2020 WARning, Part II: Perspectives

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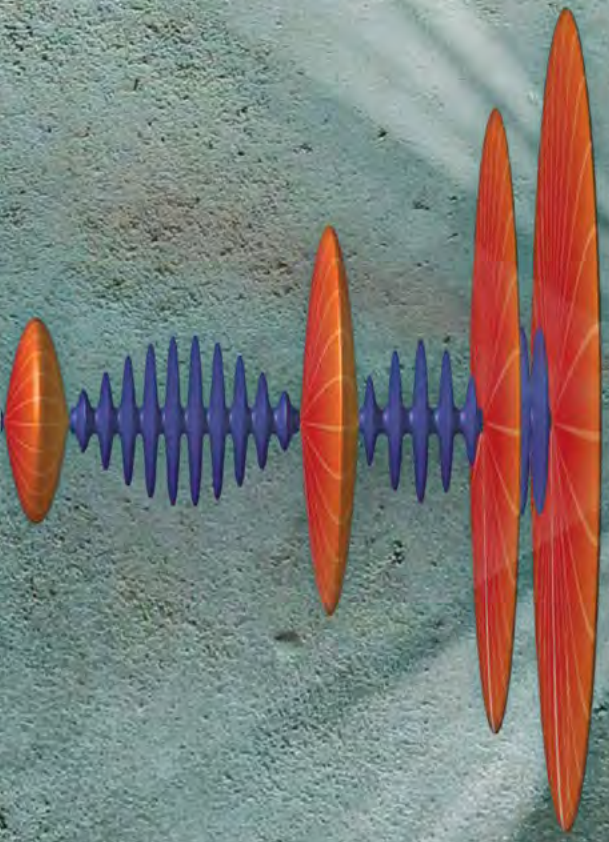
2020 WARNING

PART II: **PERSPECTIVES**



Patterns in war dynamics reveal disturbing developments

Ingo Piepers

2020 WARNING

SOCIAL INTEGRATION AND EXPANSION IN ANARCHISTIC SYSTEMS: *HOW CONNECTIVITY AND OUR URGE TO SURVIVE DETERMINE AND SHAPE THE WAR DYNAMICS AND DEVELOPMENT OF THE SYSTEM*

PART II: **PERSPECTIVES**

This study consists of the following parts:

The illustration on the first page of this book depicts the first finite-time singularity dynamic (1495-1945) as a 'turbine' consisting of four accelerating cycles that propels the System to the next level of social integration and expansion. Increasingly severe systemic wars, and non-systemic wars during relatively stable periods, are respectively shown as red and blue discs.

About the Author

Ingo Piepers studied 'International Relations and Security' at the Royal Netherlands Naval College (1980-1985). In 1997 he obtained a Master's Degree in Business Administration. In 2006 he obtained his Ph.D. from the University of Amsterdam with a doctoral thesis on the war dynamics and development of the International System.
From 1985 until 1998 Ingo served as an officer in the Royal Netherlands Marine Corps. Since 1998 he worked in a number of diverse functions in the Netherlands and in Indonesia.

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PART II

PERSPECTIVES

History is a vast early warning system

Norman Cousins

Introduction

In this part I discuss fifteen different 'perspectives' of the System; each perspective focuses on specific aspects and properties of the System. This multi-perspective approach makes it possible to acquire new insights in the exact workings of the System, and to determine relationships between properties.

I discuss the following perspectives:

1. ***The System depicted as an input-throughput-output model***
2. ***The System (1495-1945) depicted as a finite-time singularity accompanied by four accelerating cycles***
3. ***The System depicted as a coherent 'set' of closely related and optimized dynamics that made up the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)***
4. ***The System depicted as an undistorted finite-time singularity dynamic***
5. ***The System depicted as a binary network of war switches***
6. ***The System depicted as a slowly-driven, interaction-dominated threshold system***
7. ***The System depicted as a dynamical system***
8. ***The System depicted as a path-dependent dynamic***
9. ***The System depicted as a sequence of dynamics with particular characteristics***
10. ***The System depicted as energy transfers***
11. ***The System depicted as an interacting system of a deterministic and contingent domains, and accompanying variables***
12. ***The dynamic System depicted as a change model***
13. ***The finite-time singularity depicted as a distinct phase in a long-term process of social integration and expansion (SIE)***
14. ***The first international order of the System depicted as a damped oscillator***
15. ***The System depicted as a set of early warning signals***

Each chapter has a similar structure: First I show a schematic representation of the aspects and properties the perspective focuses on, followed by an explanation and discussion of the perspective.

1 The System depicted as an input-throughput-output model

1.1 Schematic representation of the System as an input-throughput-output model

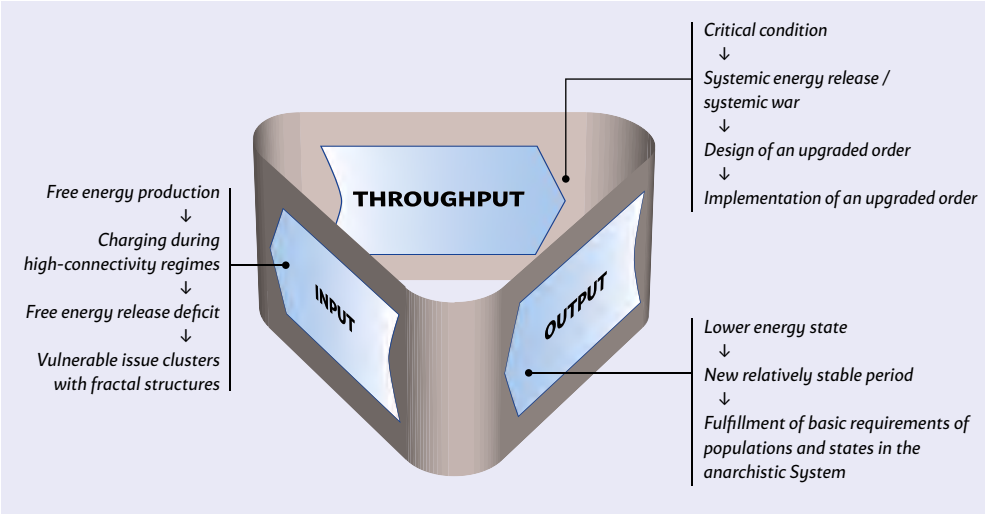

Figure 34 *This figure depicts the System as an input-throughput-output model of the anarchistic System.*

1.2 Explanation of the model

The System can be depicted as an input-throughput-output model that transforms free energy in the form of tensions into new upgraded international orders in the contingent domain of the System.

1 *Input*. Free energy is the input of the System. The free energy has its origin in the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. In the contingent domain, free energy is manifested as tensions. Increasing connectivity results in increasing interdependence of states, among other things for their mutual security. Security is a basic requirement of states and is essential for their survival.

Incompatibility between connectivity and security produces increasing numbers of security issues, and accompanying tensions and hostilities. A security dilemma that acts as a positive feedback mechanism is inherent to anarchistic systems; it further fuels tensions and hostilities in the System. These issues and tensions also produce alliance dynamics, characterized by efforts of states to ensure their security by forming alliances with other states. The issues and tensions can be transformed into destructive energy.

2 *Throughput*. The free energy the System produces crystalizes into vulnerable issue clusters. Vulnerable issue clusters are networks of states and issues that are just one step from being activated; activation results in war.

Depending on the connectivity of the vulnerable issue network and on the thresholds states use to make war decisions ('war' or 'no war'), the System reaches a percolation condition, becomes critical, and is highly susceptible to perturbations that can be communicated system-wide. System-wide communication, coordination, and planning are enabled through a correlation length of one that spans the System at criticality.

Given the condition of the System, a trigger, for example, a small incident, then unavoidably activates an issue, causing a local war. The percolation and critical condition of the System, however, ensure that this initially local war sets in motion a domino effect, causing a system-wide systemic war.

Because the correlation length of the System at criticality is one and spans the System, systemic wars are system-wide, and allow for the system-wide 'coordinated' destruction of issues and tensions, and for the design and implementation of a new system-wide order. The new order that emerges from a systemic war produces a new relatively stable period that enables further growth of the connectivity of the System.

Through systemic wars, free energy is put to work, in accordance with the principle of 'least free energy' - the second law of thermodynamics - resulting in a new order that enables a lower energy state of the System.

Four cycles can be distinguished in the war dynamics of the System. Each cycle consists of a relatively stable period followed by a systemic war. Over time, the incompatibility between the increasing connectivity of the System and security intensified. The increasing incompatibility, in combination with an increasing pace of life in the System that also impacts the speed at which tensions spread, caused the frequency of cycles to accelerate, and the severity of systemic wars to grow at an increasing rate. The increasing pace of life is also attributable to the increasing connectivity of the System.

3 *Output*. The output in Europe, the core of the System consisted of three successive orders that could still bridge the intrinsic tensions between increasing connectivity and anarchy.

Cycles, relatively stable periods and critical periods produced by the anarchistic System through the first finite-time singularity dynamic (1495-1945)				
Cycle	Period	International order / Relatively stable period	Critical period / Systemic war	Name of systemic war
1	1495-1648	1495-1618	1618-1648	Thirty Years' War
2	1648-1815	1648-1792	1792-1815	French Revolutionary and Napoleonic Wars
3	1815-1914	1815-1914	1914-1918	The First World War
4	1918-1945	1918-1939	1939-1945	The Second World War

Table 38 *This table specifies successive cycles, relatively stable periods (international orders) and critical periods (systemic wars) the anarchistic System produced by means of the first finite-time singularity dynamic (1495-1945).*

The fourth systemic war (1939-1945), however, could not produce a viable order in an anarchistic setting, given the level of connectivity and interdependence the System had reached. In 1939, the System reached the critical connectivity threshold (the singularity in finite time); the incompatibility of increasing connectivity and security reached infinite levels, resulting in the production of infinite levels of free energy restricted only by so-called 'finite-size effects,' and causing a collapse of the no longer viable anarchistic System. To ensure compliance with the second law of thermodynamics and the survival of states, the System produced a phase transition, allowing for the implementation of a fundamentally different non-anarchistic System. The second law of thermodynamics 'forced' the System to implement two dedicated hierarchies in the core of the System (Europe).

The fourth systemic war (the Second World War, 1939-1945) constituted the phase transition. Two dedicated hierarchies were initially implemented in Europe, the core of the System: A Western hierarchy controlled by the United States, and an Eastern hierarchy controlled by the Soviet Union. In 1989 when the Eastern hierarchy collapsed, the Western hierarchy absorbed components (eastern European states) of the Eastern hierarchy.

