Civilization II

Game Mechanics Booklet

Contents

Introduction

The mechanics of *Civilization II* are incredibly complex and largely undocumented. Even seasoned players often find themselves guessing what to build or how to balance earnings.

This booklet aims to take the guess-work out of managing a civilisation. If you've ever asked, "When is it profitable to build a Bank?", "Should Wine be mined or irrigated?" or "Why is my industrialised city starving?" this booklet is for you.

The tables and charts that follow generally fall into two groups. The first group answers simple **decision questions** (like those above), usually by presenting the results of calculations in an accessible way. The second group **summarises** all the information about a topic in one place; this can be either raw data or a progressive calculation (often quite complicated). Some tables cross the boundary between these groups, highlighting answers amongst other data.

This booklet is a **reference**, which means information is meant to be quickly accessible. Many tables will initially be difficult to interpret, but I guarantee that spending the time to understand them will be worth the effort. Assistance is often provided in the footnotes, or in the Explanatory Notes section at the end.

Finally, because no-one wants to share their gaming desktop with another window, this booklet is intended for **printing**. Attempting to decipher these tables on-screen is not recommended.

Wonders

Wonder	🛡	Prerequisite	Description (Expiry)

Ancient

Wonder	🛡	Prerequisite	Description (Expiry)
Colossus	200	Bronze Working	City: Trade square ⇒ +1 Trade. **(Flight)**
Great Library	300	Literacy	Receive every Civilization Advance possessed by two other civilizations. **(Electricity)**
Great Wall	300	Masonry	*City Walls* in all friendly cities. Enemy civs forced to offer cease-fire or peace. Atk ×2 vs Barbarians. **(Metallurgy)**
Hanging Gardens	200	Pottery	City: 3☺ ⇨ ☺ Friendly cities: 1☺ ⇨ ☺ **(Railroad)**
Lighthouse	200	Map Making	Triremes can't be lost at sea, other sea units move +1. All new ships are Veterans. **(Magnetism)**
Oracle	300	Mysticism	Doubles effectiveness of *Temples* (2☹ ⇨ ☺). **(Theology)**
Pyramids	200	Masonry	*Granary* in every city.

Renaissance

Wonder	🛡	Prerequisite	Description (Expiry)
Copernicus' Observatory	300	Astronomy	City: +50% Science.
King Richard's Crusade	300	Engineering	City: all squares +1 Shield. **(Industrialization)**
Magellan's Expedition	400	Navigation	Sea units move +2.
Marco Polo's Embassy	200	Trade	Embassy with every civilization. **(Communism)**
Michelangelo's Chapel	400	Monotheism	*Cathedral* in every city.
Shakespeare's Theatre	300	Medicine	City: all ☹ ⇨ ☺
Sun Tzu's War Academy	300	Feudalism	All new ground units are Veterans. Existing ground units turn Veteran on winning a combat. **(Mobile Warfare)**

Industrial

Wonder	🛡	Prerequisite	Description (Expiry)
Adam Smith's Trading Co.	400	Economics	City Improvements costing 1 maintenance now cost 0.
Darwin's Voyage	400	Railroad	Granted two Civilization Advances.
Eiffel Tower	300	Steam Engine	When built (or captured), every civ's attitude shifts +25%; continues to improve over time.
Isaac Newton's College	400	Theory of Gravity	City: Science ×2.
J. S. Bach's Cathedral	400	Theology	Friendly cities on continent: 2☹ ⇨ ☺
Leonardo's Workshop	400	Invention	All obsolete units upgraded to modern versions. **(Automobile)**
Statue of Liberty	400	Democracy	Eliminates Anarchy when changing governments. Allows the choice of any government type.

Modern

Wonder	🛡	Prerequisite	Description (Expiry)
Apollo Program	600	Space Flight	Allows spaceship construction for everyone. Reveals the entire map.
Cure for Cancer	600	Genetic Eng.	Friendly cities: 1☺ ⇨ ☺
Hoover Dam	600	Electronics	*Hydro Plant* in every friendly city.
Manhattan Project	600	Nuclear Fission	Allows nuclear weapon construction by everyone.
SETI Program	600	Computers	*Research Lab* in every friendly city.
United Nations	600	Communism	Embassy with every civilization. Enemy civs forced to offer cease-fire or peace. 50% chance successfully declaring war under Democracy.
Women's Suffrage	600	Industrialization	*Police Station* in every friendly city.

Selected Spaceship Flight Times

Module Sets	Component Sets	Structural Units	Population	Support	Energy	Mass	Fuel (Fusion)	Flight Time	Success
1	3	15	10,000	100%	100%	8,700	100%	**15.7**	100%
1	8	33	10,000	100%	100%	14,500	100%	**5.7**	100%
2	5	23	20,000	100%	100%	15,900	100%	**14.5**	100%
2	8	33	20,000	100%	100%	19,300	100%	**7.6**	100%
3	6	31	30,000	100%	100%	22,300	100%	**15.4**	100%
3	8	33	30,000	100%	100%	24,100	100%	**9.5**	100%
4	7	39	40,000	100%	100%	28,700	100%	**14.4**	100%
4	8	39	40,000	100%	100%	29,500	100%	**11.7**	100%

* A Module Set consists of three *SS Modules* (Habitation, Life Support, Solar Panel).

* A Component Set consists of two *SS Components* (Propulsion, Fuel).

* The Spaceship's ETA is the launch year plus the Flight Time, rounded down.
  It arrives at the start of this turn.

* Two sets of data are given for each number of Module Sets: the first is the
  minimum for 100% Success; the second is for the fastest flight time.

Spaceship Structural Unit Requirements

Module Sets	Component Sets	Structural Units
1		15
	4	17
	5	21
2		23
	6	25
3		31
	7	29
	8	33
4		39

This shows the number of *SS Structural Units* needed to properly connect a given number of Module Sets and Component Sets. A spaceship without enough Structural Units will not gain the benefit of the extra Modules and Components, but it will be slowed down by their extra Mass.

Throne Room

Sections	No. Sections	No. Looks	Total
Floor, Side Walls, Rear Wall, Throne	4	3	12
Front Pillars, Rear Pillars, Path, Banner	4	4	16
Planted Verge, Verdant Pillars, Paintings, Floor Mats, Urns, Chests, Statues	7	1	7
Total			**35**

* Each of the 8 main Sections progresses through a number of different period
  Looks, adding up to a total of 35 different Throne Room additions.

* The 7 objets d'art (each with but a single aspect) cannot be added until all
  other sections are complete.

Terrain Improvement Chart

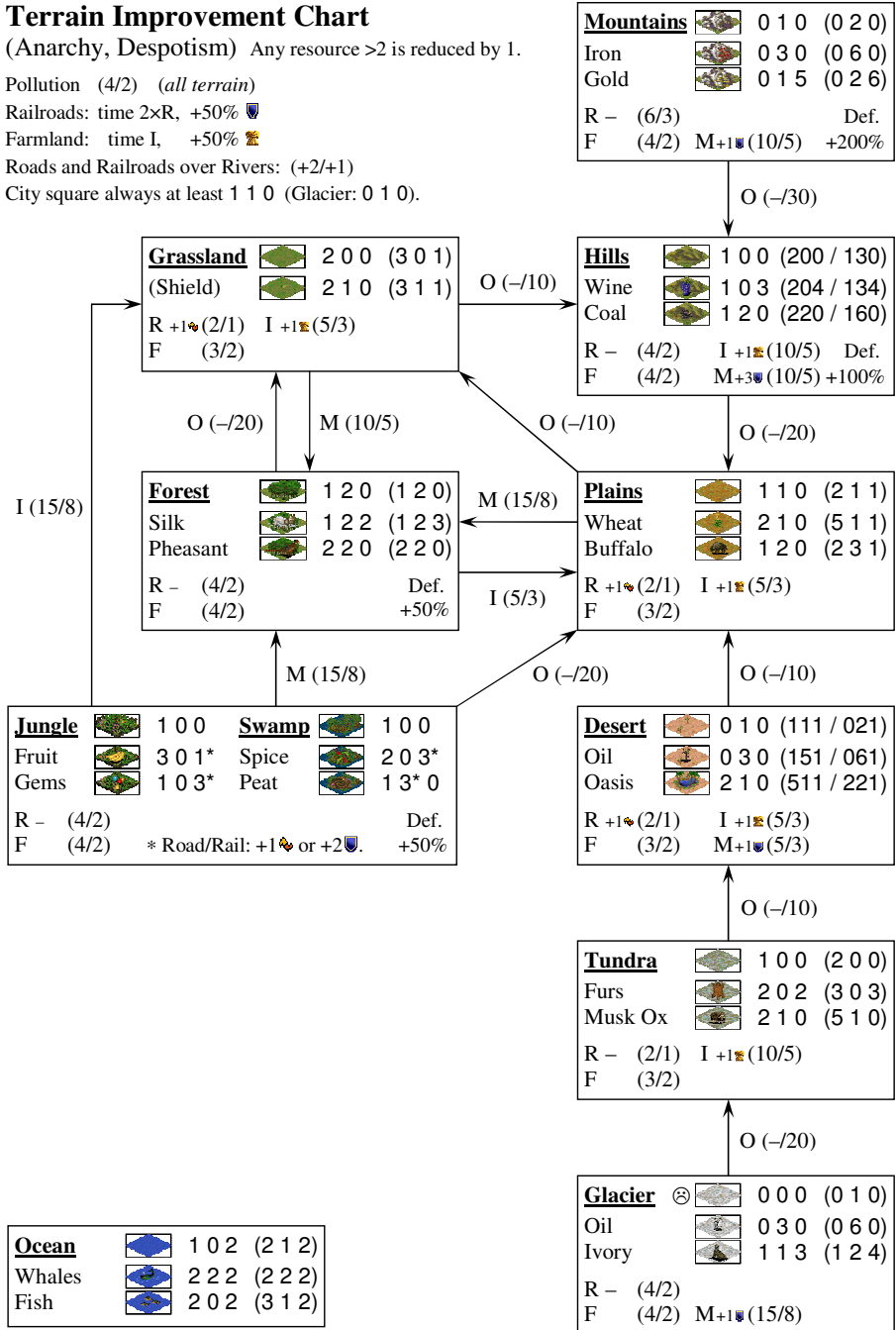(Anarchy, Despotism) *Any resource >2 is reduced by 1.*

