple, this seems dispensable. (However, Polytheism is required for Aesthetics now.) Likewise, the harmonic ratios applied to the architecture of the Parthenon aren't a strong enough reason for requiring Aesthetics in addition to Republic – that would delay the 88 As in BtS, but, as now Workshop grants 1 commerce from the wonder too much.

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 Colosseum, with its arcades, would require Construction, but, for a generic arena, Masonry should be enough. 50 The Republic tech allows Great Scientists to build Academies. Plato

one hoop too many to jump through.) This is a renamed Heroic Epic – though with the 3D model of National Epic (which shows a triumphal arch). Three powerful Marble wonders at Literature are too many, and the name "Triumphal Arch" makes it fit

game long before that. (Requiring Mathematics in addition would be

52 Catapults were typically torsion-powered, but developed from primitive (tension-powered) crossbows. 53 Moved from Compass and taking the spot of Colosseum, which takes the name "Arena" and moves to Republic. The connection between compasses and harbors is a loose one at best. Creating a harbor (or enlarging a natural harbor) through a breakwater or dredging is a

construction challenge. Changes to Harbor (flat trade route yield bonus, Merchant slot; see stat-changes.pdf) should make it a somewhat useful building by the time that Construction is discovered.

54 Adopted from Metal Casting, which is no longer a tech (see Smelting), taking the place of War Elephant, which moves to Strategy. A 15 m high statue is a great construction effort. Now that Harbor is available earlier, the Colossus can require that building. I'm also adding a Harbor requirement to the Statue of Liberty (at Liberalism). The bronze plates are, in part, covered by the production discount from Copper, but some metallurgic tech still needs to be required for the casting of the bronze plates and for the supporting iron beams inside the statue. Requiring Forge (in addition to Harbor) seems excessive, hence the Iron Working

55 Polytheism as a requirement because all three wonders, except possibly the Mausoleum, should require Polytheism. Also because Polytheism should be required at some point in the game, and connecting beauty with divinity is typical for classical aesthetics.

56 Previously at Calendar, which doesn't make any sense. The Mausoleum was most famed for the aesthetic value of its sculptures, which are influenced by theoretical works about body proportions. The Mausoleum replaces the Parthenon, which is needed more at the new Republic tech.

Shwedagon Paya (now at Coinage). Both wonders are – like many great mandirs and pagodas – influenced by the vastu shastra, which ought to qualify as an aesthetic system. In the case of the pagoda, that influence seems pretty flimsy though, and, more importantly, Shwedagon Paya wouldn't play well at the new, later position of Aesthetics in the tech tree. Angkor Wat needs to fill the vacated spot, wouldn't fit well under Alchemy and can use a buff (easier access). The actual construction date is in the 12th century AD; both Aesthetics and Philosophy appear much earlier in the game than that. It seems that this can't be helped. Imagining that Angkor Wat represents some earlier mandir, e.g. Pattadakal (7<sup>th</sup> century), may help a bit.

It's important that the wonders unlocked by Aesthetics use different resources, so that the discoverer can likely benefit from at least one production discount. These three resources are Marble, Ivory and Gold in BtS, and now Marble, Ivory and Stone, which is also fine.

58 Renamed from Code of Laws because that name – along with the tech quote – is too closely associated with the earliest written law codices. The main (mandatory) requirement is new: Sacred Kingship (a.k.a. Monarchy) – to capture the need for political stability and central authority. This change integrates Sacred Kingship better into the tech tree; in BtS, Monarchy only leads to Feudalism. As for alternative requirements, the Priesthood requirement is replaced by Monotheism (rabbinic laws) and Currency by Literature (ancient philosophical writings, e.g. the Dharmasastras). Republic as a third alternative (Greco-Roman legal tradition). Hopefully, these alternatives make Legal Tradition more difficult to beeline to than Code of Laws in BtS – but not too much more difficult.

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 is even close than the one between Buddhism and Hinduism (see Polytheism). The requirement can easily prevent either Confucianism or (more likely) Taoism from being founded at all. Two independent religions aren't needed at this point of the game, so this is fine with me (see also Alchemy, the replacement for Philosophy).

60 I need room at Feudalism, and Legal Tradition needs a replacement for Chichen Itza (now "Temple of Kukulcan" at Bookkeeping). Client states have existed since the early Mesopotamian empires.

61 New tech, mainly intended as a home for War Elephant, but also to make up for the transformation of the "eastern" tech Civil Service into a more universal one (Land Tenure, q.v.) and as a counterbalance to the "western" Republic tech (replacing Drama). "Strategy" is supposed to refer to a systematic approach to military strategy. There are already two techs with "Military" in the name (M. Tradition, M. Science - now M. Studies), and I don't want to add a third one.

62 The saddle (howdah) may have been a significant mechanical development, but that's not really what Construction is about. I'm keeping the Horseback Riding requirement so that players can't beeline to War Elephant too easily.