Through the implementation of two dedicated hierarchies, with the Western hierarchy based on democratic and capitalistic organizing principles and the Eastern hierarchy based on an authoritative and centralized economic principles of direct allocation, anarchy was neutralized within these respective hierarchies, and the incompatibility between increasing connectivity and security resolved, stopping the production of free energy within these hierarchies. The (initial) net-result was a decrease in the production of free energy in the System; however, this only was a temporary respite, until the rivalries between the United states and the Soviet Union – and the respective hierarchies they controlled – led to the production of large amounts of tensions (free energy).

Although, the finite-time singularity dynamic accompanied by four

accelerating cycles that unfolded during the 1495-1945 period was above all a European dynamic, the singularity dynamic – the System during the 1495-1945 period – also produced two other related outputs with a (ultimately) global reach: expansion of the System outside Europe, and the implementation of the first global international order (at a global scale of the System). The process of integration in Europe (the implementation of upgraded orders through four accelerating cycles) was accompanied by a process of expansion outside Europe (outside the core of the System); integration of the core of the System (Europe) and expansion of the core outside Europe were coevolving and mutually reinforcing dynamics. Because of the coevolving nature of the process of integration and expansion of the System – both 'powered' by the finite-time singularity accompanied by four accelerating cycles (1495-1945) – the ultimate phase transition through the fourth systemic war (The Second World War, 1939-1945) also had an 'external' dimension, and in fact constituted a 'dual' phase transition: At the same time as two dedicated hierarchies were implemented in Europe (the core of the System), the first global international order was established at a global scale of the System.

2 The System (1495-1945) depicted as a finite-time singularity accompanied by four accelerating cycles

2.1 Schematic representation of the System as a finite-time singularity accompanied by four accelerating cycles

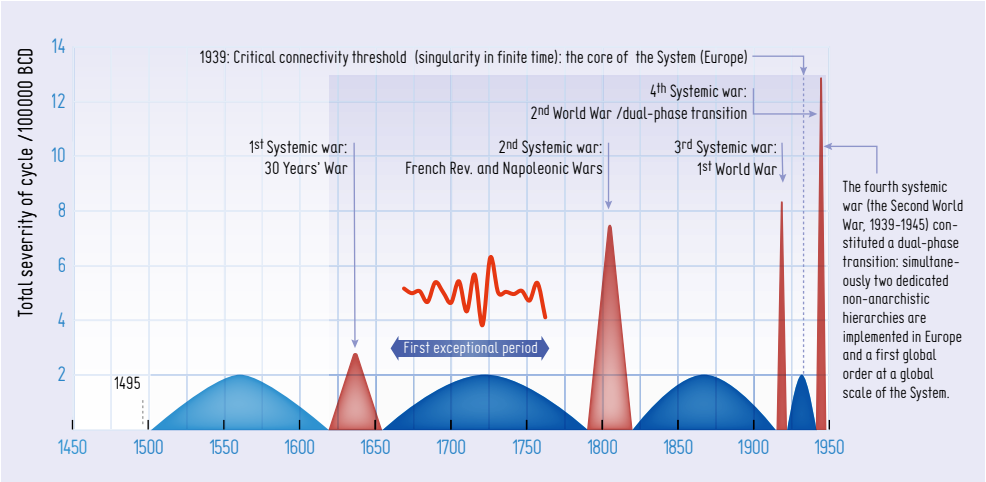

Figure 35 *This figure shows the first finite-time singularity accompanied by four accelerating cycles (1495-1945), ultimately resulting in a phase transition (through the fourth systemic war: The Second World War, 1939-1945) when in 1939 the anarchistic System reached the critical connectivity threshold. The phase transition had two related effects: The implementation of dedicated non-anarchistic hierarchies in Europe (the core of the System), and the implementation of the first global international order at a global scale of the System. In the figure the blue pyramids depict the total severity of wars during successive cycles (in BCD). The time scale (x-axis) and severities (y-axis) are shown to scale.*

2.2 Explanation of the perspective

The dynamics of the System during the 1495-1945 period qualify as a finite-time singularity accompanied by four accelerating cycles that, in 1939, reached the critical connectivity threshold and produced a phase transition resulting in (1) the initial implementation of two dedicated hierarchies in Europe, that merged into one hierarchy in 1989, and (2) the establishment of the first global international order.

It is possible to distinguish four components in the finite-time singularity dynamic that unfolded in the System during the 1495-1945 period:

1 ***Free energy – tensions – that powered the singularity dynamic***

The singularity dynamic was initiated by a combination of factors and conditions; at its core is the incompatibility between increasing connectivity (interdependence of states) and security in anarchistic systems. The incompatibility between increasing connectivity and security requirements

resulted in the production of free energy in the System that manifested itself in tensions and hostilities, the build-up of destructive potential in the form of armies, navies, etc. and in alliance dynamics.

The System obeys physical laws. In this respect, three principles related to the second law of thermodynamics are especially relevant, and determined and shaped the dynamics of the System: (1) the principle that 'free energy will be put to work', (2) the principle of 'least free energy', implying that the System will introduce a 'new' order by applying free energy that enables a lower free energy state of the system, and (3) the principle that free energy follows a path of least resistance.

The System put free energy (tensions) to work through systemic wars, and, consistent with the second law of thermodynamics, this free energy produced upgraded orders to achieve a lower free energy state in the System. However, because of the intrinsic incompatibility between connectivity and security, that was not resolved through the implementation of upgraded orders, it was just a matter of time before the anarchistic System again produced free energy (tensions), eventually reached a critical condition and produced another systemic war.

2 *Cycles*

Each of the four cycles that constitute the singularity dynamic had a similar life cycle.

Typically, a relatively stable period was followed by a systemic war. During relatively stable periods, states grew, developed, and ensured the fulfillment of their basic requirements. Population growth and the growing need for the fulfillment of basic requirements of individuals, social systems, and states, and the increasing rivalry between states following differentiated growth paths, unavoidably issues in the anarchistic System. These issues produced tensions, hostilities, and the build-up of destructive energy and alliance dynamics.

The intrinsic incompatibility between connectivity and security was the engine of the singularity dynamic, and reflects a competition between order and disorder in the System; this competition resulted in cyclic dynamics.

Given the increase in connectivity of the System and the production of free energy this implies, the second law of thermodynamics periodically forced the System through systemic wars to implement upgrade orders to allow for a lower energy state of the System.

During relatively stable periods (international orders) certain 'forces' tried to prevent change (the implementation of upgraded orders); by doing so these forces contributed to the structural stability of the international order, but also to its (increasing) level of disorder and eventual collapse.

The origin of forces that tried to maintain the status quo can be explained by the nature and dynamics of the anarchistic System in which populations and states must fulfill basic requirements to survive, and over time became increasingly dependent on other states to achieve this. During systemic wars, dominant states ensured that the upgraded order were to be implemented

promoted their specific interests in the anarchistic System. Because of these privileges these dominant states also ensured that the international orders they implemented included arrangements that supported the status quo and restrained potential rival states, that could (eventually) become a threat to them and the structural stability of international order. However, at a certain point the forces that tried to prevent change – including efforts of dominant states – were insufficient; the build-up of tensions could not be stopped and their effects no longer contained. A tipping point during the life cycle of relatively stable periods (international systems) contributed to the System becoming critical and producing a systemic war as a consequence.

As explained – as a consequence of the increasing connectivity of the System – the System produced increasing amounts of tensions (free energy). During the life cycle of relatively stable periods (international orders) these tensions were periodically released through non-systemic wars, but were also – when not released or releasable – stored in the System, and then crystallized in underlying vulnerable issue clusters. The connectivity of these issue clusters also impacted on the non-systemic war dynamics of the System.

The connectivity of these clusters, in combination with the threshold levels of states regarding war decisions, determined the size and frequency of the non-systemic wars the System produced during the relatively stable periods.

Following a systemic war, the connectivity of these clusters was initially relatively low, as was the size of non-systemic wars that were periodically triggered. During the low-connectivity regime of relatively stable periods, the connectivity of the System determined the size of non-systemic wars: increasing connectivity implied an increasing size of non-systemic wars. However, at a certain point during the life cycle of relatively stable periods, a tipping point was reached and increasing connectivity resulted in local stability that started limiting the sizes of the non-systemic wars; when the tipping point was reached the System was in a high-connectivity regime until the next systemic war.

Non-systemic, as well as systemic, wars can be considered energy releases for the System. The increasing connectivity of the underlying network of vulnerable issue clusters, in combination with the increasing inability of the System during high-connectivity regimes to periodically release free energy through non-systemic wars, primed the System for massive releases of free energy through systemic wars.

Systemic wars, contrary to non-systemic wars, are not local, and are manifestations of criticality. Criticality implies that the System reaches a correlation length of one, enabling system-wide communication, coordination, and planning. These particular conditions allowed both for the coordinated destruction of issues and tensions by employing destructive free energy, and for the collective design and implementation of new upgraded international orders that ensure at least temporary structural stability before free energy is again produced.

3 ***Accelerating dynamics (cycles)***

Increasing connectivity had a multitude of effects, including an increase in the pace of life of the System. The increasing pace of life of the System also increased the speed of spreading phenomena, including the spreading of tensions and hostilities in the System. Increasing connectivity also implied increasing growth rates of destructive free energy that built up in the System during the 1495-1945 period, and that had to be put to work (through systemic wars) at an accelerating pace, to ensure compliance with the second law of thermodynamics.

4 ***A singularity in finite-time; the critical connectivity threshold of the System***

The singularity in finite time is a result of the unsustainable accelerating growth rate of free energy and tensions in the anarchistic System.

Before the System in 1939 reached the critical connectivity threshold – the singularity in finite time – and collapsed as a consequence, the System was three times able (through the three preceding systemic wars) to implement upgraded orders within the anarchistic System; the lower levels of connectivity of the anarchistic System then still allowed the System to find viable orders within an anarchistic context, that ensured compliance with the second law of thermodynamics.

However, when the critical connectivity threshold was reached in 1939, the System produced infinite amounts of free energy (tensions) and could no longer find a viable new order within the anarchistic context; now the context had to be changed. This fundamental change was accomplished through a phase transition. Two dedicated hierarchies were initially introduced, and within these two hierarchies, anarchy and the production of free energy were neutralized; this temporarily reduced the net-amount of free energy the (now) global System produced.

The effects of the singularity dynamic situated in Europe were not limited to Europe itself; the singularity dynamic also initiated a process of expansion of European states to regions outside Europe, and contributed to the establishment of the first global international order.