Pollution   (4/2)   *(all terrain)*
Railroads: time 2×R, +50% 🛡
Farmland: time I,   +50% 🌾
Roads and Railroads over Rivers: (+2/+1)
City square always at least 1 1 0 (Glacier: 0 1 0).

Mountains   0 1 0   (0 2 0)
Iron   0 3 0   (0 6 0)
Gold   0 1 5   (0 2 6)

R –   (6/3)   Def.
F   (4/2) M +1🛡 (10/5)   +200%

O (–/30)

Grassland   2 0 0   (3 0 1)
(Shield)   2 1 0   (3 1 1)

R +1🍎 (2/1)   I +1🌾 (5/3)
F   (3/2)

O (–/10)

Hills   1 0 0   (200 / 130)
Wine   1 0 3   (204 / 134)
Coal   1 2 0   (220 / 160)

R –   (4/2)   I +1🌾 (10/5)   Def.
F   (4/2)   M +3🛡 (10/5) +100%

O (–/20)   M (10/5)   O (–/10)   O (–/20)

Forest   1 2 0   (1 2 0)
Silk   1 2 2   (1 2 3)
Pheasant   2 2 0   (2 2 0)

R –   (4/2)   Def.
F   (4/2)   +50%

M (15/8)

Plains   1 1 0   (2 1 1)
Wheat   2 1 0   (5 1 1)
Buffalo   1 2 0   (2 3 1)

R +1🍎 (2/1)   I +1🌾 (5/3)
F   (3/2)

I (15/8)   O (–/20)   I (5/3)   M (15/8)   O (–/20)   O (–/10)

Jungle   1 0 0   **Swamp**   1 0 0
Fruit   3 0 1*   Spice   2 0 3*
Gems   1 0 3*   Peat   1 3* 0

R –   (4/2)   Def.
F   (4/2)   ∗ Road/Rail: +1🍎 or +2🛡.   +50%

Desert   0 1 0   (111 / 021)
Oil   0 3 0   (151 / 061)
Oasis   2 1 0   (511 / 221)

R +1🍎 (2/1)   I +1🌾 (5/3)
F   (3/2)   M +1🛡 (5/3)

O (–/10)

Tundra   1 0 0   (2 0 0)
Furs   2 0 2   (3 0 3)
Musk Ox   2 1 0   (5 1 0)

R –   (2/1)   I +1🌾 (10/5)
F   (3/2)

O (–/20)

Ocean   1 0 2   (2 1 2)
Whales   2 2 2   (2 2 2)
Fish   2 0 2   (3 1 2)

Glacier ☹   0 0 0   (0 1 0)
Oil   0 3 0   (0 6 0)
Ivory   1 1 3   (1 2 4)

R –   (4/2)
F   (4/2)   M +1🛡 (15/8)

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Terrain Improvement Chart
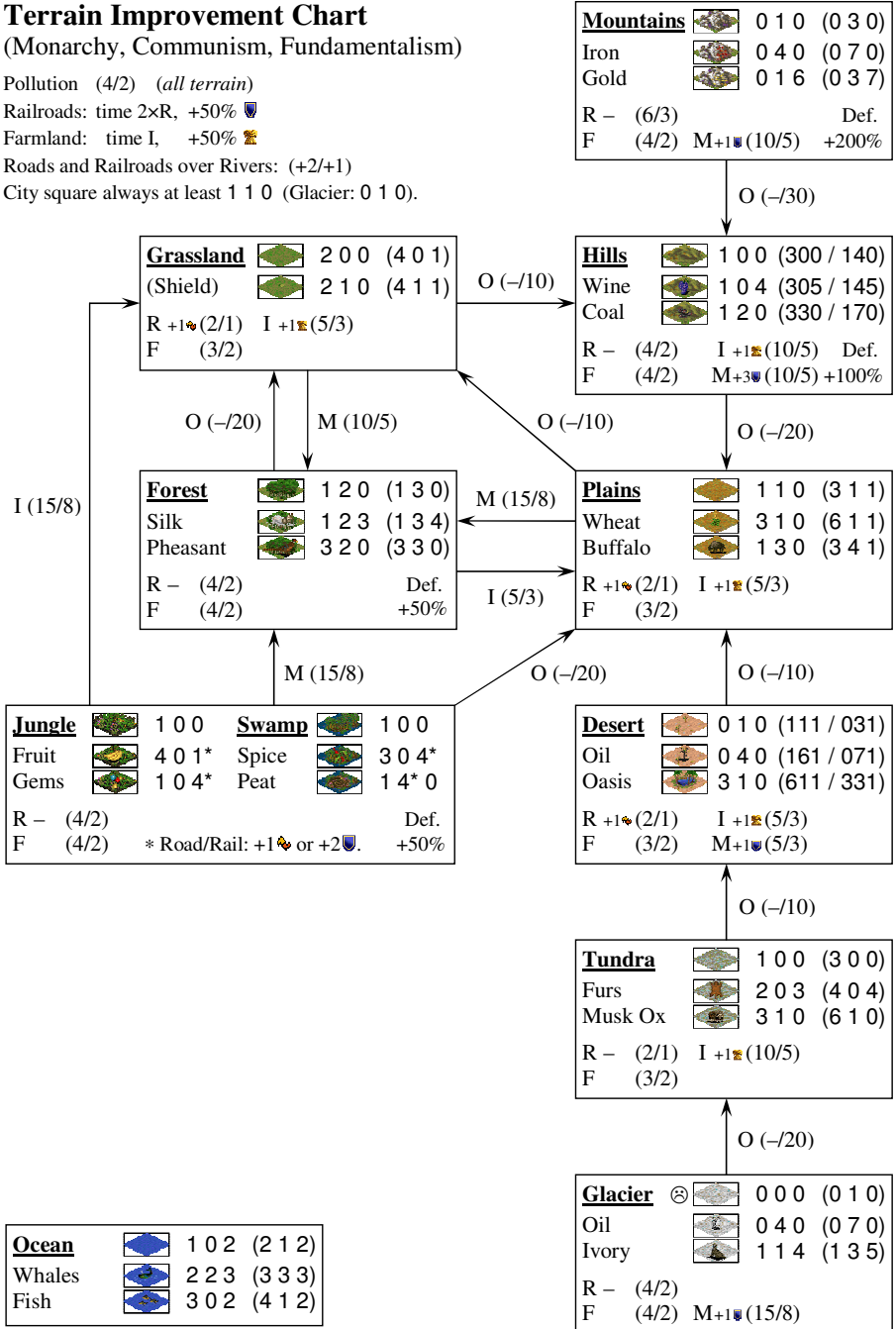
(Monarchy, Communism, Fundamentalism)

Pollution   (4/2)   *(all terrain)*
Railroads: time 2×R, +50% 🛡
Farmland: time I,   +50% 🌾
Roads and Railroads over Rivers: (+2/+1)
City square always at least 1 1 0 (Glacier: 0 1 0).