63 This is a new promotion, introduced for the Protective trait. Guerrilla warfare was pioneered by Sun Tzu. 64 Great General is the one Great Person that cannot be born through tech

discovery in BtS. That's OK, but it fits well at Strategy and the tech would otherwise be too unattractive, even for players with Ivory. 65 Moved from Mathematics, which is a pretty nonsensical requirement. 66 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 might fit better at Strategy, but Alchemy needs to do something. (Early currents of pacifism in India have at least some representation through the Shwedagon Paya; see Coinage.) The Angkor Wat moves to Aesthetics (q.v.). Alchemy and aesthetics Alchemy relates closely to metallurgy; the Coinage requirement covers

67 The research bonus should give both Monastery and Alchemy a power 68 Bronze Working and Construction replace the Metal Casting

requirement (see Smelting). 69 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 mainly used for sawing stone and not for sustainable forestry (whereas the Lumbermill mprovement 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.

70 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

Requires Literature instead of Writing. The Bible should be considered literature, and 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 in the air. Theocracy moves to Divine Law, but Theology gets to replace

Philosophy as the mandatory requirement for Liberalism (Western medieval philosophy was largely theology), and the Hagia Sophia gets a more useful ability (see stat-changes.pdf) than in BtS. 72 For the dome – which is a very important part of the Hagia Sophia. 73 Just one idea how to capture the connection between the Abrahamic religions. Might be too unattractive (will often give the holy city to a

foreign civ and only missionaries to the first discoverer). See Monasticism, and Monotheism about changes that should hamper the early spread of religions and thus give Christianity and Islam more 74 Replacing Civil Service. Maceman (now at Guilds) and irrigation

spread don't fit well at Civil Service, and it's hard to find Medieval replacements, especially because Paper (new home of Bureaucracy) fishes in the same pond. too many abilities, and to push Feudalism into the middle column of the

Medieval era – it was a High-Medieval development.

Apart from manorialism and e.g. sharecropping, Land Tenure represents various agrarian advances and adjustments in the early Middle Ages, in particular moldboard plows and other iron tools; hence the Iron

Working and Animal Husbandry requirements. 75 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). 76 This ability, together with a 1-tile irrigation spread from Aqueduct, replaces "Farms spread irrigation"; see stat-changes.pdf. 77 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.

78 Moved from Civil Service, which has has been replaced by Land 79 No tech is required in BtS, which makes this national wonder easy to overlook or forget about.

80 The divine right of kings was a 16th-century concept; not appropriate for the tech that founds Islam. The broader idea of kingship with divine legitimacy is now covered by the Sacred Kingship tech (replacing Monarchy). That's too early for Versailles of course; that wonder moves to Political Economy (formerly Economics) and the link to Nationalism (now Nation State) gets removed.

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 abetted by

religious schools. 81 Divine Law needs this more than Theology does, and a caliphate is very

can't be the first Medieval defender. That role is given to Crossbowman instead, and Longbowman becomes a larger, more flexible unit.

83 Moved from Guilds (the other requirements are as in BtS; Machinery for manufacturing the armor). Guilds and Banking are 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 fighter elite on horseback was a prerequisite for feudal societies, and, this way, Knight, Cuirassier and Cavalry are less cluttered with requirements 84 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 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 Land Tenure tech and Vassal agreement to Legal Tradition (a.k.a. Code of Laws).

85 This requires both Machinery and Feudalism in BtS; now it's either Land Tenure (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 Land Tenure. The need for a robust legal system (Legal

Tradition requirement) seems plausible enough, but mainly ensures that Republic can't sidestep Legal Tradition as well; I think that shortcut would be too powerful. 86 Maceman moves to Guilds from Civil Service (replaced by Land Tenure) and Pikeman to Banking from Engineering. These were both rather bizarre tech requirements; the original developers probably just saw no better way to spread the Medieval units out.

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

treating Maceman as heavy infantry, which tended to be mercenaries, as peasants were not afforded costly armor. The mace also came in use at about the same time as guilds (AD 900). The pike was popular among mercenary guilds, but only became widely used around AD 1300. By that time, banks played an important role in war finance, so Banking (which requires Guilds) seems like a good place 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). This is as in BtS. The heavier Maceman should then of course also require Iron (not

Copper as in BtS); instead Crossbowman can be trained with Copper As a non-urban unit, Knight is now enabled by Feudalism. About Plantations on Incense, Silk and Spice, see Agriculture. Bananas 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. Dye seems to refer mostly to (true) indigo, which was traded across Eurasia already in antiquity. However, a split into Tree Plantations and Field Plantations (true indigo is a legume) and into two groups of three resources is conceptually clean and looks promising with regard to game balance; therefore, Dye gets lumped in with Banana and Sugar.

also that the pre-colonial indigo trade in Europe was limited by the local availability of indigo from woad.) As a pre-Renaissance tech, Guilds comes a bit early for the Columbian Exchange. As a compromise, and because Compass arguably needs another ability more than Guilds does, Grocer moves to Compass. (For the record, grocers did organize in guilds – as did nearly all trades.)

-1 food, +2 production, +1 commerce because. This might be a bit much – it's -1 food, +1 production compared to Watermill and Lumbermill –, but taking the commerce away again at Guilds would be 89 Requires Alchemy now instead of Iron Working (but Alchemy requires Iron Working). Lodestones were of interest to alchemists. founded his Academy in 387 BC, so Academies shouldn't appear in the 90 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

beginning (see Smelting), the yield total at Guilds is now

spurred naval exploration. And Compass needs the ability more than Paper (which now has Bureaucracy). 91 Moved from Guilds (q.v.). Kind of replacing Harbor, which has moved 92 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 12<sup>th</sup> century. They did not use compasses, but Compass is the only naval tech at the proper time. 93 Moved from Machinery because windmills didn't become widespread until the 13<sup>th</sup> century AD. Conversely, Castle has moved leftward to

Feudalism. Pikeman has moved to Banking.