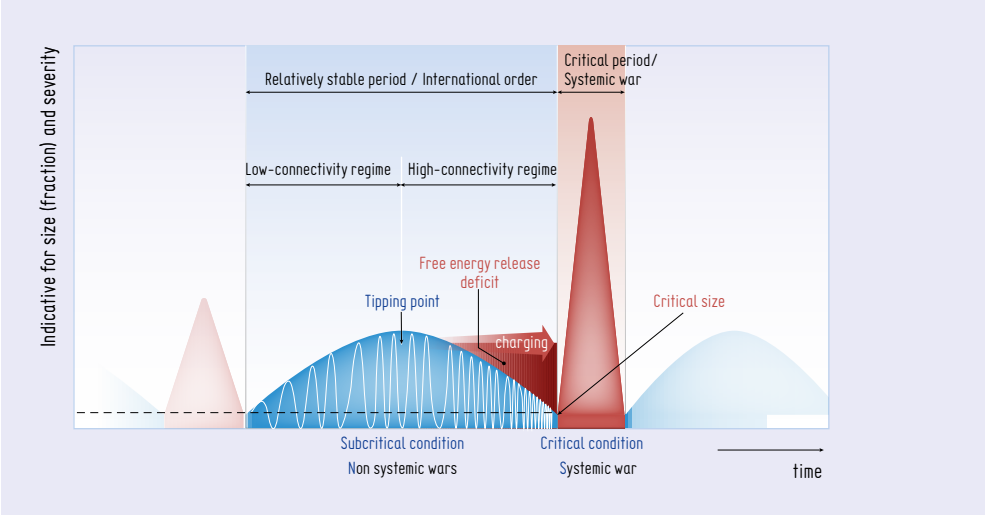

Figure 36 *This figure shows a schematic representation of a typical cycle. The finite-time singularity dynamic that developed and unfolded in the System during the period 1495-1945, was accompanied by four accelerating cycles. Cycles have similar life cycles. This study suggests that the System is presently in the high-connectivity regime of the first cycle of the second finite-time singularity dynamic (19454-...), and is 'charging', and storing free energy (unresolved issues and tensions) that crystalize in vulnerable issue clusters. The moment the clusters percolate the System, the System will become critical and produce a systemic war.*

Direct and indirect connectivity effects	
Effect	Explanation
Increasing incompatibility of the System.	Connectivity and security are intrinsically incompatible in anarchistic systems. Incompatibility produces the tensions and free energy that power the singularity dynamic.
Emergence of a tipping point in the non-systemic war dynamics during relatively stable periods of cycles, marking a switch from a low- to high-connectivity regime.	During relatively stable periods the connectivity of the System increases. The connectivity of the System determines the size and frequency of non-systemic wars the System produces. When the System reaches the tipping point of relatively stable periods states become more stable because of (what I name) the connectivity/stability-effect; from that point onwards, until the System becomes critical, the size of non-systemic wars the System can produce decreases. This effect primes the System for systemic war.
Increasing pace of life.	Population size determines the pace of life of the System. An increase in the pace of life also implies in increase in the speed of spreading phenomena, including the spreading speed of tensions and hostilities in the System.

Direct and indirect connectivity effects	
Increasing robustness and fragility.	Increasing connectivity of the System implies increased robustness and increased ability to absorb perturbations without producing non-systemic wars. Increasing robustness implies that the System's ability to produce free energy-release events (non-systemic wars) becomes increasingly limited/restrained. At the same time as the System's robustness increases, the fragility of the System (the ability of the System to maintain itself in a stability domain) decreases; robustness and fragility of the System are two sides of the same coin.
Increasing structural stability.	Connectivity increase also contributes to the structural stability of the System; its organizational stability (permanence) as well as the permanence (stability) of state-structures (form and size) in the System.
Increasing energy requirements of systemic wars to accomplish a rebalancing of the System through the implementation of upgraded orders.	Increased connectivity of the System impacts the energy required to rebalance the increasingly stable System.
Increasing interdependence.	Connectivity growth and growth of interdependence go hand-in-hand. Increasing interdependence has positive and negative effects in an anarchistic System. Positive: it improves the ability of states to fulfill certain basic requirements. Negative: it unavoidably produces issues and tensions that negatively affect the security of states, but also identities of humans and social systems.
Increasing alliance dynamics.	Increasing connectivity results in (more) issues and tensions in the System; in response states try to hedge certain risks by forming alliances.

Table 39 *This table shows and explains the most obvious connectivity effects.*

3 The System depicted as a coherent 'set' of closely related and optimized dynamics that made up the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)

3.1 Schematic representation of the coherent set of closely related and optimized dynamics, that made up the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)

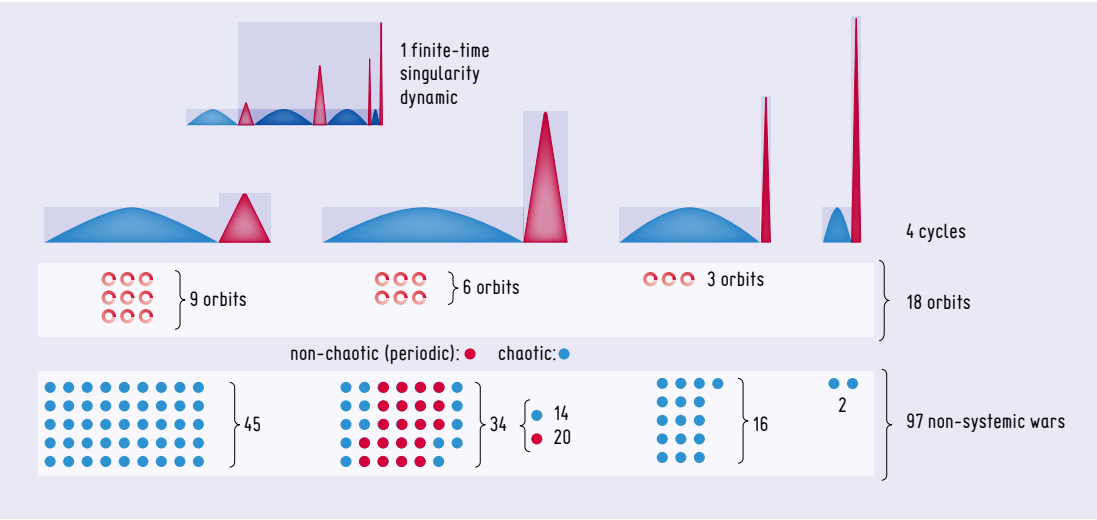

Figure 37 *This figure schematically shows the four 'levels' of dynamics that can be distinguished in the System during the period 1495-1945.*

3.2 Explanation of the model

It is possible to distinguish between four levels of 'dynamics' that together formed the highly optimized finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

The basic building blocks – level four dynamics – of the other three dynamics (levels) are non-systemic wars. During the 1495-1945 period, the anarchistic System produced 97 non-systemic wars; expansion wars excluded.

A closer look at the non-systemic war dynamics of the System reveals, that non-systemic wars 'normally' (when the System was regulated by at least three degrees of freedom and produced chaotic non-systemic war dynamics as a consequence) grouped in 'orbits' in phase state. Each orbit consists of a number of non-systemic wars, that produce circular trajectories in phase state (defined by the size and intensity of non-systemic wars). Each orbit can be defined by the average size of the non-systemic wars that make up respective orbits.

During the life span of the second cycle (1648-1815) the non-systemic wars were temporarily distorted, and non-chaotic in nature. This period I name the first exceptional period (1657-1763). During this period the System did not produce 'orbits', but periodic war dynamics instead. I determined that the System would have produced 18 orbits, if its dynamics would not have been distorted during the exceptional period (1657-1763).

During the life span of the finite-time singularity dynamic (1495-1945), the System also produced four accelerating cycles; each cycle consisting of a relatively stable period, followed by a systemic war. It is no coincidence that the life spans of successive relatively stable periods and the respective systemic wars, accelerated with the same rate (except for the fourth systemic war, the Second World War, 1939-1945, which had a longer life span because it included besides a European 'component', also a global component, as I explain in this study).

Consistency of dynamics of the System (1495-1945) Calculations based on data from Levy (38)			
Level	Dynamic	Number of occurrences	Remarks
1	Finite-time singularity	1	
2	Cycle	4	Accelerating
3	Orbit	18	Number determined through interpolation.
4	Non-systemic wars	97	During successive relatively stable periods (international orders) the System produced respectively: 45 - 34 - 16 - 2 non-systemic wars; expansion wars excluded.

Table 40 *This table shows the number of occurrences of four types of dynamics in the System during the 1495-1945 period.*

Occurrences of dynamics per cycle (1495-1945) Calculations based on data from Levy (38)					
Type	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Total
Non-systemic wars (level 4)	45	34	16	2	97
Orbits (level 3)	9	6 (Est. through interpolation)	3	0	18
Cycles (level 3)	1	1	1	1	4
Finite-time singularity dynamic (level 1)					1

Table 41 *Specification of dynamics of cycles of the first finite-time singularity dynamic (1495-1945).*

Above tables shows the different levels – dynamics – that can be distinguished. These levels form the components (building blocks) of the finite-time singularity, accompanied by four accelerating cycles, consisting of 97 non-systemic wars, that grouped in 18 orbits (if the non-systemic war dynamics would

not have been temporarily distorted during the first exceptional period (1657-1763)).

The numbers 1 - 4 - 18 - 97, respectively the number of singularity dynamics (1), cycles (4), orbits (18), and non-systemic wars (97), qualify as a Zipfian distribution.

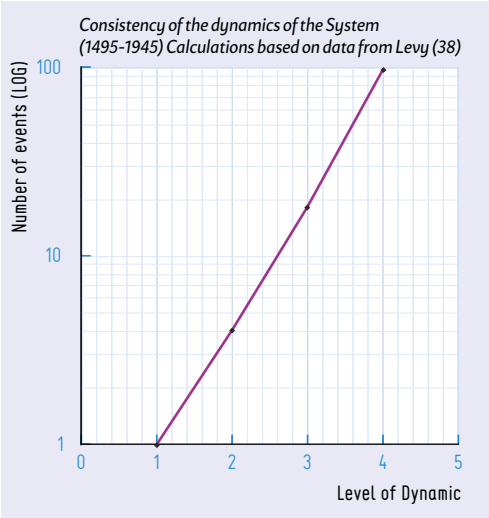

Figure 38
This figure shows the number of non-systemic wars (97, nine expansion wars excluded), orbits (18) and cycles (4), that constituted the first finite-time singularity (1495-1945). The number of occurrences of respective dynamics qualify as a Zipfian distribution.

However, the Zipfian distribution of the appearances of the respective dynamics is not the only remarkable regularity; the number of non-systemic wars during successive cycles – as well as the number of orbits they grouped into (assuming no distortion during the second cycle) – both decreased linearly.