Mountains   0 1 0 (0 3 0)
Iron   0 4 0 (0 7 0)
Gold   0 1 6 (0 3 7)

R –   (6/3)   Def.
F   (4/2) M+1🛡(10/5)   +200%

O (–/30)

Grassland   2 0 0 (4 0 1)
(Shield)   2 1 0 (4 1 1)

R +1🐾(2/1) I +1🌾(5/3)
F   (3/2)

O (–/10)

Hills   1 0 0 (300 / 140)
Wine   1 0 4 (305 / 145)
Coal   1 2 0 (330 / 170)

R –   (4/2)   I +1🌾(10/5)   Def.
F   (4/2)   M+3🛡(10/5) +100%

O (–/20)   M (10/5)

O (–/10)

O (–/20)

Forest   1 2 0 (1 3 0)
Silk   1 2 3 (1 3 4)
Pheasant   3 2 0 (3 3 0)

R –   (4/2)   Def.
F   (4/2)   +50%

M (15/8)

Plains   1 1 0 (3 1 1)
Wheat   3 1 0 (6 1 1)
Buffalo   1 3 0 (3 4 1)

R +1🐾(2/1) I +1🌾(5/3)
F   (3/2)

I (5/3)

I (15/8)

M (15/8)

O (–/20)

O (–/10)

Jungle   1 0 0   **Swamp**   1 0 0
Fruit   4 0 1*   Spice   3 0 4*
Gems   1 0 4*   Peat   1 4* 0

R –   (4/2)   Def.
F   (4/2)   * Road/Rail: +1🐾 or +2🛡.   +50%

Desert   0 1 0 (111 / 031)
Oil   0 4 0 (161 / 071)
Oasis   3 1 0 (611 / 331)

R +1🐾(2/1)   I +1🌾(5/3)
F   (3/2)   M+1🛡(5/3)

O (–/10)

Tundra   1 0 0 (3 0 0)
Furs   2 0 3 (4 0 4)
Musk Ox   3 1 0 (6 1 0)

R –   (2/1) I +1🌾(10/5)
F   (3/2)

O (–/20)

Ocean   1 0 2 (2 1 2)
Whales   2 2 3 (3 3 3)
Fish   3 0 2 (4 1 2)

Glacier ☹   0 0 0 (0 1 0)
Oil   0 4 0 (0 7 0)
Ivory   1 1 4 (1 3 5)
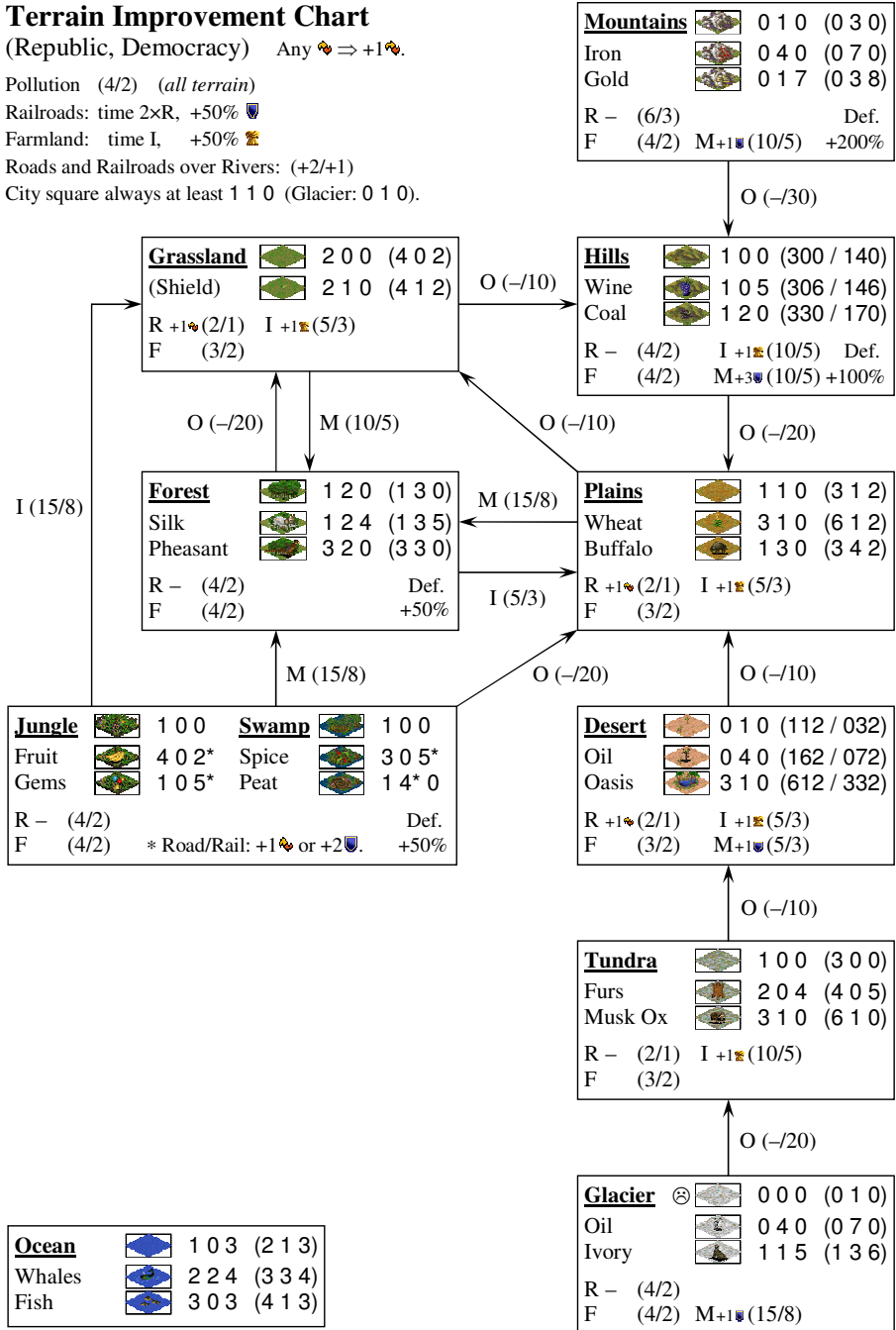
R –   (4/2)
F   (4/2) M+1🛡(15/8)

Terrain Improvement Chart

(Republic, Democracy)   Any 🐝 ⇒ +1🐝.

Pollution (4/2) (all terrain)
Railroads: time 2×R, +50% 🛡
Farmland: time I, +50% 🌾
Roads and Railroads over Rivers: (+2/+1)
City square always at least 1 1 0 (Glacier: 0 1 0).

Mountains	[icon]	0 1 0	(0 3 0)
Iron	[icon]	0 4 0	(0 7 0)
Gold	[icon]	0 1 7	(0 3 8)
R –	(6/3)		Def.
F	(4/2)	M+1🛡(10/5)	+200%

O (–/30)

Grassland	[icon]	2 0 0	(4 0 2)
(Shield)	[icon]	2 1 0	(4 1 2)
R +1🐝(2/1)	I +1🌾(5/3)		
F	(3/2)		

O (–/10)

Hills	[icon]	1 0 0	(300 / 140)
Wine	[icon]	1 0 5	(306 / 146)
Coal	[icon]	1 2 0	(330 / 170)
R –	(4/2)	I +1🌾(10/5)	Def.
F	(4/2)	M+3🛡(10/5)	+100%

O (–/20)   M (10/5)   O (–/10)   O (–/20)

Forest	[icon]	1 2 0	(1 3 0)
Silk	[icon]	1 2 4	(1 3 5)
Pheasant	[icon]	3 2 0	(3 3 0)
R –	(4/2)		Def.
F	(4/2)		+50%

M (15/8)   I (5/3)

Plains	[icon]	1 1 0	(3 1 2)
Wheat	[icon]	3 1 0	(6 1 2)
Buffalo	[icon]	1 3 0	(3 4 2)
R +1🐝(2/1)	I +1🌾(5/3)		
F	(3/2)		

I (15/8)   M (15/8)   O (–/20)   O (–/10)

Jungle	[icon]	1 0 0	**Swamp**	[icon]	1 0 0
Fruit	[icon]	4 0 2*	Spice	[icon]	3 0 5*
Gems	[icon]	1 0 5*	Peat	[icon]	1 4* 0
R –	(4/2)				Def.
F	(4/2)	∗ Road/Rail: +1🐝 or +2🛡.			+50%

Desert	[icon]	0 1 0	(112 / 032)
Oil	[icon]	0 4 0	(162 / 072)
Oasis	[icon]	3 1 0	(612 / 332)
R +1🐝(2/1)	I +1🌾(5/3)		
F	(3/2)	M+1🛡(5/3)	

O (–/10)

Tundra	[icon]	1 0 0	(3 0 0)
Furs	[icon]	2 0 4	(4 0 5)
Musk Ox	[icon]	3 1 0	(6 1 0)
R –	(2/1)	I +1🌾(10/5)	
F	(3/2)		

O (–/20)

Glacier ☹	[icon]	0 0 0	(0 1 0)
Oil	[icon]	0 4 0	(0 7 0)
Ivory	[icon]	1 1 5	(1 3 6)
R –	(4/2)		
F	(4/2)	M+1🛡(15/8)	

Ocean	[icon]	1 0 3	(2 1 3)
Whales	[icon]	2 2 4	(3 3 4)
Fish	[icon]	3 0 3	(4 1 3)

Effectiveness of Terrain Improvements

Terrain	I	F	M	R	RR
Mountains	–	–	✓	✗	AD
Iron	–	–	✓	✗	✓
Gold	–	–	✓	✓	AD
Hills	✓	AD	✓	✗	✓
Wine	✓	AD	✓	✓	✓
Coal	✓	AD	✓	✗	✓
Plains	✓	AD	–	✓	✗
Wheat	✓	✓	–	✓	✗
Buffalo	✓	AD	–	✓	✓
Grassland	AD	✓	–	✓	✗
(Shield)	AD	✓	–	✓	✗
Forest	–	–	–	✗	AD
Silk	–	–	–	✓	AD
Pheasant	–	–	–	✗	AD
Jungle	–	–	–	✗	✗
Fruit	–	–	–	✓	✗
Gems	–	–	–	✓	✗
Swamp	–	–	–	✗	✗
Spice	–	–	–	✓	✗
Peat	–	–	–	✗	✓
Desert	✓	✗	✓	✓	AD
Oil	✓	✗	✓	✓	✓
Oasis	✓	✓	✓	✓	AD
Tundra	✓	AD	–	✗	✗
Furs	AD	✓	–	✓	✗
Musk Ox	✓	✓	–	✗	✗
Glacier	–	–	✓	✗	✗
Oil	–	–	✓	✗	✓
Ivory	–	–	✓	✓	AD
Ocean	(✓)	–	(✓)	–	–
Fish	(✓)	–	(✓)	–	–
Whales	(AD)	–	(AD)	–	–

Key

–	Improvement not allowed.
✓	Always effective.
✗	No effect under any government (except River squares).
AD	No effect under Anarchy or Despotism.
(✓)	*Harbor* and *Offshore Platform* are always effective.
(AD)	No effect from *Harbor* or *Offshore Platform* under Anarchy or Despotism.