94 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 Divine Law (a. k. a. Divine Right) is required mostly in order to delay the Taj Mahal – the real mausoleum was built in the 17<sup>th</sup> century. Plus,

Divine Law can use a buff, and the building group includes a mosque.

To be consistent, Notre Dame requires Theology (and so does Cristo Redentor; see Steel). 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. 96 The free Great Merchant switches places with Mercantilism because Banking has to be a Medieval tech, while mercantilism emerged in the 16<sup>th</sup> century. There are some famous bankers like the Medici and Fugger whom the Great Merchant could represent. 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 requirement, and Mathematics and Literature are required in addition as essential parts of the curriculum. Obviously, Education has to be a Medieval tech (not Renaissance as in BtS). 98 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.

99 BtS requires Machinery for Optics (which enables Caravel in BtS). For Astronavigation, this requirement would seem out of place. Caravels could require Machinery for the (lateen) rigging. Construction would be easier to justify (for the carvel planking), but that might make it a bit too easy to beeline to Caravels. 100 This promotion has no tech requirement in BtS. I'm increasing the base

speed of Galley and Trireme by one, and Navigation I and II on top of that would make these ships implausibly fast. 101 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.

102 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. 103 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.

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. Additionally, the new (military) Strategy tech is required. Music has been renamed to Patronage and that requirement has moved down to Nation State.

104 Cuirassiers and the military bands that the Music requirement in BtS

These changes may seem to make Cuirassier quite a bit easier to beeline to, however, the tech requirements of Guns (a. k. a. Gunpowder) have Cavalry still requires Military Tradition but is visually relocated to Rifling, the much tougher of the two requirements.

105 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 16<sup>th</sup> century. 106 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

107 Military Science (a. k. a. Military Studies) would represent the alliances leading up to WW1 best, which were, in part, built on the laws of war codified in the conventions of The Hague and Geneva – however, Military Studies doesn't have room.

108 This tech comes too early for Free Market ("The Wealth of Nations": 1776), and Mercantilism comes too early at Banking. Therefore push Free Market to Liberalism and turn Economics into the Mercantilism tech. Rename it to "Political Economy" because just "Economics" would be strongly associated with market economics, and in order to cover political philosophy as well. In mercantilism, economical policy

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

Castle still goes obsolete with Free Market (i.e. at Liberalism). This extends the lifespan of Castle a bit further. The free Great Merchant moves to Banking to fill the gap left by Mercantilism. 109 To reduce deforestation, Lumbermill becomes available with Machinery but yields only 1 commerce initially. The extra production at Political Economy gives Lumbermill the same yields that it gets in BtS

at Replaceable Parts. The proper time for Lumbermill should be around 1500, when forestry became widespread in some parts of the world. Political Economy is about right, and forestry also aligns with the mercantilist view of a state's land as a resource to be managed. 110 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.)

111 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. 112 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 113 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. 114 See stat-changes.pdf about this. It's the Sentry promotion under a

Land Tenure is also supposed to relieve Feudalism, for which there are 115 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

116 New tech replacing Chemistry. 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 (petrochemistry). The production bonus to Workshop moves to Replaceable Parts (q.v.). 117 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. 118 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 (where it already was prior to the BtS expansion), while Rifleman moves two to the right (see Rifling), meaning that Grenadier is, as it should be, more often contemporary with Musketman than with

Rifleman. The stats and abilities of Grenadier need to change

119 Catapults and trebuchets aren't supposed to deal collateral damage 120 Moved from Astronomy (now called Optics) to avoid making two naval wonders obsolete at once. 121 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

Bacon, so Scientific Method is clearly a pre-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

middle of the 17<sup>th</sup> century, as were those of Descartes, Galilei and

except that Divine Law (q.v.) can substitute for Engineering. 122 Tech trading is difficult to rationalize for the pre-Industrial eras – mainly because of the element of consent: Historic rulers have generally not been able to prevent a technology from spreading to other, similarly advanced civilizations for long. During the Industrial era, withhold technologies looks more feasible because the technologies become increasingly complex while the number of years per game turn decreases.

Ideally, tech exchange in the early game and midgame should happen

only automatically through a tech diffusion system based on tile culture

(c.f. Alphabet), and an early-Industrial tech should enable tech trading. Scientific Method comes too early, but needs a strong ability as it doesn't do anything valuable in BtS. Scientific Method should only allow tech to be imparted; for tech-fortech 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 needs to be nerfed, regardless of the required tech.