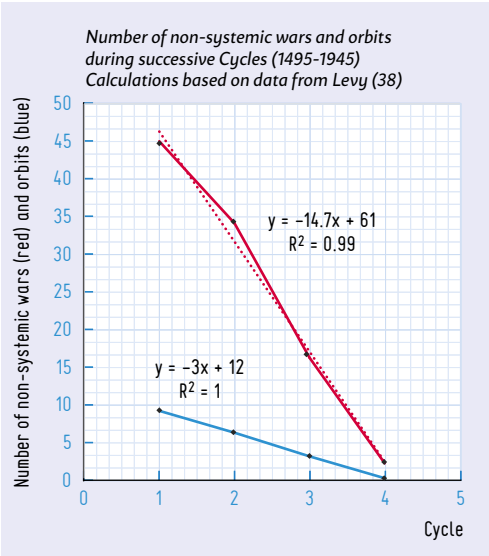

Figure 39
This figure shows the number of non-systemic wars (in red, expansion wars excluded, 45 - 34 - 16 - 2) and the number of orbits (in blue, 9 - 6 - 3 - 0, number of orbits of the second cycle based on interpolation) the anarchistic System produced during successive cycles of the first finite-time singularity dynamic (1495-1945). I argue that the System would have produced six orbits during the second cycle if the System's non-systemic war dynamics would not have been disturbed during the first exceptional period (1657-1763). The number of orbits of the first, third and fourth cycle (respectively: nine, three and zero) is based on empirical data. The number for the third cycle (six) is determined by interpolation.

Furthermore, the number of occurrences during cycles at each level of dynamics also developed very regularly; they can be consistently described by a second degree polynomial ($y = a\,x^2 + bx + c$), when x is the type of dynamic, and y the number of occurrences at respective levels.

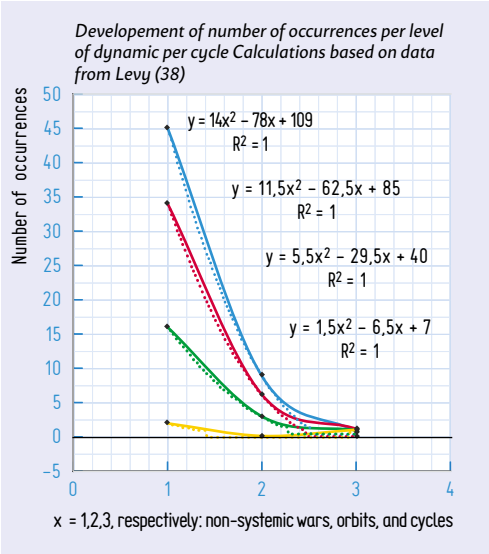

Figure 40
This figure shows the number of occurrences per type of dynamic (non-systemic wars, orbits and cycles) per cycle; the first cycle in blue, etc.
In each case – in case of each cycle – the development of the number of occurrences can be described by a second degree polynomial, with in all cases $R^2 = 1$.

Below table gives an overview of regularities, and their mathematical equations.

Overview of regularities, and their mathematical equations. Data Levy (38)			
Dynamic	Equation (y = number of occurrences)	R^2	Type
First finite-time singularity dynamic (1495-1945)		1.00	Zipfian distribution
Orbits	$y = -3x + 12$ (x = cycle number)	1.00	Linear
Non-systemic wars	$y = -14.7x + 61$ (x = cycle number)	0.99	Linear
Cycle 1 (1495-1648)	$y = 14x^2 - 78x + 109$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 2 (1648-1815)	$y = 11.5x^2 - 62.5x + 85$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 3 (1815-1918)	$y = 5.5x^2 - 29.5x + 40$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 4 (1918-1945)	$y = 1.5x^2 - 6.5x + 7$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial

Table 42 *Overview of regularities, and their mathematical equations.*

The various dynamics in the System are powered by the free energy (tensions) the anarchistic System produced; the production of free energy (tensions) in the System was (and still is) a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. The second law of thermodynamics applies to the free energy (and the dynamics) the anarchistic System produced (and still produces).

The four types of dynamics I identified fulfill certain functions for the System, and comply with the 'demands' of the second law of thermodynamics.

Through non-systemic wars (the fourth level of dynamics), the System released 'local' tensions in the System, that concerned a limited number of states, and specific issues they 'shared'.

These 'separate' non-systemic wars, however, grouped in orbits (clusters); with specific properties, further analysis shows. The size development of successive orbits (defined by the average size of non-systemic wars making up respective orbits), reveals their function for the System.

During the first cycle (1495-1648) the System produced 45 non-systemic wars, that 'grouped' in nine orbits.

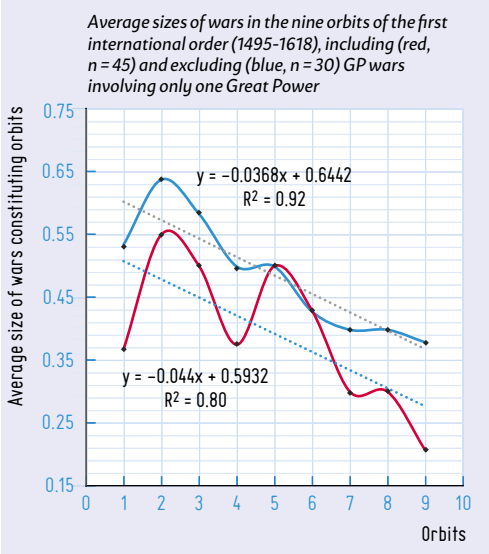

Figure 41
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).

As above figure shows, the sizes of these orbits (the average sizes of non-systemic wars, making up these nine orbits), constitute a damped oscillator: non-systemic wars making up orbits can be considered efforts of the System to re-establish a certain balance – equilibrium – during the first relatively stable period (in this particular case). Because these corrective actions (orbits) were implemented with a delay, they caused over- and undershoots (oscillations). The damping of these oscillations, I contribute to the connectivity/local stability effect, that increasingly impacted on the sizes of successive non-systemic wars, during the life span of the first relatively stable period. When the oscillations

eventually faded out – became completely damped – the System became critical, and produced a systemic war (the Thirty Years' War, 1618-1648).

The second level of dynamics – cycles – are a direct response to 'demands' of the second law of thermodynamics. During relatively stable periods, the System produced (and still produces) accelerated amounts of free energy (tensions). Because of the connectivity/local stability effect, at a certain point during the life span of a cycle, these tensions could not be released any longer through non-systemic wars, and instead of being released, these tensions were 'stored' in the System, formed a 'free energy release deficit', and crystallized in underlying vulnerable issue clusters with fractal structures, that eventually percolated the System, and caused it to become critical and produce a systemic war.

Through systemic wars – consistent with the second law of thermodynamics – the System put free energy (tensions) to work, to implement upgraded orders that allowed for a lower energy state (a 'new' relatively stable period) of the System. This dynamic ensured that the performance of the System (the fulfillment of basic requirements of uneven states in the System) was maintained.

However, because of the increasing connectivity of the System, the System (still) produced accelerating amounts of free energy (tensions), that eventually (at an accelerating rate) had to be put to work, to ensure compliance with the second law of thermodynamics. The increasing connectivity of the System, however, not only resulted in the production of accelerating amounts of free energy (tensions), but also in an acceleration of the System's intrinsic dynamics, including the frequency of successive cycles (systemic wars).

This accelerating dynamic could however not be sustained, and when the anarchistic System in 1939 reached the critical connectivity threshold, the anarchistic System produced 'infinite 'amounts of free energy (tensions) and collapsed as a consequence. In response, the System produced a dual-phase transition (1939-1945, the fourth systemic war, the Second World War). Through this dual-phase transition, the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System.

Functions of dynamics – components – of the anarchistic System (1495-1945)

Level	Dynamic	Number of appearances	Function
1	Finite-time singularity dynamic	1	Ensure performance and evolvability of the System; balance criticality and subcriticality of the System
2	Cycle	4	Balance – optimize – order and disorder during the life span of cycles
3	Orbit	18	Re-establish equilibrium during relatively stable periods
4	Non-systemic war	97	Release local tensions

Table 43 *This table shows the functions of the four 'types' of dynamics that can be distinguished in the System during the period 1495-1945.*

4 The System depicted as an undistorted finite-time singularity dynamic

4.1 Schematic representation of the undistorted finite-time singularity dynamic

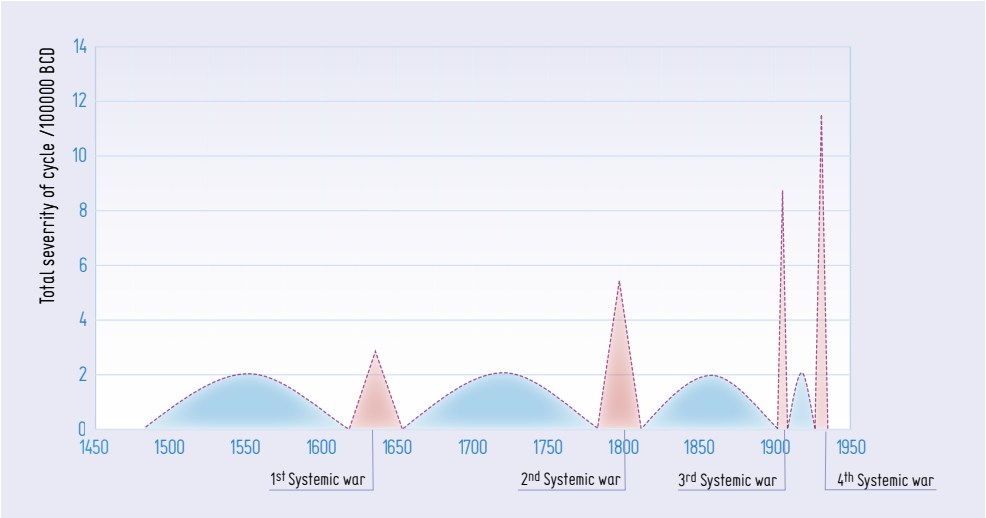

Figure 42 *This figure shows the undistorted finite-time singularity that can be constructed when a number of 'corrections' is applied based on the insights provided by this study.*

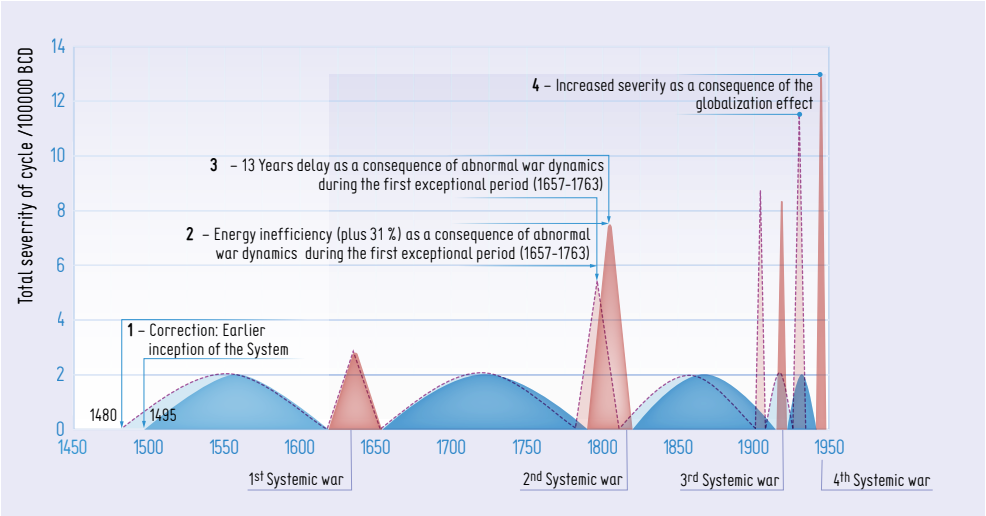

Figure 43 *This figure shows both the actual and undisturbed singularity dynamics: the differences – 'distortions' discussed in this study – are visible and explained.*

4.2 Explanation of the model

In this chapter I discuss an undistorted – theoretical – version of the finite-time singularity dynamic accompanied by four accelerating cycles, the System produced during the 1495-1945 period.