Shows which terrain improvements do not increase the amount of resources produced by a square, due to the nature of the terrain resource calculations. This is especially an issue under primitive governments.

Terrain Keys

For this page and the next

Terrain Properties

🌾🛡💰 Food/Shields/Trade
M   Movement Cost
D   Defence Multiplier

Type of Improvement

I   Irrigation
F   Farmland
M   Mining
R   Roads
RR   Railroads
O   Engineer Transformation

Terrain Abbreviations

Mt   Mountains
Hi   Hills
Pl   Plains
Gr   Grassland
Fo   Forest
Ju   Jungle
Sw   Swamp
Dt   Desert
Tu   Tundra
Gl   Glacier

Terrain Type Summary

Terrain	🌾🛡💰[6]	M	D	R[1]	I[2]	M	O	R[4]	I[5]	M	O	F	Special 1	🌾🛡💰	Special 2	🌾🛡💰
				Resource Change				Time[3]								
Mountains	010	3	3	–	–	+1🛡	Hi	6	–	10	30	4	*Iron*	040	*Gold*	016
Hills	100	2	2	–	+1🌾	+3🛡	Pl	4	10	10	20	4	*Wine*	104	*Coal*	120
Plains	110	1	–	+1💰	+1🌾	Fo	Gr	2	5	15	10	3	*Wheat*	310	*Buffalo*	130
Grassland	200	1	–	+1💰	+1🌾	Fo	Hi	2	5	10	10	3	*Shield*	210	*Shield*	210
Forest	120	2	1½	–	Pl	–	Gr	4	5	–	20	4	*Silk*	123	*Pheasant*	320
Jungle	100	2	1½	–	Gr	Fo	Pl	4	15	15	20	4	*Fruit*	401	*Gems*	104
Swamp	100	2	1½	–	Gr	Fo	Pl	4	15	15	20	4	*Spice*	304	*Peat*	140
Desert	010	1	–	+1💰	+1🌾	+1🛡	Pl	2	5	5	10	3	*Oil*	040	*Oasis*	310
Tundra	100	1	–	–	+1🌾	–	Dt	2	10	–	10	3	*Furs*	203	*Musk Ox*	310
Glacier	000	2	–	–	–	+1🛡	Tu	4	–	15	20	4	*Oil*	040	*Ivory*	114
Ocean	102	1	–	–	–	–	–	–	–	–	–	–	*Whales*	223	*Fish*	302

[1] Railroads increase Shield production by 50%, rounded down.

[2] Farmland increases Food production by 50%, rounded down.

[3] Time for a Settler to complete the improvement (except Engineer Transformation). An Engineer takes half the time, rounded up. Pollution takes 4 turns for a Setter to clean up.

[4] Roads/Railroads over a River, add 2 turns. Railroads take twice as long as Roads.

[5] Farmland takes the same time as Irrigation.

[6] The central City square always produces at least 110 (Glacier 010).

Optimal Terrain Types

Terrain Type	Food 🌾	Shields 🛡	Trade 💰
		Resource to Maximise	
Unimproved			
Normal	Grassland	Forest	N.A.
Special 1	Fruit	Iron, Oil	Spice, Wine
Special 2	Musk Ox, Oasis, Pheasant	Peat	Gold
Overall	Fruit	Iron, Oil, Peat	Gold
Improved			
Normal	**Grassland**	**Hills**	Desert, Plains, Grassland
Special 1	**Wheat**	Iron, Oil	Spice, Wine
Special 2	Musk Ox, Oasis	**Coal**	Gold
Overall	Musk Ox, Oasis, Wheat	Iron, Oil, Coal	Gold

Resource Calculations for Each City Square

Food Calculation

1. City Square always at least 110 (Glacier 010, Oil(G) 040).
2. Irrigation: +1F (Hi, Pl, Gr, Dt, Tu and their Specials).
3. Farmland: +50% F (round dn).
4. Harbor: +1F (Ocean).
5. If more than 2F, reduce by 1F under Anarchy or Despotism.

Shield Calculation

1. City Square always at least 110 (Glacier 010, Oil(G) 040).
2. King Richard's Crusade: +1S every square (before Industrialization).
3. Mining: +1S (Mt, Dt, Gl), +3S (Hi).
4. Railroads: +50% S (round dn).
5. Offshore Platform: +1S (Ocean).
6. If more than 2S, reduce by 1S under Anarchy or Despotism.

Trade Calculation

1. River: +1T
2. Roads: +1T (Dt, Gr, Pl or if already producing T, eg: River).
3. Colossus: +1T if already producing T (before Flight).
4. +1T if already producing T under Republic or Democracy.
5. If more than 2T, reduce by 1T under Anarchy or Despotism.

City Mechanics and Sample Cities

To **retain their current size**, cities require twice as much Food as they have population units.
To **increase in size**, cities require ten times the size to which they aspire worth of Food in storage.

The cities below meet the following **criteria**:

  * No Special Terrain (except the Special City, where indicated).
  * Grassland produces no Shields (except the City Square).
  * Every city square in use.
  * Every square with Railroads, and either Farmland or Mining, as appropriate.
  * Can support its population without Food caravans.

Factory columns indicate Shield production with Factory, Manufacturing Plant <u>and</u> Power Plant.

Minimum Effort Cities
No Irrigation, no Roads, Hills mined.

Description	Terrain 1	Terrain 2	Size	Shields	Factory
Size (Grassland)	21 Grass	None	21	1	2
Production (Forest)	19 Grass	2 Forest	20	5	12
Production (Hills)	19 Grass	2 Hills	20	7	17

Fully Terraformed Cities (Anarchy, Despotism)

Description	Terrain 1	Terrain 2	Size	Shields	Factory
Grassland	21 Grass	None	32*	1	2
Plains	21 Plains	None	21	21	52
Production 1	10 Grass	11 Forest	21*	23	57
Production 2	10 Grass	11 Hills	21*	34	85
Production 3	19 Plains	2 Forest	20	23	57
Production 4	19 Plains	2 Hills	20	25	62

  * This size cannot be maintained due to 1 Hunger.

Fully Terraformed Cities

Description	Terrain 1	Terrain 2	Size	Shields	Factory
Grassland	21 Grass	None	42	1	2
Plains	21 Plains	None	32*	21	52
Production 1	7 Grass	14 Forest	21	43	107
Production 2	7 Grass	14 Hills	21	57	142
Production 3	10 Plains	11 Forest	21*	43	107
Production 4	10 Plains	11 Hills	21*	54	135

  * Converting the City Square to Grassland will alleviate 1 Hunger
    without affecting Production or Trade.

Special Cities

Description	Terrain	Size	Shields [1]	Crusade [2]	Trade [3]
Largest City [4]	17 Grass, 4 Wheat/Oasis.	46	12–52	77–157	42 / 63
Ideal Trade City	17 Grass, 4 Gold.	34	32–72	87–167	66 / 99
Max Trade City	Same as previous, but all squares Rivers.	34	32–72	87–167	87 / 120
Ideal Production City	4 Grassland, 13 Hills, 3 Coal, 1 Wheat.	20	185–195	280–300	10 / 15
Production (Plains) [5]	4 Plains, 13 Hills, 3 Coal, 1 Wheat.	(–4) [7]	195	300	10 / 15
Production (no Grass) [6]	1 Plains, 16 Hills, 1 Coal, 3 Wheat.	20	187	292	8 / 12
Max Production City	17 Hills, 4 Coal.	(–17) [7]	240	345	0

[1] If given as a range, the higher number is the theoretical limit if all Grassland bears Shields. Production Cities assume the City Square is Mined Hills. If it hasn't been Mined, Shield Production drops by 10, making other options more worthwhile. Note that the Turns Remaining display never reflects production greater than 99.

[2] Production if **King Richard's Crusade** (normally expires with **Industrialization)** and Factories were able to operate together.

[3] The second number is achieved with Superhighways. Trade may be increased further by Rivers, Trade Routes and the **Colossus** (prior to **Flight**). A Republic or Democracy is assumed.