123 Moved from the Representation civic. Overall, this is a slight buff for

specialists (which is also implemented in K-Mod, but at Computers and

without nerfing Representation). Almost all tile improvements receive 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. 124 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

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. It's needed for the nation's cultural identity. The Political Economy requirement (alter-

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

125 Nationalism arose in the 19<sup>th</sup> century; can't be a Renaissance tech. Even

moves to Liberalism, and the Great Library to Printing Press.

native to Military Tradition) alludes to theories that attribute the emergence of nation states more to economical developments than to national sentiment. obsolete, and the effect of firearms is already captured by the high 126 Moved from Drama, which got merged into Literature. Makes sense for

a tech called "Nation State" to enable more than one national wonder. 127 Moved from the Medieval tech Music (now called Patronage) and replacing the Taj Mahal (moved to Engineering). The free Great Artist should really appear in Renaissance, and famous compatriots help

shape a nation (e.g. national poets). 128 To simplify city management, garrisons are no longer required by the Like those resources, indigo was grown in colonial plantations. (Note midgame. Nation State is a sensible home for this ability because, in a nation state, it's understood that even major cities don't have to fend for themselves when attacked. Military Tradition would also work and has more room, but that tech can be skipped, which isn't ideal for an easeof-use improvement like this.

> tech. The free-tech ability isn't worth the distortions that it causes in BtS (players frequently beelining to Liberalism and all techs near it). It also (probably) overstates the importance of liberalism for the increase of power and wealth in the West (i.e. the Great Divergence). There are still many powerful rewards for early discoverers of techs in the Renaissance era or one of the adjoining columns: tech trading; a free Great Merchant, Artist and Scientist; gunpowder units; and Drafting. Instead of being required for Education (q.v.), Paper is now required for Liberalism. Paper money is seen by some historians as one cause for

to make the shift to paper money explicit in the tech tree (a Printing Press requirement would supplant Paper), and it's not obvious to me that liberalism couldn't have developed without printing. 130 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 economic 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

played a role in the dissemination of liberal philosophy, but I would like

131 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. 132 Moved from Scientific Method, where too many (Marble) wonders

went obsolete. Religious wonders might as well go obsolete with

obsoletion tech.

a mercantile wonder. 133 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 17<sup>th</sup> 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, which is the main requirement in BtS) 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. Political Economy, the tech that encompasses absolutism (Versailles) becomes the new main requirement.

the relations between king, nobility and clergy. The new rights for the (elected) parliament could be attributed to democratic ideas (Republic required – needs to factor in to the Age of Enlightenment somewhere). 134 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. 135 These go obsolete with Astronomy in BtS, but it's doubtful that Stonehenge had an important astronomical function. Hereditary Rule now

gives Monument +1 happiness (instead of the military happiness

ability), and losing that happiness is painful unless the obsoletion tech

provides some remedy – such as the Representation civic. One could

imagine that a constitution restricts the king's ability to erect monu-

The Feudalism requirement accounts for the roots of renaissance

Constitution) and, more generally, medieval constitutions determining

constitutions in the Magna Carta (cited in the tech quote for

136 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. 137 "Military Science" is the more commonly used term, but would sugges

that Scientific Method is required. Military science is (mostly) not a science in a strict sense. Requires Education for the "studies" part, the new (military) Strategy tech and Blast Furnace (previously Chemistry) only for Ship of the Line. The other unit that requires cast iron, Grenadier, moves directly to Blast Furnace (q.v.). The Commando promotion moves to Alphabet (q.v.). 138 This is West Point, moved from Military Tradition and renamed to something less US-centric (it gets pretty bad in the second half of the

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

gameplay reasons (military production too fast in the late game). 139 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. 181 Moved from Scientific Method. There are no units that require Oil in 140 See Fishing.

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

didn't carry out any tactics resembling tank warfare; especially not

much later and get Blitz for free. To my knowledge, early modern ships

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 were a Blitz promotion for ships with a different name, then some later tech would have to enable Blitz for Armored units; don't want that. 142 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 may argue that loans are required for large-scale manufacturing, which benefits most from interchangeable

parts. Blast Furnace (replacing Chemistry) is required for cast iron

parts. Engineering is required for Chemistry in BtS; this requirement

143 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.

moves one column down the tree to Replaceable Parts.

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 Drydock ability is a decent fit: replaceable parts increased the efficiency (also) of the shipbuilding industry. 144 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. Due to the

powerful relative to Watermill if the extra Workshop production came

Workshop buff at Smelting (q.v.), Workshop would also be too

any earlier.

145 The Watt steam engine went into production in 1776, but steam engine parts were not interchangeable until 1880. Therefore Steam Power shouldn't require Replaceable Parts. Scientific Method is required in addition to Blast Furnace (which replaces Chemistry) to account for prerequisites in early chemistry, e.g. gas laws and pneumatics. Blast furnaces are needed for the cast iron parts of the engine I'm drawing the line between Renaissance and Industrial era in the early

19th century. 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

Removed the worker rate bonus. Players tend to have too many workers

specifically are taking too long to build, I would simply reduce their build time from 3 turns to 2 turns. 146 Levee at Steam Power (same as in BtS) makes sense to me because river transportation on steamboats increased the need for river 147 Moved from Steel to give Ironclad a longer window of utility. Also, the first ironclads, produced in 1862 for the US Civil War, were not clad in

modern steel; the first steel mill in the US based on the Bessemer

in the late game; there is no need to make them faster. If railroads

(BtS: obsolete with Steam Power).

process was set up in 1865.

148 This ability represents the large American aqueducts that stretch across hundreds of miles. Steam Power is needed for the pumping stations. 149 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.).