Such an 'undistorted' model can be constructed as follows:

1 By applying mathematical equations that describe the dynamics and development of the actual finite-time singularity dynamic, including the frequency of cycles and the accelerating growth of the severities of successive systemic wars.

2 By correcting distortions in the actual finite-time singularity dynamic, including a misinterpretation of data by historians.

3 By 'finite-tuning' certain parameters and properties of the singularity dynamic, assuming consistency between correlation coefficients.

This is an iterative process.

The theoretical singularity dynamic can be used to analyze the performance of the actual singularity dynamic (as it unfolded), and can shed light on some of the assumptions made in this study. A theoretical model of the first finite-time singularity dynamic (1495-1945) can also be of help as a framework for reference in assessing the condition of the current global System and of the second singularity dynamic the System is now producing.

4.3 Corrections

The finite-time singularity the System produced during the 1495-1945 period was distorted for a number of reasons; in the theoretical model these distortions are 'corrected'. The distortions and corrections include:

1 ***Misinterpretation of data and of historical events that established the start date of the System***

The start time of the System was not 1495 but 1480, as I explain in statement 152 This distortion can be attributed to a misinterpretation of historic events. This correction also means that six non-systemic wars should be included in the first relatively stable period (international order). This also implies that the sum of the severities of non-systemic wars during this relatively stable period should be corrected upwards.

2 ***Abnormal war dynamics during the first exceptional period (1657-1763) that caused a delay in the System's development and 'energy inefficiencies'***

During the life span of the second relatively stable period (1648-1792), non-systemic war dynamics were temporarily distorted (1657-1763); they were periodic and 'hyper-excited' instead of chaotic and more 'controlled' (as is normally the case). This distortion I attribute to a temporary decrease in the number of degrees of freedom in the System from $n > 2$, implying chaotic dynamics, to $n = 2$, implying periodic dynamics. These abnormal,

non-chaotic, non-systemic war dynamics caused a delay in the unfolding and development of the singularity dynamic. I argue that the second systemic war was delayed by about 13 years.

I also argue that the abnormal war dynamics during the first exceptional period (1657-1763) caused energy inefficiencies – an overproduction of tensions of which the extreme severities of wars during that period are symptomatic – and a shift in the energy release distribution (energy release ration of the second cycle). I calculated the overproduction of tensions and destructive energy was about 31 percent for the second cycle.

3 ***Finite-size effects cut the singularity dynamic short***

When the System in 1939 approached the singularity in finite time (the critical connectivity threshold of the anarchistic System), it was confronted with finite-size effects, the analysis suggests. Theoretically, had finite-size effects not constrained its dynamics, the System could have produced a fifth systemic war. The theoretical model suggests that a fifth systemic war would have started nine years after completion of the fourth systemic war, in 1954 (the 'calculation' is based on an extrapolation of the life span of successive relatively stable periods of the first finite-time singularity dynamic).

4 ***The fourth systemic war (the Second World War, 1939-1945) constituted a dual-phase transition and marked the globalization of the System; this 'globalization effect' resulted in a longer duration and increased severity of this war***

The fourth systemic war (the Second World War, 1939-1945) constituted a dual-phase transition that also marked the moment the System developed from a European-centric System to a global System. It is possible, based on the deterministic shortening of successive cycles, to determine the theoretical duration of the fourth systemic war, if this globalization effect is ignored. The theoretical model suggests that the lifespan of the fourth systemic war (the Second World War) would have been 2.5 in case of an 'Europe only' scenario.

Not only should the duration of the fourth systemic war be reduced – if the globalization effect is ignored – but also its severity: The theoretical model suggests that about 13 percent of the destructive energy, measured by severity (in terms of BCD), was deployed outside Europe.

These distortions explain (most of) the differences between the actual finite-time singularity as it unfolded in the period 1939-1945, and the theoretical (undistorted) finite-time singularity dynamic, as presented and discussed in this paragraph.

If the time-scale of the life span of the finite-time singularity is taken into consideration, the differences between the actual and theoretical finite-time singularity dynamics are not significant; except for the energy-inefficiencies caused by the abnormal war dynamics during the first exceptional period (1657-1763); the singularity dynamic is remarkably robust, and is obviously not easily distorted.

Most significant distortions and corrections applied to the theoretical model			
	Distortion	Cause of distortion	Correction
1	Start date first international order (of the System) too late	Methodological shortcoming	1495 must be 1480
2	Delay in the unfolding of the second cycle (1648-1792)	Abnormal war dynamics during the first exceptional period (1657-1763)	Caused a delay of 13 years.
3	Energy inefficiency (1): Overproduction of tensions and hyper-excited war dynamics during the first exceptional period: Increased total severity of the second cycle.	Abnormal war dynamics during the first exceptional period (1657-1763)	A reduction of 31 percent in the total severity of the actual second cycle.
4	Energy inefficiency (2): distortion in the energy release distribution (release ratio)	Abnormal war dynamics during the first exceptional period (1657-1763)	Resolved through other corrections
5	Lengthening of the duration of the fourth systemic war (the Second World War, 1939-1945)	Globalization effect	Correction of 3.5 years on the actual duration of the fourth systemic war (6 minus 2.5)
6	Increased severity of the fourth systemic war (the Second World War, 1939-1945)	Globalization effect	Minus 13 percent of the severity of the actual fourth systemic war
7	Collapse of the anarchistic System in 1939, no fifth cycle.	Finite size effects	Not applied in theoretical model

Table 44 *In this table I show the most important distortions I identified in the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) and the corrections that were applied to the theoretical model.*

4.4 Fine-tuning of the theoretical model

Construction of the theoretical – undistorted – version of the finite-time singularity dynamic includes the 'fine-tuning' of its parameters and properties.

The corrections I discussed in the previous paragraph, are also based on this (iterative) process of fine-tuning.

The fine-tuning is based on two assumptions: (1) that the relationships between variables and properties I propose in this study are correct, and (2) that the properties of specific variables of the finite-time singularity dynamic accompanied by four accelerating cycles should develop regularly. The second assumption is related to the observation that physical laws apply to the System's dynamics and development, and that the System is (as a consequence) highly deterministic in nature.

I assume that the correlation coefficients presented in the below tables concern causal relationships (I also discuss in this study), and can be considered a measure for consistency of the singularity dynamic.

		Actual										
		1	2	3	4	5	6	7	8	9	10	11
1	Severity cycle	X										
2	Severity IO	-0.24	X									
3	Severity SW	0.90	-0.63	X								
4	LS cycle	-0.85	0.71	-0.99	X							
5	LS IO	-0.80	0.72	-0.96	0.99	X						
6	LS SW	-0.82	0.49	-0.87	0.79	0.69	X					
7	No. non-sw	-0.95	0.49	-0.98	0.93	0.87	0.93	X				
8	Intensity cycle	0.87	-0.50	0.91	-0.94	-0.96	-0.61	-0.85	X			
9	Intensity IO	-0.22	1.00	-0.62	0.70	0.71	0.47	0.47	-0.49	X		
10	Intensity SW	0.81	-0.67	0.94	-0.90	-0.83	-0.97	-0.95	0.72	-0.65	X	
11	Pop size Eur.	0.89	-0.56	0.96	-0.91	-0.83	-0.97	-0.99	0.77	-0.54	0.99	X

Table 45 *This table shows the correlation coefficients of properties of the actual finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).*
'Severity cycle' stands for the sum of the severities of all wars (non-systemic and systemic) of successive cycles. severity in BCD; 'Severity IO' stands for the sum of the severities of non-systemic wars during successive international orders. severity in BCD; 'Severity SW' stands for the severity of systemic wars of successive cycles. severity in BCD; 'LS cycle' stands for the lifespan of successive cycles in years; 'LS IO' stands for the lifespan of successive international orders in years; 'LS SW' stands for the lifespan of systemic wars in years; 'No. non-sw' stands for the absolute number of non-systemic wars during respective cycles; 'Intensity cycle' stands for the intensities of successive cycles, intensity defined as its total severity of wars during cycles divided by their respective life spans; 'Intensity IO' stands for the intensities of successive cycles, intensity defined as its total severity of non-systemic wars during successive international orders divided by their respective life spans; 'Intensity SW' stands for the intensity of systemic wars, intensity defined as the severity of systemic wars, divided by their lifespan; 'Pop size Eur.' stands for the populations size of Europe, at the start of the systemic wars of successive cycles.

		Actual										
		1	2	3	4	5	6	7	8	9	10	11
1	Severity cycle	X										
2	Severity IO	−1.00	X									
3	Severity SW	1.00	−1.00	X								
4	LS cycle	0.84	0.96	−0.96	X							
5	LS IO	−0.92	0.92	−0.92	0.99	X						
6	LS SW	−0.96	0.96	−0.96	0.88	0.82	X					
7	Number non-sw	−1.00	1.00	−1.00	0.95	0.92	0.96	X				
8	Intensity cycle	0.84	−0.84	0.84	−0.95	−0.98	−0.69	−0.83	X			
9	Intensity IO	0.71	−0.71	0.71	−0.87	−0.92	−0.54	−0.70	0.98	X		
10	Intensity SW	0.95	−0.95	0.95	−1.00	−0.99	−0.88	−0.94	0.94	0.87	X	
11	Pop size Eur.	0.98	−0.98	0.98	−0.93	−0.88	−0.99	−0.97	0.77	0.63	0.93	X

Table 46 *This table shows the correlation coefficients of properties of the 'corrected' - undistorted - singularity dynamic. The fine-tuning is based on a model of the finite-time singularity dynamic. that is accompanied by four (not five) accelerating cycles. In this model, the globalization effect, is not included; the model represents 'Europe only'.*
'Severity cycle' stands for the sum of the severities of all wars (non-systemic and systemic) of successive cycles, severity in BCD; 'Severity IO' stands for the sum of the severities of non-systemic wars during successive international orders, severity in BCD; 'Severity SW' stands for the severity of systemic wars of successive cycles, severity in BCD; 'LS cycle' stands for the lifespan of successive cycles in years; 'LS IO' stands for the lifespan of successive international orders in years; 'LS SW' stands for the lifespan of systemic wars in years; 'No. non-sw' stands for the absolute number of non-systemic wars during respective cycles; 'Intensity cycle' stands for the intensities of successive cycles, intensity defined as its total severity of wars during cycles divided by their respective life spans; 'Intensity IO' stands for the intensities of successive cycles, intensity defined as its total severity of non-systemic wars during successive international orders divided by their respective life spans; 'Intensity SW' stands for the intensity of systemic wars, intensity defined as the severity of systemic wars, divided by their lifespan; 'Pop size Eur.' stands for the populations size of Europe, at the start of the systemic wars of successive cycles.