[4] This is also the best Trade city possible without any Trade Specials.

[5] The Ideal Production City, with Grassland replaced by Plains to guarantee maximum Shields.

[6] The ideal self-supporting Production City with guaranteed Shield Production (ie: no Grassland).

[7] Shows the Food Shortfall to maintain a size of 20. This may be compensated by Food Caravans.

Terrain Conversions to Balance a City with 1 Hunger

From → To	Time [1]	Food [2]	Shields	Trade
Plains → Grassland	10	+1	–1	–
Forest → Grassland [3]	19	+3	–3	+1 [5]
Jungle/Swamp → Grassland	14	+3	–	+1 [5]
Grassland → Forest	5	–3	+3	–1 [5]
Grassland → Plains	14	–1	+1	–
Grassland → Hills (F) [4]	10	–1	–	–1 [5]
Grassland → Hills (M) [4]	15	–3	+4	–1 [5]
Silk → Wheat	9	+5	–2	–3
Wine (M) → Wheat	20	+5	–3	–4

[1] Number of turns for an Engineer to perform the conversion, including Irrigation or Mining, if applicable.

[2] When Food production is reduced, an Engineer may be built and immediately disbanded to eliminate hunger.

[3] This transformation is most quickly achieved by first Irrigating to Plains.

[4] Hills may remain Farmland or be Mined.

[5] The change in Trade is one greater in a Republic or Democracy.

Note: Railroads, Farmland and Mines are assumed in all cases.

City Improvements

Military — Unit Care

Improvement	🛡	🌀	Prereq.	Description
Barracks	40	1	None	Ground units: build Veterans, repair in one turn. (Obsoleted by **Gunpowder** and **Mobile Warfare**.)
Port Facility	80	3	Amphib. Warfare	Sea units: build Veterans, repair in one turn.
Airport	160	3	Radio	Air units: build Veterans, repair in one turn. Allow airlifts.

Military — Defence

Improvement	🛡	🌀	Prereq.	Description
City Walls	80	0	Masonry	Triple defence factors vs ground units (except Howitzers).
Coastal Fortress	80	1	Metallurgy	Double defence factors vs shore bombardment by enemy ships.
SAM Missile Battery	100	2	Rocketry	Double defence factors vs air units and non-nuclear missiles.
SDI Defense	200	4	The Laser	Protect everything within three spaces from nuclear attack.

Population

Improvement	🛡	🌀	Prereq.	Description
Granary	60	1	Pottery	Maintain half of Food store during size increase.
Aqueduct	80	2	Construction	Allow growth beyond size 8.
Sewer System	120	2	Sanitation	Allow growth beyond size 12.
Mass Transit	160	4	Mass Production	Eliminate pollution caused by population.

* An *Aqueduct* must be built before a *Sewer System*.

Happiness

Improvement	🛡	🌀	Prereq.	Description
Temple	40	1	Ceremonial Burial	1☹ ⇒ ☺ (two after **Mysticism**).
Colosseum	100	4	Construction	3☹ ⇒ ☺ (four with **Electronics**).
Cathedral	120	3	Monotheism	3☹ ⇒ ☺ (two after **Communism**, +1 with **Theology**).
Police Station	60	2	Communism	Reduce citizens unhappy due to absent units by one per unit.

Financial

Improvement	🛡	🌀	Prereq.	Description
Marketplace	80	1	Currency	Tax and Luxury +50%
Bank	120	3	Banking	Tax and Luxury +50%
Stock Exchange	160	4	Economics	Tax and Luxury +50%
Capitalization	(600)	0	Corporation	Convert all Shield production into Taxes.

* A *Marketplace* must be built before a *Bank*, before a *Stock Exchange*.

Science

Improvement	🛡	🌀	Prereq.	Description
Library	80	1	Writing	Science +50%
University	160	3	The University	Science +50%
Research Lab	160	3	Computers	Science +50%

* A *Library* must be built before a *University*, before a *Research Lab*.

Corruption and Trade

Improvement	🛡	😊	Prereq.	Description
Palace	100	0	Masonry	Mark capital. No corruption and waste in the city; decreased in all nearby cities.
Courthouse	80	1	Code of Laws	Corruption –50%, resistance to bribery. Under Democracy, 1☹ ⇨ ☺
Superhighways	200	5	Automobile	Trade squares +50% Trade. Trade Routes +50% Trade.

Production — Food

Improvement	🛡	😊	Prereq.	Description
Harbor	60	1	Seafaring	Ocean squares +1 Food.
Supermarket	80	3	Refrigeration	Farmland squares +50% Food.

Production —Shields

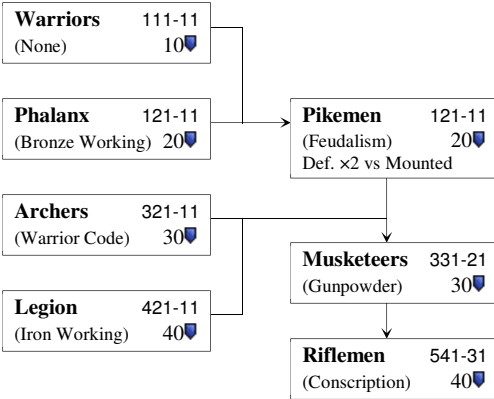| Improvement	🛡	😊	Prereq.	Description
Factory	200	4	Industrialization	Shield production +50%
Manufacturing Plant	320	6	Robotics	Shield production +50%
Power Plant	160	4	Refining	Factory ×2.
Nuclear Plant	160	2	Nuclear Power	Factory ×2. Shield pollution –50%. Risk of meltdown until **Fusion Power**.
Hydro Plant	240	4	Electronics	Factory ×2. Shield pollution –50%. Safer than Nuclear Plant. Only next to river.
Solar Plant	320	4	Environmentalism	Factory ×2. Shield pollution –100%. Slow global warming.
Recycling Center	200	2	Recycling	Shield pollution –66%
Offshore Platform	160	3	Miniaturization	Ocean squares +1 Shield.

* A *Factory* must be built before a *Manufacturing* or power plant.

* Only one power plant may be active at any time.

* Although any power plant may be built at any time, building one plant precludes the building of inferior plants, in the following order: *Power*, *Nuclear*, *Hydro*, *Solar*.
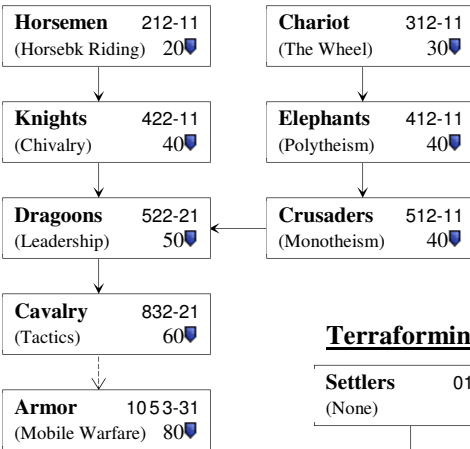
Spaceship

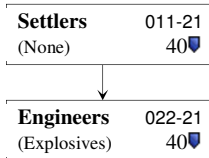| Improvement	🛡	😊	Prereq.	Max	Description
Spaceship Component	160	0	Plastics	8 ea	**Thrust:** Thrust +25% **Fuel:** Fuel for one Thrust Component.
Spaceship Module	320	0	Superconductor	4 ea	**Habitation:** living space for 10,000 colonists. **Life Support:** support for one Habitation Module. **Solar Panel:** power for two other modules.
Spaceship Structural	80	0	Space Flight	39	Link *Components* and *Modules* together.

Unit Upgrade Paths (Ground Units)
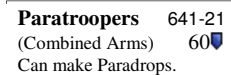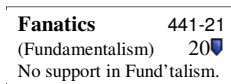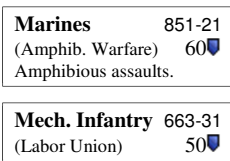
Defensive Units

Warriors	111-11
(None)	10🛡

Phalanx	121-11
(Bronze Working)	20🛡

Pikemen	121-11
(Feudalism)	20🛡
Def. ×2 vs Mounted	

Archers	321-11
(Warrior Code)	30🛡

Legion	421-11
(Iron Working)	40🛡

Musketeers	331-21
(Gunpowder)	30🛡

Riflemen	541-31
(Conscription)	40🛡

Mounted Units

Horsemen	212-11
(Horsebk Riding)	20🛡

Chariot	312-11
(The Wheel)	30🛡

Knights	422-11
(Chivalry)	40🛡

Elephants	412-11
(Polytheism)	40🛡

Dragoons	522-21
(Leadership)	50🛡

Crusaders	512-11
(Monotheism)	40🛡

Cavalry	832-21
(Tactics)	60🛡

Armor	10 5 3-31
(Mobile Warfare)	80🛡

Terraforming Units

Settlers	011-21
(None)	40🛡

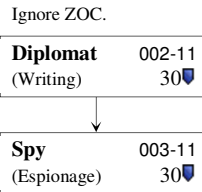| Engineers	022-21
(Explosives)	40🛡

Miscellaneous Ground Units

Marines	851-21
(Amphib. Warfare)	60🛡
Amphibious assaults.	