150 Moved from Astronomy, which gets renamed to Astronavigation in order to allow Observatory to move. The telescope (1608) very much belongs at Optics, but the first large observatory (Greenwich) did not open until 1676, and Physics needs this building much more than Optics does. This also moves Observatory farther away from University - cities don't need two buildings that boost research in a row. 151 Replacing Democracy. The name "Equality" allows the tech to become an additional requirement for the State Property civic (main require-

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

ment: Corporation, q.v.), and then the rest of Communism can be

Democracy in BtS, but was a major influence on the revolutions in France and America. 152 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. 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

153 The requirement to actually run liberal civics (rather than just knowing their prerequisite techs) is just for flavor. 154 Part of an effort to make resources less decisive for city growth in the late game. In Europe, and perhaps elsewhere, game populations shrunk once hunting stopped being a privilege of the nobility.

155 The Chemistry requirement is gone because Chemistry has been

replaced by Blast Furnace, which doesn't work as a requirement for

a Great Spy for building a Security Bureau.

Biology. Early modern chemistry is assumed to be covered by the Scientific Method requirement (which is already present in BtS). To make Biology not too easy to beeline to, the Optics requirement moves one tech upstream from Medicine. 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 The Rifleman 3D model appears to show a soldier from the Napoleonic Wars, but the Civilopedia text talks about the American Civil War. The 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, and integrates Military Studies better into the tech tree. Historically, this additional requirement could represent advances in logistics, probably less so in tactics – line infantry fell out of use only as a consequence of rifles supplanting muskets. 159 Cannon moves to Blast Furnace (replacement for Chemistry), Ironclad to Steam Power and Drydock to Replaceable Parts. For all of these,

160 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. 161 "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.

especially in beams and reinforced concrete.

removed from Steam Power.

change.

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

162 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 already been proposed in the 1850s. Theology is required in order to be consistent with Notre Dame requiring Theology (see Divine Law). 163 This ability should make it more worthwhile to found cities past the midgame, especially on land discovered through Caravels. Improved construction methods seem like the best historical explanation. Could think of this ability as a replacement for the worker rate bonus

As a construction-themed tech, Steel is the most natural place for Creative Constructions. 165 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 moves to the new Rapid Fire tech (q.v.).

Railroad. The Oil requirement implies Combustion, so there is no real

164 Moved from Combustion; Combustion gets Standard Ethanol instead.

167 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. 168 Moved from Rifling. Firearms didn't make city walls completely

166 Moved from Combustion because Combustion no longer requires

German Wikipedia cites J. Osterhammel, a historian, stating that "if anything made walls obsolete, it was the railroad," and argues that city growth caused walls to be abandoned. This line of reasoning makes it unnecessary to exempt the "defensive abilities" of Walls from obsoletion. Simpler is better, and that exception is confusing because all abilities of Walls are defensive. 69 Requires Liberalism instead of Economics (now Political Economy) in

bombard rate of Cannon (which I intend to increase further). The

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.) Nationalism (renamed to Nation State) is now required directly because it's no longer implied by the 129 Liberalism takes over Free Market from Political Economy (q.v.; for-Constitution requirement. Requiring Nation State for Corporation is merly Economics) but loses Free Speech (see Constitution) and the free consistent with requiring it for the Free Market civic (see Liberalism). 170 Communism has (in part) been replaced by Equality, and Equality is

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. 171 That is, no HQ is required. This change lowers the initial investment for the shift from mercantilism to free markets. The printing press of course

spreading a corporation, allowing corporation yields to be reduced

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

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

still required for State Property. Either Corporation or Liberalism

should be required in addition because the concept of social ownership

and too many extra trade routes could encourage city spam. The obsoletion of the Great Lighthouse moves to Optics. 173 Moved from Electricity and renamed from "Bomb Shelter" to "Fallout Shelter". A bomb shelter is also a protection against air raids, but the building only protects against nukes, whereas Bunker does reduce air damage. Therefore, Bunker (now at Steel) is assumed to represent both bunkers and air raid shelters, and Bomb Shelter is renamed.

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

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. 174 This has no tech requirement in BtS but is only available for Great Warlords. Quick free healing shouldn't be available in the early game, and the first couple of Great Generals shouldn't always be used for Liberalism instead of Scientific Method, and Temple of Artemis is even "super medics." Plus, the Medicine tech needs a buff. 175 Merging Democracy, Communism and Fascism into just two techs (Equality and Totalitarianism) opens up room for a new Industrial-era

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;

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-

(Newton's laws of motion) and Steel because all the firearms in ques-

I've gotten the name "Rapid Fire" from the American Revolution Mod;

Machine Gun at Railroad even seems completely nonsensical.

tion were mass-produced in steel.

alternative, but comes a bit too early.

"Howitzer".

the tech icon would also come from there. 176 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

should make clear why Field Gun comes earlier: field guns were not

designed for indirect fire. Accordingly, Mobile Artillery gets named

177 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. 178 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

179 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 80 Requires Railroad and, indirectly, Steel in BtS. Steel made sense for the ships (Destroyer, Transport) enabled by Combustion in BtS, but these

be required, just as it isn't required for Steam Power.

move to Ballistics and Industrialism. Just for the engine, Steel shouldn't

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 Public Transportation moves to Railroad, additionally requiring Oil, meaning that Combustion also remains required.

the first two Industrial-era columns, so Combustion (in the first

the second half of the 19<sup>th</sup> century.