I calculated the average of the absolute values of the 55 correlation coefficients of the actual and theoretical (undistorted) finite-time singularity dynamics; I name the average the 'consistency index' of the finite-time singularity dynamic. I consider the consistency index a measure for the consistency of the finite-time singularity dynamic. The consistency indices of the actual and theoretical singularity dynamic are respectively 0,78 and 0,90.

5 The System depicted as a binary network of war switches

5.1 Schematic representation of the System as a network of binary switches

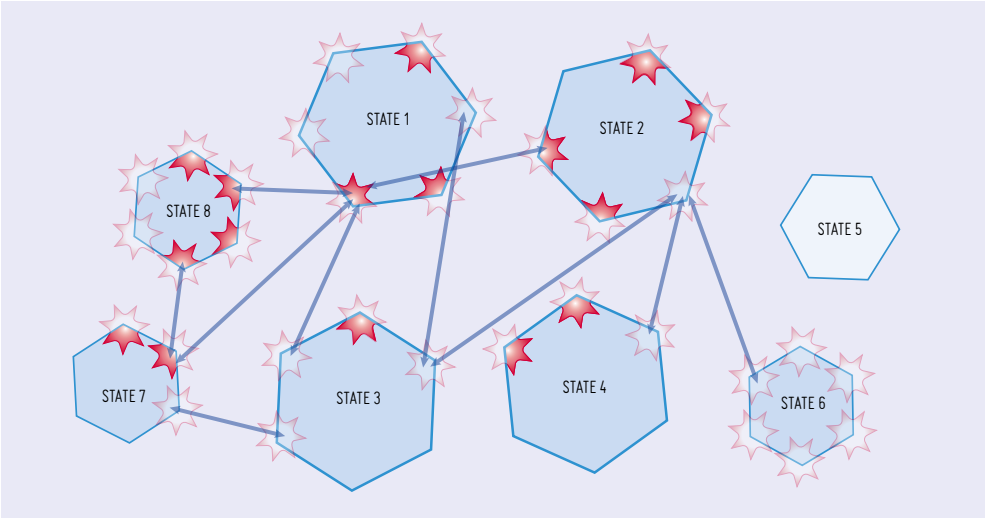

Figure 44 *This figure depicts the System as a network of binary 'war switches'. States constitute the switches (nodes) in this network. States are integral components of the network of vulnerable issue clusters. Vulnerable issue clusters are one step from being activated and producing a war (energy release). I assume that states are linked to (are integral parts of) a number of issues (and issue clusters) that during relatively stable periods develop in the System. The connectivity of the issue network determines if the System is in a low- or high-connectivity regime.*
In above figure, states are depicted as (blue) hexagons. Issues states have, are shown as ('thorny') stars. Issues of states can either be 'vulnerable' (depicted in dark red, one step from being activated in war) or 'not vulnerable'. Connectivity of states (to the issue network) and thresholds states use to decide to go to war (or not), determine the dynamics of the issue network and of the properties (size and frequency) of war dynamics in the System. In the present international order, the 'South China Sea' and the 'Ukraine' can be considered issue clusters.

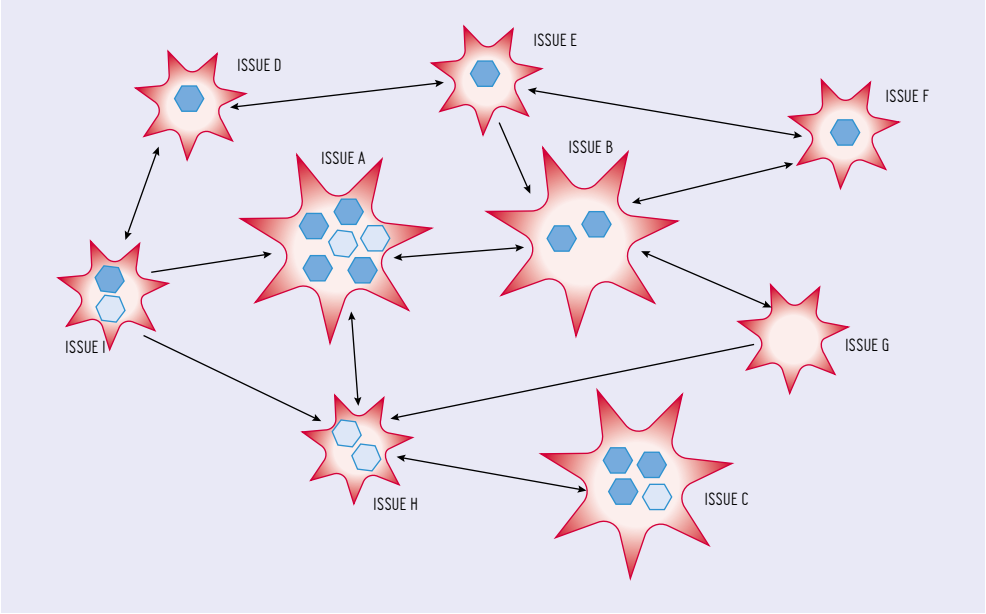

Figure 45 *This figure depicts the System as a network of binary switches from an issue perspective. Thorny stars depict issues. Issues 'contain' states, which are depicted as hexagons. Dark blue hexagons represent states for which the issue is 'vulnerable' (one step from being activated in war). Issues and states constitute a dynamic network.*

5.2 Explanation of the model

To a very high degree, states base war decisions ('war' or 'no war') regarding issues they are confronted with in the System, on war decisions of other states. War decisions qualify as binary decisions with externalities and thresholds. Issues are defined by the positions of states regarding these and other issues. States apply decision thresholds to issues. A decision threshold determines when a state switches to a favorable war decision.

Decision thresholds can be represented by fractions. A decision fraction is defined as the ratio of the number of states that switch to a positive war decision regarding a particular issue to the total number of states that are linked to the issue. If the decision threshold fraction is exceeded, states switch to a positive war decision.

Issues, thresholds, and positions of states are not static, but develop and evolve. States and issues are linked and form a dynamic network. If an issue is one step, that is, one additional positive war decision of a connected state, from activating a war, the issue is considered vulnerable. Issues are connected, and a single switch to war can – depending on the properties of the network – cause a cascade of wars as in a domino effect.

The connectivity of the vulnerable issue network and the decision thresholds that states apply determine the dynamics (the sizes and frequencies) of non-systemic wars during relatively stable periods. Typically, during

relatively stable periods, low- and high-connectivity regimes – limited by a tipping point – can be identified. The moment the tipping point is reached, states become locally stable as a consequence of their high-connectivity in the issue-network. Their increased local stability starts constraining the size of non-systemic wars and the ability of the System to release free energy; instead of being released, the tensions that build-up during that phase (the high-connectivity regime) are temporarily 'stored' in the System, and crystallize in underlying vulnerable issue clusters. When these vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war, to implement an upgraded order that enables a lower energy state of the System.

The finite-time singularity accompanied by four accelerating cycles that the System produced during the time frame 1495-1945 was remarkably consistent and robust, implying that the underlying mechanisms and dynamics that produced the singularity dynamic were largely unchanged over time.

A network of binary switches is at the heart of the singularity war dynamic of the System. The consistency of the singularity dynamic shows that the nature of decision-making of units (states) in the System regarding war did not change over time, and is – it seems – independent of the exact nature of these units.

6 The System depicted as a slowly-driven, interaction-dominated threshold system.

6.1 Explanation of the System depicted as a slowly-driven, interaction-dominated threshold system

The anarchistic System, the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, qualifies as a slowly-driven, interaction-dominated threshold system (32).

To qualify as a slowly-driven, interaction-dominated threshold system, a number of conditions must be met:

1 ***Interaction-dominated***. The System consisted (and still consists) of a high number of components (populations, units, states, and issues) that regularly interacted on the basis of certain rules. The purpose of these interactions was (and still is) the fulfillment of a set of basic requirements, necessary for their survival. These interactions dominate(d) - and determined and shaped - the dynamics of the System. In case of the anarchistic System the multitude of 'micro' interactions between its components, especially states, to ensure the fulfilment of their basic requirements and survival, resulted in emergent self-organized macro dynamics; the finite-time singularity dynamic. The finite-time singularity dynamic accompanied by four accelerating cycles unfolded remarkably regular, and was instrumental in the establishment of a next level of SIE.

2 ***Rules***. Two sets of rules determine and shape interactions: physical laws and other deterministic mechanisms and principles in the deterministic domain of the System (for example, the second law of thermodynamics and related principles), and rules in the contingent domain of the System, including decision rules regarding conflict interactions. Development of certain structures and regular dynamics in the System can be attributed to the consistent application of these rules.

3 ***Slowly-driven***. The singularity dynamic was driven by the incompatibility between connectivity and security that causes issues and tensions (free energy) in anarchistic systems. Connectivity growth of the issue network (for example, caused by population growth and rivalry between states) is a relatively slow driver of the System, and in combination with the ability of the System to maintain itself in a metastable condition, allowed the System to experience relatively stable periods that permitted further growth and the balanced fulfillment of basic requirements. ***A separation of time scales***. Connectivity growth produced tensions and free energy in the System; this is a much slower process than the release events (wars) the anarchistic System produces as a consequence. The slow build-up of free energy and its fast release through wars work at different time scales. Thresholds and metastability enabled the separation of time scales.

4 ***Thresholds and metastability***. A separation of time scales in the System was achieved through thresholds and metastability. Thresholds allow for the buildup and storage of tensions and free energy in the System. The ability of the System to maintain itself for an extended time in a configuration other than the System's state of least energy is indicative for its metastability. The local stability of states that was created during high-connectivity regimes of relatively stable periods further enabled the storage of free energy, and also acted as a local threshold (as defined by Jensen). This effect refers to the deterministic domain.

In the contingent domain, structural stability is achieved through forces that maintain the status quo and resists forces for change (also referred to as inertia of the System, for example, because such rigidity serves their interests). Great Powers that were successful in embedding certain privileges in the international order had a special interest in ensuring the status quo.

Intrinsic properties of the System during relatively stable periods controlled its dynamics. As the abnormal war dynamics during the exceptional period show, the number of degrees of freedom are an integral component of the control properties of the System. More than two degrees of freedom produced chaotic war dynamics that restrained the size, intensity, and severity of the wars the System produced; chaotic dynamics requiring more than two degrees of freedom, in fact, constituted an internal control mechanism.