Mech. Infantry	663-31
(Labor Union)	50🛡

Fanatics	441-21
(Fundamentalism)	20🛡
No support in Fund'talism.	

Paratroopers	641-21
(Combined Arms)	60🛡
Can make Paradrops.	

Artillery Units

Catapult	611-11
(Mathematics)	40🛡

Cannon	811-21
(Metallurgy)	40🛡

Artillery	10 1 1-22
(Machine Tools)	50🛡

Howitzer	12 2 2-32
(Robotics)	70🛡
Ignores City Walls	

Espionage Units

Ignore ZOC.

Diplomat	002-11
(Writing)	30🛡

Spy	003-11
(Espionage)	30🛡

Trade Units

Ignore ZOC.

Caravan	011-11
(Trade)	50🛡

Freight	012-11
(The Corporation)	50🛡

Explorers	011-11
(Seafaring)	30🛡
Move cost = 1/3	

Partisans	441-21
(Guerrilla Warfare)	50🛡
Move cost 1/3. Ignore ZOC	

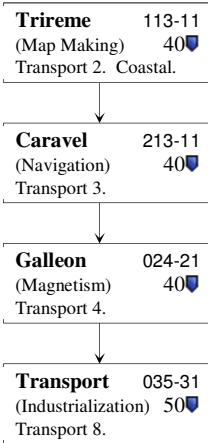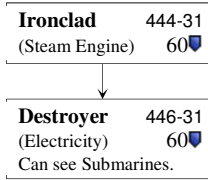| Alpine Troops	551-21
(Tactics)	50🛡
Move cost = 1/3	

Unit Upgrade Paths (Sea Units)

Sea Unit movement rates are increased as follows: Lighthouse +1 (Magnetism),
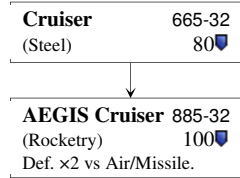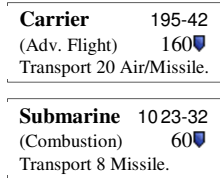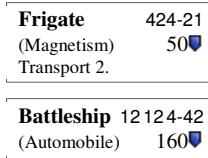Magellan's Expedition +2, Nuclear Power +1.

Transport Ships

Trireme   113-11
(Map Making)   40🛡
Transport 2. Coastal.

↓

Caravel   213-11
(Navigation)   40🛡
Transport 3.

↓

Galleon   024-21
(Magnetism)   40🛡
Transport 4.

↓

Transport   035-31
(Industrialization) 50🛡
Transport 8.

Small Ships

Ironclad   444-31
(Steam Engine) 60🛡

↓

Destroyer   446-31
(Electricity)   60🛡
Can see Submarines.

Miscellaneous Sea Units

Frigate   424-21
(Magnetism)   50🛡
Transport 2.

Battleship 12 12 4-42
(Automobile)   160🛡

Carrier   195-42
(Adv. Flight)   160🛡
Transport 20 Air/Missile.

Submarine   10 23-32
(Combustion)   60🛡
Transport 8 Missile.

Cruisers

Can see Submarines.

Cruiser   665-32
(Steel)   80🛡

↓

AEGIS Cruiser 885-32
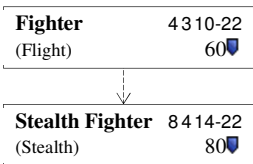(Rocketry)   100🛡
Def. ×2 vs Air/Missile.

Unit Upgrade Paths (Air Units)

Air units ignore City Walls and ZOC.
Air units (except Helicopters) must finish their turn on a City, Airbase or Carrier.
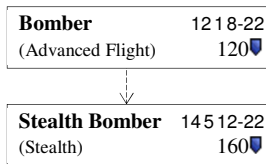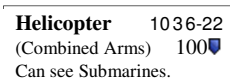
Fighters

Can attack Air Units.

Fighter   4 3 10-22
(Flight)   60🛡

⇣

Stealth Fighter 8 4 14-22
(Stealth)   80🛡

Bombers

Land every other turn.

Bomber   12 1 8-22
(Advanced Flight) 120🛡

⇣

Stealth Bomber 14 5 12-22
(Stealth)   160🛡

Missiles

Cruise Missile 18 0 12-13
(Rocketry)   60🛡

Nuclear Missile 99 0 16-11
(Rocketry)   160🛡

Helicopter 10 3 6-22
(Combined Arms) 100🛡
Can see Submarines.
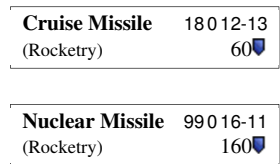
Note: Leonardo's Workshop is made obsolete by **Automobile**, which can be skipped by
acquiring **Mass Production** and **Mobile Warfare** (by cheating or stealing). Dotted lines
indicate upgrades that are only achievable in this manner.

Superhighways Earnings Analysis

Δ Trade	10% Tax	10% Nett	20% Tax	20% Nett	30% Tax	30% Nett	40% Tax	40% Nett	50% Tax	50% Nett	60% Tax	60% Nett	70% Tax	70% Nett	80% Tax	80% Nett	90% Tax	90% Nett	100% Tax	100% Nett
1	0	–5	0	–5	0	–5	0	–5	2	–3	2	–3	2	–3	2	–3	2	–3	2	–3
2	0	–5	0	–5	2	–3	2	–3	2	–3	2	–3	2	–3	5	0	5	0	5	0
3	0	–5	2	–3	2	–3	2	–3	5	0	5	0	5	0	5	0	7	2	7	2
4	0	–5	2	–3	2	–3	5	0	5	0	5	0	7	2	7	2	10	5	10	5
5	2	–3	2	–3	5	0	5	0	7	2	7	2	10	5	10	5	12	7	12	7
6	2	–3	2	–3	5	0	5	0	7	2	10	5	10	5	12	7	12	7	15	10
7	2	–3	2	–3	5	0	7	2	10	5	10	5	12	7	15	10	15	10	17	12
8	2	–3	5	0	5	0	7	2	10	5	12	7	15	10	15	10	17	12	20	15
9	2	–3	5	0	7	2	10	5	12	7	12	7	15	10	17	12	20	15	22	17
10	2	–3	5	0	7	2	10	5	12	7	15	10	17	12	20	15	22	17	25	20
11	2	–3	5	0	7	2	10	5	15	10	17	12	20	15	22	17	25	20	27	22
12	2	–3	5	0	10	5	12	7	15	10	17	12	20	15	25	20	27	22	30	25
13	2	–3	7	2	10	5	12	7	17	12	20	15	22	17	25	20	30	25	32	27
14	2	–3	7	2	10	5	15	10	17	12	20	15	25	20	27	22	32	27	35	30
15	5	0	7	2	12	7	15	10	20	15	22	17	27	22	30	25	35	30	37	32

(The table columns are grouped under the heading "Tax Rate", with sub-columns labelled "Tax" and "Nett" for each rate.)

* Additional Tax earned and Nett change in income achieved by building *Superhighways*, assuming a *Stock Exchange* has already been built. *Superhighways* increase Trade by 50% (rounded down) in any square with Roads or Railroads, and for every Trade Route; the sum of these increases is ΔTrade.

* Amounts may vary by up to 3 on either side of a boundary point.

Tax, Luxury, Science and Trade Calculations

These calculations are complicated by the need for intermediate results to be whole numbers. Science and Luxuries are rounded down from a half, so that Tax + Science + Luxuries = Trade.

$$\text{Science} = [\ \text{Trade} \times \text{Science Rate} + 0.49\ ]$$

$$\text{Luxuries} = [\ \text{Trade} \times \text{Luxury Rate} + 0.49\ ]$$

$$\text{Tax} = \text{Trade} - (\ \text{Science} + \text{Luxuries})$$

$$\text{Tax} = [\ \text{Trade} \times (\ \text{Science Rate} + \text{Tax Rate}\ ) + 0.5\ ] + \lfloor\ 0.5 - \text{Trade} \times \text{Science Rate}\ \rfloor$$

A *Marketplace*, *Bank* or *Stock Exchange* will increase Tax earnings by a half each (rounded down):
(T is Trade, r_t is the Tax Rate, r_s is the Science Rate, r_l is the Luxury Rate.)

Base Tax:
$$t_{\text{base}} = [\ T\,(r_t + r_s) + \tfrac{1}{2}\ ] + \lfloor\ \tfrac{1}{2} - T\,r_s\ \rfloor$$
$$= [\ T\,r_t + \tfrac{1}{2}\ ] \pm 1$$

with Marketplace:
$$t_{\text{Marketplace}} = [\ 3t_{\text{base}} / 2\ ]$$

with Bank:
$$t_{\text{Bank}} = 2t_{\text{base}}$$

with Stock Exchange:
$$t_{\text{Stock Exchange}} = [\ 5t_{\text{base}} / 2\ ]$$
$$= 5/2\ [\ T\,r_t + \tfrac{1}{2}\ ] \pm 3$$

If $r_l = 0$, then $r_s = 1 - r_t$, hence $t_{\text{base}} = [\ T\,r_t + \tfrac{1}{2}\ ]$ (similarly if $r_s = 0$)

The construction of *Superhighways* increases Trade by ΔT. The flow-on effect on Taxes (Δt) may be estimated by replacing T with ΔT.