182 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). 83 Moved from Plastics and taking the spot of Creative Constructions,

which moves to Steel. Combustion is the most straightforward

biofuel anymore; more like Standard Oil. See stat-changes.pdf.)

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

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

often involves petrochemical cracking, but it seems that no petro-

chemistry 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. 185 Requires Replaceable Parts for mass-manufacturing electrical equipment like light bulbs, resistors and switches. 6 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,

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

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

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. 188 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 for all power plants in any case. 189 Both moved from Plastics because hydroplants were the earliest power plants, in use long before the discovery of synthetic polymers. Steel is Bunker and Bomb Shelter (now called Fallout Shelter), which move to

Steel and Medicine.

192 The 3D model, apparently, shows a WW2 US soldier with an M1 rifle (in service since 1936). This kind of unit comes a bit too early in BtS; the Rapid Fire requirement delays it. The Infantry unit would otherwise also replace Rifleman too soon now that Rifling is an Industrial-era tech. The M1 is a semi-automatic (gas-operated) rifle, so requiring Rapid Fire is also historically sound.

190 Coal Plant moves to Electricity and Pentagon to Industrialism.

191 See stat-changes.pdf about these requirements for Factory.

193 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. 94 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

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

that don't need more health aren't going to research Ecology. 195 New name for Recycling Center. 196 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

now the main requirement. The Scrub action has been removed; see Exclusion Zone (new name for the Fallout feature) in stat-197 Moved from Industrialism because that tech looked too crowded in BtS, and because synthetic substitutes have not diminished the monetary value of ivory that much.

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

important novelty at Ballistics is indirect fire.

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

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

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.). 99 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 (or at least no earlier) than Battleship; Destroyer has a distinct role as an anti-Air, anti-Submarine unit. (I'm intending to make Battleship a bit more vulnerable to aircraft and subs; see stat-changes.pdf).

access to Oil less crucial. This, in turn, should allow for a more realistic, namely clustered, placement of Oil resources during map generation. 200 Moved from Industrialism as that would be a bit much on top of Ballistics; the manufacturing process is covered by requiring Assembly Line instead of Industrialism. Railroad is needed for the vehicle's continuous tracks, a crucial innovation that was inspired by railroads. (An early patent was named "endless railway.")

201 Requires Rapid Fire for the machine guns mounted on Fighter. No

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

the main requirement. (Radio is also pretty crowded.)

I'm drawing the line between Industrial and Modern era in the late 1930s. This yields a pretty even distribution of techs. Flight could really go either way: The 3D models appear to show planes introduced in the 30s (Spitfire, B-17). 202 Still requires Radio (for search radar) and Flight, but since both are in the same column now, Flight as the more obvious requirement becomes

Carrier without Fighter, and Paratrooper also carries an automatic rifle.

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

The Rapid Fire tech covers nitroglycerine and other high explosives, so

Aluminum (or just Electricity) should then also be required for Fighter. 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 Aluminum though). 204 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

205 Cristo Redentor moves to Steel (q.v.) and Bomber to Flight with Radio

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

aircraft had aluminium in their airframes. One could argue that

as an additional requirement instead of vice versa. Steel could be justified as a requirement, but they'll play better at earlier An Industrial-era tech because submarines were already deployed in WW1, and the Eiffel Tower was completed in 1889. 206 Attack Submarine and Nuclear Submarine (previously just called "Submarine") have switched places. Attack Submarine was introduced in BtS as a counter against the vanilla Submarine unit, probably representing early Cold War hunter-killer designs. This role is too narrow.

Instead, Attack Submarine becomes the ordinary submarine unit for the

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

senting the cruise missile and ballistic missile subs of the Cold War. As for requiring 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. 207 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.

meaning that Uranium becomes useful shortly after it is revealed, which could be unfair to civs without Uranium. That said, Uranium only becomes crucial once and if the Manhattan Project is built. 208 Radio is also required for all naval units that detect Submarines. This should make early Submarines more dangerous. Even with Radio, Air Recon should only reveal Submarines that are adjacent to another ship. (A submarine spotted on the surface by aircraft will dive and change its 258 Requires Superconductors instead of Fiber Optics because position if it isn't promptly engaged.) Too easy in BtS to spot

Radio directly leads to Fission now (not required for Fission in BtS),

Submarines with air units. 209 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 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 happiness and health. goes obsolete with Ecology instead of Industrialism. 210 Requires the new Rapid Fire tech instead of just Rifling. The 3D model appears to show an AK-47.