When the number of degrees of freedom of the System was reduced to two, this internal control mechanism was neutralized and non-systemic war dynamics became more extreme. Two degrees of freedom producing periodic dynamics allow for a higher energy state. When $n = 2$, the dynamics of the System were dominated by tensions produced by connectivity growth of the issue network. Abnormal periodic dynamics impacted on the performance and evolvability of the finite-time singularity dynamic, causing inefficiencies and a time delay in its unfolding.

5 ***Criticality***. During the unfolding of the singularity dynamic (1495-1945), the System became critical four times, and produced four systemic wars as a consequence. Criticality implies a correlation length that spans the System (a correlation length of one), and that enables system-wide communication, coordination, and planning necessary for the design and implementation of an upgraded order that better matches the free energy produced as a consequence of the intrinsic incompatibility between connectivity and security of the anarchistic System.

In the terminology of this perspective, a slow driver, connectivity, pushes the System to a critical point. When the System eventually reaches the critical point, free energy is released in a relatively short period of time through systemic war. Local stability of the System has a threshold effect. Internal control mechanisms (e.g., a third degree of freedom introducing chaotic dynamics) allow for metastability.

7 The System depicted as a dynamical system

7.1 Introduction

From a dynamical system perspective, the dynamics of a system are to a high degree determined by its feedback structures and how they interact. In the System there were (and are) multiple interacting feedbacks at play, and in some cases the dominance of a certain feedback structure (loop-dominance) changed over time, depending on certain conditions of the System.

In this section, causal loop diagrams are shown for the following phenomena and their feedback structures: (1) connectivity growth, (2) the security dilemma, (3) interacting self-fulfilling prophecies, (4) intrinsic incompatibility of increasing connectivity and security in anarchistic systems, (5) cyclic dynamics that accompany the finite-time singularity dynamic, and (6) competition between order versus disorder during the life span of cycles.

7.2 Connectivity growth

7.2.1 Causal loop diagram related to feedback structures of connectivity growth

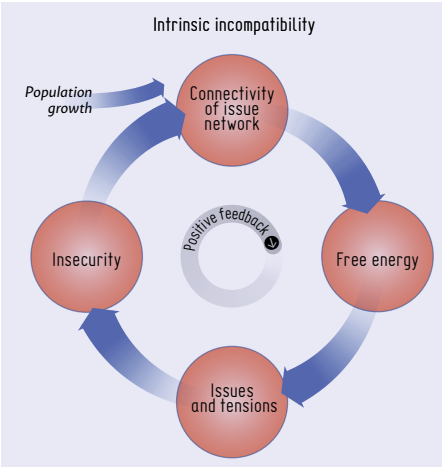

Figure 46
This figure shows variables that impact on the connectivity of the System, the System's driver, and how they interact. The connectivity of the System continuously grew at an increasing rate related to the growth rate of the population of the System during the unfolding of the singularity (1495-1945). The security dilemma itself constitutes a positive feedback mechanism and is (itself) also an integral component of the positive feedback mechanisms shown in this causal loop diagram.

7.2.2 Explanation of the causal loop diagram

A number of variables impacted the connectivity of the System. This study is especially concerned with the connectivity of the network of issues and states. I consider population growth the basic driver of the System's connectivity. In order for humans, societies, and populations to survive, a number of basic requirements must be fulfilled. The fulfillment of these growing requirements, given the growth of the population of the System, required an increasing number of interactions and connections. An increase in the average age of populations and higher welfare expectations also contribute(d) to the increasing demands for resources.

Populations are organized in states; clusters of humans that leverage economies of scale and scope (synergies) to better fulfill their basic requirements and improve their survival changes. States are responsible for the security of their populations in an anarchistic System. Population growth implies increased connectivity and increased interdependence. Increased interdependence in an anarchistic system, despite its contribution to the fulfillment of the basic requirements of populations, also results in increased insecurity. In the anarchistic System, states compete(d) for scarce resources. Increased connectivity also implies increased rivalry. In an anarchistic System the security dilemma increasingly contributed to the tensions in the System.

7.3 The security dilemma

7.3.1 Causal loop diagram of feedback structures related to the security dilemma

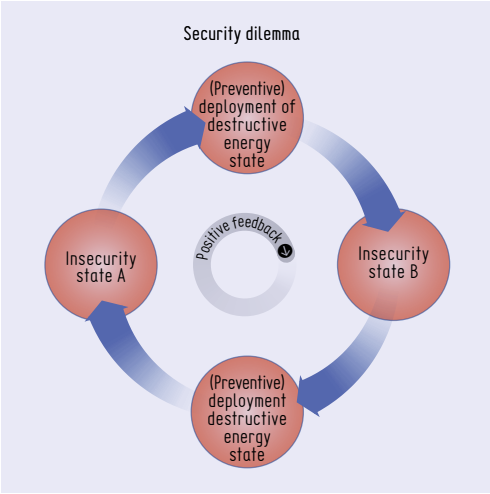

Figure 47
This figure shows the workings of the security dilemma, an integral component of anarchistic systems.

7.3.2 Explanation of the causal loop diagram.

The security dilemma qualifies as a self-reinforcing positive feedback mechanism, and is an integral component of anarchistic systems. In anarchistic systems, states are ultimately responsible for their own security. One state's security, typically achieved through a combination of destructive energy and alliances, is another state's insecurity. The state that feels insecure will enhance its security by producing, preventively mobilizing, and deploying destructive energy, and by creating its own alliances. This then affects the sense of security of other states, setting in motion a self-reinforcing mechanism that creates more tensions and new issues. Through the security dilemma issues and tensions create more issues and tensions, etc.

7.4 Interacting self-fulfilling prophecies

7.4.1 Causal loop diagram of feedback structures related to interacting self-fulfilling prophecies

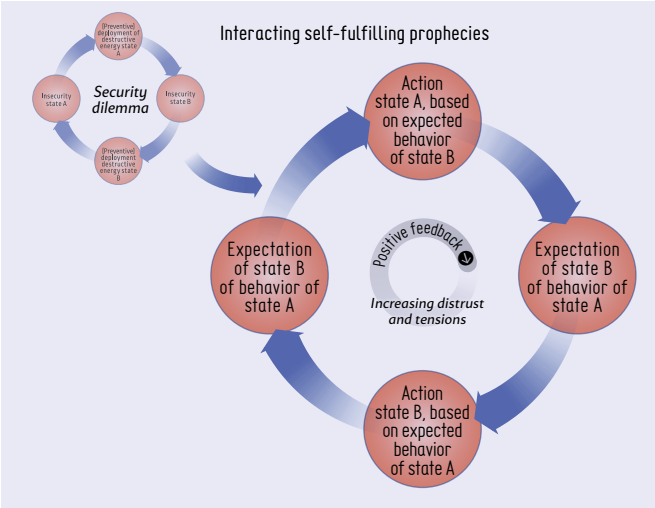

Figure 48
This figure shows the interactions between variables that make up interacting self-fulfilling prophesies in the System.

7.4.2 Explanation of the causal loop diagram

Interacting self-fulfilling prophecies constitute a very powerful mechanism that produced and shaped (and still produces and shapes) tensions, issues, and the structure of underlying vulnerable issue clusters in the System. This positive feedback mechanism is closely related to the security dilemma. In an anarchistic system, there is a certain level of distrust regarding the intensions of other states, especially rivals, and to what extent they could pose a threat to the fulfillment of basic requirements.

In an anarchistic system, perceived threats by state A sometimes provoke precautionary actions by state B, for example the preventive deployment of destructive energy. Countermeasures by state A confirm state B's distrust of state A, and start a self-reinforcing loop. This is a self-fulfilling prophecy. Interacting self-fulfilling prophecies produce and shape issues and tensions.

Through interacting self-fulfilling prophecies states can justify their interactions. Because of this powerful mechanism, it is not difficult in anarchistic systems to prove oneself right. A perceived threat, even if it is just imagined, has a high change of becoming true. Through interacting self-fulfilling prophecies, every state can produce and justify its actions and intensions, creating its own reality.

Interacting self-fulfilling prophecies act as an interface between the deterministic and contingent domain of the System, as I explain elsewhere in this study.

7.5 Intrinsic incompatibility between increasing connectivity and security in anarchistic systems.

7.5.1 Causal loop diagram of feedback structures and dynamics related to the incompatibility between connectivity and security in anarchistic systems.

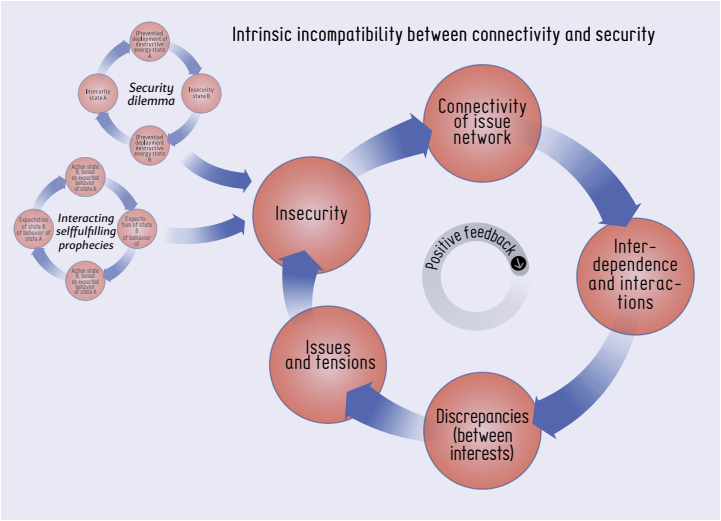

Figure 49
This figure shows the self-reinforcing dynamics that are caused by the intrinsic incompatibility between connectivity and security in anarchistic systems, and how it results in the production of free energy.

7.5.2 Explanation of the causal loop diagram

Increasing connectivity and security are intrinsically incompatible in anarchistic systems, and as a consequence of this intrinsic incompatibility an anarchistic system produces free energy (tensions in the contingent domain of the System).

In the contingent domain, this intrinsic incompatibility is contained in the contradictory effects of increasing interdependency of states. Increasing interdependence in anarchistic systems, on the one hand contributes to the ability of states to more effectively and efficiently fulfill their basic requirements, but on the other hand – 'at the same time' – also produces issues and tensions (free energy) that negatively affect its performance, and to which the second law of thermodynamics apply.