[x] indicates rounding towards zero. $\lfloor x \rfloor$ indicates rounding down. Δx indicates a change in x.

Tax Earnings Analysis

Base Tax	Marketplace				Bank					Stock Exchange				
	Tax		Nett*		Tax		Nett			Tax		Nett		
	Δ	Σ	Δ	Σ	Δ	Σ	Δ	Σ	Σ*	Δ	Σ	Δ	Σ	Σ*
0	+0	0	−1	−1	+0	0	−3	−4	−3	+0	0	−4	−8	−7
1	+0	1	−1	0	+1	2	−2	−2	−1	+0	2	−4	−6	−5
2	+1	3	+0	2	+1	4	−2	0	1	+1	5	−3	−3	−2
3	+1	4	+0	3	+2	6	−1	2	3	+1	7	−3	−1	0
4	+2	6	+1	5	+2	8	−1	4	5	+2	10	−2	2	3
5	+2	7	+1	6	+3	10	+0	6	7	+2	12	−2	4	5
6	+3	9	+2	8	+3	12	+0	8	9	+3	15	−1	7	8
7	+3	10	+2	9	+4	14	+1	10	11	+3	17	−1	9	10
8	+4	12	+3	11	+4	16	+1	12	13	+4	20	+0	12	13
9	+4	13	+3	12	+5	18	+2	14	15	+4	22	+0	14	15
10	+5	15	+4	14	+5	20	+2	16	17	+5	25	+1	17	18
11	+5	16	+4	15	+6	22	+3	18	19	+5	27	+1	19	20
12	+6	18	+5	17	+6	24	+3	20	21	+6	30	+2	22	23
13	+6	19	+5	18	+7	26	+4	22	23	+6	32	+2	24	25
14	+7	21	+6	20	+7	28	+4	24	25	+7	35	+3	27	28
15	+7	22	+6	21	+8	30	+5	26	27	+7	37	+3	29	30

* **Adam Smith's Trading Co.** affects the Nett totals by waiving the maintenance cost of a Marketplace. In this case, the Nett columns for a Marketplace are the same as the Tax columns.

* Hence, a **Marketplace** is only profitable to build once the city is earning 4 coins per turn (2 with Adam Smith's Trading Co.); a **Bank** once the city is earning 10 coins; and a **Stock Exchange** once it is earning 20 coins per turn.

Superhighways Cost-Benefit Analysis
Additional Trade Required to Achieve Specified Increase in Nett Income

Increase in Income	Tax Rate									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Break Even	15	8	5	4	3	3	3	2	2	2
+2	25	13	9	7	5	5	4	4	3	3
+5	35	18	12	9	7	6	5	5	4	4
+7	45	23	15	12	9	8	7	6	5	5
+10	–	28	19	14	11	10	8	7	7	6

* Estimate the increase in trade from *Superhighways* (number of Grassland and Plains squares plus half of Trade Routes) and compare with the body of the table.

* **Superhighways** increase the amount of Trade earned in squares with Roads or Railroads by 50% (rounded down), and have the same effect on Trade Routes. Factoring in the cost of maintaining the Superhighways (5 coins), the table shows the approximate increase in Trade (main body) required to increase nett income by the amount shown (left side), given for each Tax Rate (top).

* A **Marketplace**, **Bank** and **Stock Exchange** are assumed to have been built. The break-even and profit points are equal without a *Stock Exchange*, and are equal to the profit point (+2) with a *Stock Exchange*.

* The required increase in Trade may vary by ±1 as a result of rounding during the tax calculation.

* *Superhighways* are, in general, only worth building in a Republic or Democracy.

Production Cities

No Wheat

City Type	City Square	Shields	Shields (Crusade)	Food Surplus	Trade	Terrain Grass	Plains	Hills	Wheat	Coal
1	H	180–195	270–300	+1	12/18	6	0	11	0	4
2	H	195	300	−5	12/18	0	6	11	0	4
3	H	172	277	+1	18/27	0	9	8	0	4
4	H	**240**	345	−17	0/0	0	0	17	0	4
1	G	172–187	262–292	+2	14/21	7	0	10	0	4
2	G	187	292	−4	14/21	1	6	10	0	4
3	G	172	277	0	18/27	1	8	8	0	4
4	G	**232**	337	−16	2/3	1	0	16	0	4

More Coal than Wheat

City Type	City Square	Shields	Shields (Crusade)	Food Surplus	Trade	Terrain Grass	Plains	Hills	Wheat	Coal
1	H	**185–195**	280–300	0	10/15	4	0	13	1	3
2	H	**195**	300	−4	10/15	0	4	13	1	3
3	H	180	285	0	14/21	0	6	11	1	3
4	H	225	330	−12	2/3	0	0	17	1	3
1	P	177–187	272–292	0	12/18	4	1	12	1	3
2	P	187	292	−4	12/18	0	5	12	1	3
3	P	172	277	0	16/24	0	7	10	1	3
4	P	217	322	−12	4/6	0	1	16	1	3

Equal Coal and Wheat

City Type	City Square	Shields	Shields (Crusade)	Food Surplus	Trade	Terrain Grass	Plains	Hills	Wheat	Coal
1	H	180–187	277–292	+2	10/15	3	0	14	2	2
2	H	187	292	−1	10/15	0	3	14	2	2
3	H	180	285	+1	12/18	0	4	13	2	2
4	H	210	315	−7	4/6	0	0	17	2	2
1	G	**182–187**	282–292	0	10/15	3	0	14	2	2
2	G	**187**	292	−2	10/15	1	2	14	2	2
3	G	180	285	0	12/18	1	3	13	2	2
4	G	202	307	−6	6/9	1	0	16	2	2

More Wheat than Coal

City Type	City Square	Shields	Shields (Crusade)	Food Surplus	Trade	Terrain Grass	Plains	Hills	Wheat	Coal
1	H	185–187	287–292	+1	8/12	1	0	16	3	1
2, 3	H	**187**	292	0	8/12	0	1	16	3	1
4	H	195	300	−2	6/9	0	0	17	3	1
1	G	177–180	280–285	+2	10/15	2	0	15	3	1
2, 3	P	**180**	285	0	10/15	0	2	15	3	1
4	P	187	292	−2	8/12	0	1	16	3	1

No Coal

City Type	City Square	Shields	Shields (Crusade)	Food Surplus	Trade	Terrain				
						Grass	Plains	Hills	Wheat	Coal
1–4	H	180	285	+3	8/12	0	0	17	4	0
1–4	G	172	277	+4	10/15	1	0	16	4	0

Key

Five different tables are provided, as the desired mix of Type 1 Specials (Wheat) and Type 2 Specials (Coal) cannot always be located.

The government is assumed to be a Republic or Democracy.

City Types

Type 1: Self-supporting City with greatest potential Shield Production.

Type 2: Type 1 City with Production guaranteed by replacing Grassland with Plains; usually Hungry.

Type 3: Self-supporting version of Type 2 City.

Type 4: Maximum Production City, generally composed of all Hills and exhibiting Hunger.

City Square

The City Square may be Hills, Plains or Grassland.

Two versions of each City Type are presented for each mix of Special Terrain: one with Mined Hills as the City Square, and one with either Plains or Grassland. Plains or Grassland is selected to ensure the Food Surplus is an even number, as such a city may be maintained indefinitely.

A City built on Hills that have not been Mined, produces 10 Shields less than indicated, making other terrain types a better choice. A City Square with Hills may be mined during the founding of a city or during conversion from Grassland to Hills, by ensuring the Mining action spans the founding or end of conversion.

Shields

A *Factory*, *Manufacturing Plant* and power plant are assumed.

If given as a range, the higher number is the theoretical limit if all Grassland bears Shields.

If given in bold, the city is built on optimal terrain for this city type, also indicating the ideal mix of Wheat and Coal. Two optimal configurations are indicated for each city type: one built on Hills, the other not.

Shields (Crusade)

Production if **King Richard's Crusade** (normally expires with **Industrialization**) and *Factories* were able to operate together.

Food Surplus

The city is assumed to be size 20 (hence exploiting all 21 squares in its radius).

A positive Food Surplus indicates the city may grow further. A negative Food Surplus indicates Hunger, which may be compensated by Food Caravans.

If the Food Surplus is odd (and the City is built on Hills), the City will eventually find itself on the brink of starvation unless one square is converted between Plains and Grassland. A successful conversion to Shield Grassland will maintain Shield Production.

Trade

The second number is achieved with Superhighways. Trade may be increased further by Rivers, Trade Routes and the **Colossus** (prior to **Flight**), or decreased by a different type of government.

Terrain

The number of Terrain squares of each type required for an optimal city.

All Terrain is assumed to feature Railroads, and either Farmland or Mining, as appropriate.

Explanatory Notes

This booklet is intended as a reference, so much of the information is presented in abbreviated form; with time, it will become second nature. Some of the more obscure conventions are explained below.