WW2 landing craft. These aren't oceangoing, but the unit could represent the contemporary Liberty and Victory ships, which according to Wikipedia, "came to symbolize U.S. wartime industrial output," meaning that Industrialism is a good match. It's also nice to have Marine and

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

12 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 of a connection. At Industrialism, the Pentagon can represent the military-industrial complex 213 Moved from Rocketry, mostly, because that tech doesn't have room 214 Replacement for Fascism, also taking over parts of Communism (which

is otherwise replaced by Equality). Totalitarianism requires Equality for

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

was too little that the tech could plausibly do, considering that it's a dead end in the tech tree. Paratrooper has moved to Flight and Mount Rushmore to the new Rapid Fire tech. 215 The spy stuff is a pretty silly way to represent communism in the game; fits much better under the label "Totalitarianism." The free Great General is, for now, entirely removed. There's also no tech granting a free Great Prophet, so I think this is fine. The new Error:

candidate for a free Great General and could even be renamed to "Strategy" but would arguably become too powerful that way. 6 For consistency, all pre-Medieval wonders should go obsolete at some point if there isn't a special reason against obsoletion. At Totalitarianism, all government civics are guaranteed to be unlocked, and obsoleting a symbol of democracy boosts the evil image of Totalitarianism.

Reference source not found tech (replacing Civil Service) is a good

217 Requires Ballistics (replacement for Artillery) instead of Flight or Artillery. Rocketry is a subfield of ballistics, so Ballistics has to be required. Perhaps Flight should be required in addition, but supersonic aerodynamics seem to be quite different from (and less tricky than) the subsonic aerodynamics relevant for constructing planes. Only Combustion is required instead; rocket engines are normally internal combustion engines.

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

218 MANPADS only became effective in the 60s through infrared homing. Require Radio for that. (Infrared is a type of radiation.) The first Modern column would otherwise be a bit early for such a unit. 219 Civilopedia talks about "high-velocity cannons," but the combat animations show a shaped-charge warhead fired from a recoilless gun. Recoilless guns exhaust gas like rocket launchers. Shaped charges are also needed for initiating nuclear explosions (explosive lens). It's convenient to assume that Rocketry covers this because Rocketry is

220 An electromotor is required for inertial guidance (gyroscope).

221 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

required for nukes anyway.

no Battleships were commissioned after WW2, so Battleship should not remain without a replacement for so long. Rocketry alone would be a too early though. I'm adding a high air interception chance because missile cruisers developed from anti-air cruisers and continued to have air defenses; Computers are needed for the ballistics computer. (In particular, a tracking and guidance system such as Aegis would not be in caliber and fire rate.) The new name "Ballistics" for the Artillery tech possible without electronic computers.) 222 Replacing the speed bonus for ships. A big speed boost came from steam turbines, but I don't think refrigeration had any part in this. Moreover, the speed bonus makes it harder for players to keep track of

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

circumnavigation bonus should be replaced with some other perk.)

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

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

reduced by 1, and then Refrigeration brings the output to the same level

as in BtS. Apart from food conservation, the bonus could also represent

trawling, fish farms and other developments in commercial fishing that

BtS fails to capture. (This change is inspired by the Civ 4 Reimagined

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

Biology (q.v.). Refrigeration is a better explanation for a seafood company than healthy diets. 224 The nonsensical Plastics requirement was added by the BtS expansion, presumably for balance reasons. Not much of a point in obsoletions this late in the game, and the Medieval wonders University of Sankore and Spiral Minaret come so

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

Railroads don't seem to have had a strong impact on the development of 225 Internet moves to Fiber Optics (q.v.), so Computers needs a new ability. The processes, Research, Wealth and Culture, are too powerful in BtS. Set the conversion rate to 80% initially, and to 100% (as in BtS) only with Computers. This ability could make Computers one of several techs to beeline to when aiming at a Space victory. 226 Moved from Ecology, which is no longer a Modern tech. For consis-

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

manufactured television sets should have some economic requirement.

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

now happens at Scientific Method.

And Mass Media might be a bit too easy to beeline to in BtS column) is early enough, and systematic oil exploration only began in considering that it unlocks a victory condition. 228 Same as in BtS. Could be explained with advertisements, particularly "a diamond is forever" by De Beers. See stat-changes.pdf about the name 229 Hydroplant and Three Gorges Dam move to Electricity and Standard

230 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 requirement for a fuel company. (Standard Ethanol isn't primarily about 231 This bonus mirrors the health bonus at Genetics and should make up for the resource obsoletions at Plastics and in the Industrial era (Whale, Dye, Ivory). Plastics have improved numerous consumer goods or made

them affordable. Not sure if it should be +2 or +3 happiness.

232 Oil appears only on Ocean tiles, so this tile improvement should really be about deep-sea drilling. Synthetic materials are probably used for this, e.g. for tubes and pontoons, but I doubt that they're really needed. I guess a slightly better explanation is that such materials increase the demand for oil and this motivates deep-sea wells. 233 Part of an effort to make resources less crucial for city growth in the

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

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

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

computers at the Baikonur Cosmodrome when Sputnik 1 was launched. The Apollo Project is inconceivable without computers requirement for Broadway. No commerce bonus to Windmill. 1 food, 1 235 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 in 1957) is a much greater technological achievement than a guided missile staying within the Earth's atmosphere.

addition to Plastics and the hidden Computers requirement for the Satellites tech). 236 This effect should also disable the fog of war for tile ownership because that leads to problems with ICBMs, which can target fogged tiles. required for the reinforced concrete. The power plants take the place of 237 Moved from Laser. Don't want to require the combination of Satellites and Laser for both SDI and Space Elevator (moved to Laser from Robotics). The present-day measures of the Missile Defense Agency (successor of the SDI) don't seem to rely on lasers, although lasers

238 The Satellites requirement (supposedly for satellite guidance) moves

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

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

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

down the tree to Stealth; instead require Rocketry for the advanced engines (turbojet, turboshaft) and Radio for radar homing (air-tosurface and air-to-air missiles) and safe air traffic control (radio navigation, landing guidance). 239 Moved from Flight. Strategic airlift without jet aircraft is difficult to imagine. The commercial use of planes was also too small prior to jets to justify an extra trade route from Airport. 240 This should really happen at Rocketry because Cavalry upgrades to Tank and Anti-Tank now instead of Gunship, meaning that Cavalry is

added the Laser requirement.