Wonders: Advances in brackets indicate when the effect of the Wonder expires.

Terrain Improvements Charts: These charts provide information about terrain resources and terrain interconversion. The three charts also reflect the effects of various governments on terrain resources. Shorthand is used to compact the information, and bears further explanation.

    Each box contains information about one terrain type and its specials. Groups of three numbers indicate Food, Shield and Trade produced by this terrain; the first set is the natural production of unimproved terrain; numbers in brackets indicate the maximum possible production for fully improved terrain (Railroads, and Farmland or Mines, but no Rivers, and ignoring Superhighways). For Hills and Desert the first set of numbers in brackets corresponds to Farmland, the second to Mines. For Jungle and Swamp, asterisks indicate the components further improved by Roads or Railroads. Ocean squares are maximised by a Harbor and Offshore Platform rather than terrain improvement. The base effects of Roads (R), Fortress (F), Irrigation (I) and Mining (M) are indicated below, followed by the number of turns for a Settler/Engineer to complete the improvement, in brackets. Any defensive benefit from the terrain appears on the right. Arrows indicate how Engineers may convert one terrain to another and how long it takes. Finally, the sad face beside Glacier represents the unhappy citizen caused by attempting to extract resources from a Glacier.

Terrain Tables: Terrain is characterised by five numbers; the first three are the Food, Shields, Trade code mentioned above; the last two indicate the movement cost of the terrain (M) and the defence multiplier (D). Each type of terrain (except Grassland) may bear one of two Special Resources; when terrain is converted from one base type to another, the resource is also converted, according to a predictable pattern. Hence there are two independent sets of Special Terrains, and special resources may only be converted to others in their own set. Both Special Resources for Grassland are the same, referred to as Shield Grassland. Many squares without Special Resources nevertheless bear Shields when converted to Grassland.

Optimal Terrain Types: Engineers may be used to optimise the resources generated by each city square by converting one terrain to another. This table gives the terrains and resources to aim for in order to maximise Food, Shield or Trade production. For most cities, the items in bold represent the best value.

Resource Calculations: This is the full set of rules used by the game to calculate the resource production of a square within the city radius. All calculations start with the base resource production of the terrain. The first rule is most interesting, ensuring a city built on any non-Glacial terrain will always generate at least one Food *and* one Shield from its central City Square. Hence, building a city on normal Grassland will always provide a bonus Shield.

Sample Cities: A city is most productive when every city square is in use (size 20). Maximum Shield Production is achieved by balancing Food and Shield-generating squares, as indicated in the tables (ignoring the beneficial effects of Minstrels, Scientists and Tax Collectors). The Special Cities are the best way to use Special Terrain to maximise city Size, Trade or Production. The various Production options indicate different strategies to maximise Production. Note that there will normally be sufficient Shield Grassland to make the "no Grass" option superfluous, and while the "Max Production City" is somewhat difficult to maintain, the "Plains" option requires no more than a very realistic two Food Caravans. A more complete examination of Production optimisation options is provided amongst the supplementary tables.

Terrain Conversions to Balance a City with 1 Hunger: Towards the end of the game, cities will tend to reach their maximum size and stop growing. If a city's Food production is odd, it will end up with a negative Food Surplus of 1 (Hunger), eventually exhausting the city's Food supply and causing the loss of Engineers and a reduction in Size. If the city is celebrating We Love the President Day, this will occur repeatedly every couple of turns. A city may be planned to avoid such a situation right from the beginning. Corrections may be made by trading resource squares between adjacent cities or by converting terrain according to this table. Shown are the most common conversions between odd and even Food-producing terrain, the most useful of which are: 1) Grassland to Forest; 2) Plains to Grassland on the City Square. A city's Food production is most easily planned by carefully managing the conversion of Jungle and Swamp to either Forest or Grassland.

City Improvements: Tables indicate the Shield cost to build, maintenance cost in Gold, prerequisite Advance, effect and obsolescence. Financial, Science and Production improvements apply their adjustments together rather than consecutively; for example, a Library and University together will exactly double Science production. Halves are rounded down subsequently. Even though these improvements must be built in order, losing an earlier one does not counteract the effect of later improvements, except for power Plants. A power Plant (of any variety) increases Shield Production by half of the base value, but *only* if the city has a currently-operating Factory *or* Manufacturing Plant.

Unit Upgrade Paths: Unit information is presented so as to show the effects of **Leonardo's Workshop**, but all information about each unit is shown: the prerequisite Technology Advance is in brackets; the five-number code (ADM-HF) gives values for Attack, Defence, Movement, Hit Points and Firepower (two-digit values are separated to avoid ambiguity); the number of Shields required to build the unit is on the right; with any special abilities listed below. Dashed arrows indicate upgrades that Leonardo's Workshop would do if it didn't expire before those units are available. ZOC stands for Zones of Control, which may be ignored by some units, allowing free passage through enemy territory. Move cost 1/3 indicates the unit can move three squares each turn over any terrain (and as far it likes along Railroads). Carriers can only transport 20 Air or Missile units; however, more can safely end their turn on a Carrier, a trick that can allow air units to be permanently stationed over the sea by using the Sleep command, then moving the Carrier.

Tax Earnings Analysis: Δ stands for the change in Tax or Nett income; Σ stands for total Tax or Nett income. Most worthy of note is that a Marketplace, Bank or Stock Exchange is only profitable if the city is earning 4, 10 or 20 tax without it, respectively. The effect of a change in Tax Rate may also be estimated.

Superhighways Cost-Benefit Analysis: The additional Trade from Superhighways may be estimated by counting the number of Grassland and Plains squares and adding half the Trade from Trade Routes. Calculating the flow-on effect to Tax income involves three roundings, making this table somewhat imprecise. This rounding is also the reason why Nett Income can only increase by 0, +2, +5, etc. Nonetheless, the table gives a good idea of when Superhighways will actually support themselves, and what effect changing the Tax Rate will have on that self-sufficiency. A more complete analysis is in the supplementary tables.

Governments: Although the game manual divides governments into old and new, from the point of view of game mechanics, they are better divided into three groups: 1) Anarchy and Despotism; 2) Monarchy, Fundamentalism and Communism; 3) Republic and Democracy.

Supplementary Tables

The following information is considered optional — more a curiosity than directly useful to play.

Superhighways Earnings Analysis: Can be used to roughly determine the effect of changes in Tax Rate on the financial effectiveness of Superhighways. In reality, this also depends on the Science Rate.

Tax, Luxury, Science and Trade Calculations: Formulae used to estimate or accurately calculate the Tax earnings, Science or Luxuries of a city. Square brackets [ ] indicate rounding, as shown. Amounts ± occur when rounded terms are combined imprecisely; this type of simplification is useful for rough estimates.

Production Cities: The optimal mix of terrain for a Production City depends on four things: 1) the mix of Type 1 and 2 Special Resources; 2) the terrain of the City Square (Mined Hills are best); 3) whether the city will support itself or rely on Food Caravans; and 4) the availability of Shield Grassland (Plains are better than non-Shield Grassland). The tables show the mix of terrain that will maximise Shield Production for each combination of these parameters, assuming all squares have Railroads, and Farmland or Mining.

Governments

Government	Unit Cost Limit [1]	Food/ Settler [2]	Happiness [3]	Corruption	Max T/L/S [4]	Special
Anarchy	city size	1	3u ☹ ⇨ ☺ [6]	Very High	60% [10]	Only while changing governments. Similar to Despotism.
Despotism	city size	1	3u ☹ ⇨ ☺ [6]	High [9]	60%	Squares producing three or more of any resource (Food, Shields, Trade) produce one less of that resource.
Monarchy	3	1	3u ☹ ⇨ ☺ [6]	Moderate [9]	70%	
Fundamentalism	8 [5]	2	N.A. [7]	Very low	80%	All Science production is halved. Improvements converting ☹ ⇨ ☺ instead produce equivalent "tithes" and require no maintenance. Diplomatic penalties for terrorist acts are reduced.
Communism	3	2	3u 2☹ ⇨ ☺ [6]	None	80%	All new Spy units are Veterans.
Republic	all	2	1☹ /unit away [8]	Low [9]	80%	Trade-producing squares produce +1 Trade. Senate may force peace.
Democracy	all	2	2☹ /unit away [8]	None	100%	Trade-producing squares produce +1 Trade. Immunity to bribery. Senate may force peace.

[1] Beyond this limit, each unit costs one Shield per turn to maintain.

[2] Settlers consume this amount of Food per turn.

[3] Units present or absent from a city may make citizens happy or unhappy.

[4] This is the maximum rate at which Science, Tax or Luxury production may be set.

[5] Fanatics above this limit do not require maintenance.

[6] Martial law may be instituted by up to three military units, each thereby making either one or two unhappy citizens content.

[7] Under Fundamentalism, no citizen is ever unhappy.

[8] Each unit not in a friendly city (or in a Fortress within three squares of a friendly city) causes one or two citizens in its home city to become unhappy. Application of this rule under Republic varies with difficulty level.

[9] The farther a city is from its capital, the higher its level of corruption.

[10] During times of Anarchy, no maintenance is charged, no taxes are collected and no scientific research conducted.