241 Requires Radio for the radioactivity (only Electricity in BtS). 242 Requires Satellites instead of just Rocketry because Satellites is the spaceflight tech now. 243 Removed the Satellites requirement. Plastics is a reasonable requirement for synthetic crystals, but Satellites should only be required for SDI, which moves directly to Satellites. Neither the Avenger described in the Civilopedia entry for Mobile SAM, nor the Patriot that the 3D model resembles, nor the M109 howitzer shown by the Mobile Artillery model appear to rely on satellites for aim or homing. They do employ laser for rangefinders, and the M109 can also fire a laser-guided shell. Laser rangefinders are electronic devices, hence the Computers

requirement. At least Mobile SAM should also require a ballistics

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

245 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

computer to be able to hit jet aircraft.

normally obsoleted by Rocketry (which now enables Anti-Tank). But

there is only enough room left for either Stable or Horse at Rocketry,

and both should go obsolete together in order to tidy up the UI.

it. Laser could be needed for powering the elevator and for producing 246 Removed the Satellites requirement. Probably a remnant from when Jet Fighter and Stealth Bomber were at Composites (prior to the BtS 247 Moved from Robotics because I don't see any connection between Mechanized Infantry and Robotics. The 3D model shows an M113; these first entered service in 1960. The armor is not made from a composite material but an aluminium alloy. Some infantry rifles from

Armor and Mechanized Infantry at the same tech. Hard to find a different place for either unit though. The additional requirement of 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

249 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

want Satellites to be a dead end (no longer leads to Laser), and geoloca-

ways too in which these high-tech units use satellite navigation. Don't

tion through satellites should have some military benefit in the game. (BtS requires Satellites already for Advanced Flight.) 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

were built already before WW2. Similarly, the important theoretical discoveries about superconductivity in the 50s and 60s did not hinge on 2 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

The bonus to Industrial Park represents industrial robots; hence also the

Industrialism requirement for Robotics. Prior to Robotics, Industrial

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

changes.pdf for details. This is part of an effort to reduce the production output of industrialized cities. 253 Replacing the Superconductors requirement with Computers because I see no connection between genetics and superconductors. If the Genetics tech covers recent advances like genetic engineering, gene therapy and the Human Genome Project, then computers are needed for DNA sequence assembly.

engineered humans can endure cryostasis. 255 Three health would exaggerate the effects of genetics on human health compared with other 20<sup>th</sup> century advances like vaccination or antibiotics that are, supposedly, represented by the three health from Hospital. Instead, give Genetics a food bonus representing high-

Had already been at Fiber Optics prior to the BtS expansion. Superconductors would otherwise be a dead end (no longer required for Genetics). Also, magnetic confinement is the main approach toward fusion energy, though the magnets probably don't have to be

otherwise be a dead end (no longer required for Fusion), and because fiber optics (with its uses in computer networks) seems more likely than stealth technology to lead to future innovations that increase people's

211 Moved from Combustion. This change should help Ironclad and Ship of the Line (which can't take down Transports). The 3D model shows a

the 60s have fiberglass stocks (e.g. M14, M16), and the Humvee has composite armor. The new Rapid Fire tech is required for the select-fire rifles. 248 The 3D model shows an M60. That's an early second-generation tank without composite armor (just steel). It's also not ideal to have Modern As for the resource requirements, Industrial-era ships are allowed to run Laser for Modern Armor should help a bit. The M60, or at least many on Coal but move faster with Oil. This should fill a gap between coalvariants of it, had a laser rangefinder. Also, the T64 tank, contemporary fueled (early) ironclads and oil-fueled WW2 navies, and make early

> 250 As with Submarines (see Radio), the Recon mission should only reveal stealth ships adjacent to another ship. Allowing only Stealth Destroyers to detect Stealth Destroyers is pretty silly. Surely, the Stealth Destroyer's (phased-array?) radar system can also be installed on aircraft (and on other ships, but let's keep it simple). 251 New name for Laboratory. The BtS expansion moved this building from Computers to Superconductors. It's still too easy to access, making

physics justify Fission as an additional requirement. I'm removing the Computers requirement because several successful particle accelerators in which e.g. robotic arms could be useful in a docking bay. Prior to the

BtS expansion, Docking Bay was also at Robotics.

254 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

yielding 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 256 No obsoletion of Kremlin; pointless this late. 257 Moved from Computers in order to make Fiber Optics more attractive.

wonders this late in the game. Can now also be used on SS parts.

259 That Engineer is fairly useless in BtS as there are few if any worthwhile 260 Requires Fiber Optics instead of Stealth because Fiber Optics would