7.6 Cyclic dynamics that accompany the finite-time singularity dynamic

7.6.1 Causal loop diagram concerning the cyclic dynamics of the singularity dynamic

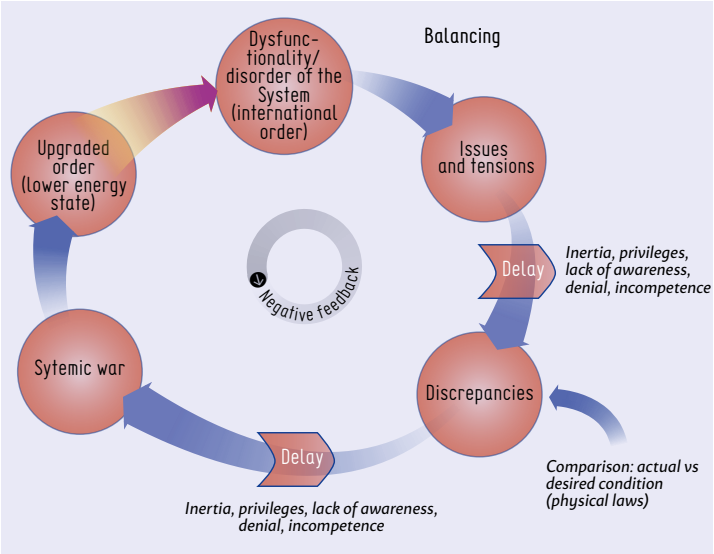

Figure 50 *This figure shows the balancing negative feedback mechanism that produced the four cycles that accompanied the finite-time singularity dynamic (1495-1945). Because corrective action through systemic wars are delayed responses of the System to disorder, systemic wars cause overshoot effects. The accelerating frequency of the four cycles can be attributed to the increasing connectivity of the System, causing an increase in its pace of life and the spreading of tensions in the System.*

7.6.2 Explanation of the causal loop diagram

As Sterman explains (69), oscillations (cycles) are generated by negative feedback with delays. The cycles in the war dynamics of the System can be attributed to delayed corrective actions of the System to implement new orders through systemic wars, as determined by the second law of thermodynamics. The delays were (and still are) caused by the (meta)stability of the System through international orders; international orders have the effect of thresholds, that allow for the build-up of tensions (free energy) in the System.

New orders were only temporarily effective in maintaining structural stability. Because of the continuously increasing connectivity of the System and the intrinsic incompatibility between increasing connectivity and security in anarchistic systems, free energy was produced at an increasing rate. As a consequence, the second law of thermodynamics forced the System to re-order at an increasing pace.

At a certain point, however, when the critical connectivity threshold

of the System was reached (1939), free energy (tensions in the contingent domain) was produced at an infinite rate, requiring systemic wars to produce new orders at an infinite frequency. As a consequence of these 'infinite requirements', the anarchistic System could not find a viable order anymore and collapsed. At that point the System experienced a dual-phase transition (1939-1945) and simultaneously two dedicated hierarchies were implemented in Europe (the core of the System), and the first global international order at the (now) global scale of the System.

Sterman explains that in the case of an oscillatory dynamic, the corrective action itself also experiences delays, causing an overshoot in the other direction. Systemic wars produce overshoot effects. This effect can be explained as follows: Destroying issues and tensions in the System by destroying the connectivity of the underlying network of vulnerable issue clusters, and implementing a new order caused a reset of the initial conditions and of the parameters of the System, respectively. This reset allowed for renewed growth of the issue network. The upgraded orders that were successively implemented in compliance with the second law of thermodynamics, were in each case more stable, robust and more fragile. These enhanced properties of successive upgraded orders, including their structural stability, robustness, and fragility, constitute the reset of the parameters of the System.

Systemic wars create space for new issue networks in two respects: by destroying the old network of issues and accompanying tensions, and by implementing an upgraded order. These effects qualify as an overshoot, as defined by Sterman.

Another example of oscillations in the war dynamics of the System can be observed in the non-systemic war dynamics during the first relatively stable period (international order). During this period of time (1495-1618), the System produced 45 non-systemic wars, that can be 'organized' - grouped – in nine orbits in phase state (defined by size and intensity of non-systemic wars), as I explain in this study, certain properties of these orbits – the average sizes of non-systemic wars constituting these cycles - did not develop arbitrarily, but can be depicted as a damped oscillation, that 'faded out' shortly before the System became critical in 1618 and produced a systemic war (the Thirty Years' War, 1618-1648). This damped oscillation was produced by delayed corrections states applied through non-systemic wars to re-establish a certain equilibrium in the international order that was temporarily disturbed.

A dynamic with these properties does make sense, not only from a (theoretical) dynamical system's perspective, but also from the perspective that states are motivated in their interactions (including war decisions) by the need to fulfill basic requirements to ensure their survival; an 'order' with a certain equilibrium is a prerequisite to achieve this in anarchistic systems. If this reasoning and argumentation is correct (as I argue), it also further confirms that these orbits are not artificial constructs, and that non-systemic war dynamics indeed are chaotic in nature as these orbits in phase state (also) suggest.

7.7 Competition between order and disorder during the life span of cycles

7.7.1 Causal loop diagram related to feedback structures and dynamics of cycles

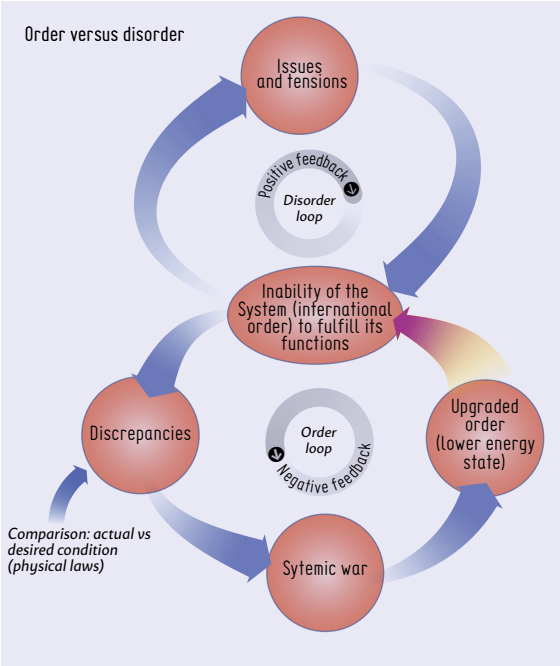

Figure 51
This figure shows the causal loop diagram of a single oscillation – a relatively stable period – followed by a systemic war. Two interacting loops can be identified: A positive feedback loop and a balancing negative feedback loop. The self-reinforcing positive feedback loop in this model consists of two variables: the inability of the international order to fulfill its function, and issues and tensions.
At a certain point, a vulnerable issue cluster percolates the System, and the System becomes critical; criticality results in systemic war. At that point the actual and desired state of the System as demanded by the second law of thermodynamics, can no longer be sustained. The order loop becomes dominant and ensures that an upgraded order is implemented (through a systemic war).

7.7.2 Explanation of the causal loop diagram

The finite-time singularity dynamic the System developed during the 1495-1945 period was accompanied by four accelerating cycles. All of the cycles developed similarly to the model depicted in this figure. When the System reached a critical condition (respectively in 1618, 1792, 1914 and 1939), a change in loop dominance took place. During relatively stable periods, dynamics of the System were dominated by self-reinforcing positive feedback mechanisms, causing increases in connectivity, but also in issues, and tensions. These tensions crystalized into underlying vulnerable issue clusters that eventually percolated the System. When the percolation condition was met, the System was critical and produced a systemic war. Through systemic war, the System re-established order, in compliance with the second law of thermodynamics.

The moment the System switched from relative stability to systemic war, a balancing negative feedback mechanism became dominant.

8 The System depicted as a path-dependent dynamic

8.1 Introduction

The dynamics of the singularity dynamic are path-dependent and increasingly locked-in on a dual-phase transitions, that became unavoidable as a consequence. This path-dependent dynamic can be approached from two complementary perspectives: a deterministic perspective and a contingent perspective.

It is possible to analytically distinguish between a deterministic and contingent domain in the System; these domains are complementary, and form an integrated dynamic. The distinction makes it possible to better understand the workings of the System, and how deterministic laws and properties interact with contingent variables and conditions. In this paragraph I apply this approach.

8.2 Path-dependency and lock-in in the deterministic domain of the System

In the deterministic domain, free energy is produced as a consequence of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. Connectivity increases at an accelerating rate, producing free energy at an accelerating and unsustainable growth rate. The singularity in finite time marks the point in time (1939) when the System reached its critical connectivity threshold and the System produced infinite amounts of free energy.

The second law of thermodynamics states that 'free energy will be put to work', and that, by doing so, 'order is implemented that enables a lower free energy state of the System'.

Four times during the 1495-1945 period, the second law of thermodynamics forced the System to re-order and implement increasingly stable orders that were better able to deal with the increasing levels of free energy the anarchistic System produced. These system-wide orders were implemented each time (four times in total) when the System reached a critical condition during the 1495-1945 period. Criticality implies a correlation length of one for the System, allowing for the system-wide communication, coordination, and planning that was necessary for the collective design implementation of upgraded system-wide orders.

Because of the accelerating growth in the connectivity of the System, the first three orders only offered a temporary solution for the System. Ultimately, when the anarchistic System reached in 1939 the critical connectivity threshold, it was confronted with infinite levels of free energy that threatened to destroy it. At that point, the no longer viable anarchistic System collapsed, and the second law of thermodynamics forced the System into another stability domain in which anarchy was neutralized. Through a phase transition, dedicated hierarchies were introduced in Europe that

neutralized anarchy and the production of free energy; levels of free energy became manageable again, and the System, at least temporarily, complied with the second law of thermodynamics.

The same systemic war that produced two dedicated hierarchies in Europe, also produced the first global international order in the now-expanded globalized System. Both orders, Europe and the global stage, coevolved.

These dynamics qualify as a path-dependent dynamic: The production of free energy (tensions) by the anarchistic System, application of the second law of thermodynamics, the initial conditions of the System and the urge of its constituents to survive, caused the System to lock-in on increasing levels of order simultaneously in Europe and on the global stage. Positive feedback through the production of increasing levels of free energy, as a consequence of connectivity growth, powered these path-dependent dynamics.

8.3 Path-dependency and lock-in in the contingent domain of the System

The path-dependent dynamic, logic, discussed in the previous paragraph concerns the dynamics of the deterministic 'core' of the contingent path-dependent dynamic that developed simultaneously in the contingent domain of the System; it should be kept in mind that the distinction between a deterministic and contingent domain in the System, serves above all analytical purposes. Free energy manifests itself by tensions in the contingent domain. Increasing interdependence enhances the capability of states to fulfill their basic requirements, but also unavoidably produces new insecurity issues. The intrinsic incompatibility of interdependence and security in anarchistic systems produces tensions. Increasing connectivity means increasing interdependence and implies increasing levels of insecurity and tensions.

To fulfill their basic requirements, states require structural stability and predictability; structural stability and predictability in the contingent domain of the System were provided by international orders: collectively agreed upon arrangements that reflected the power and influence positions of states and provided rules that determine how states should interact. During systemic wars, dysfunctional orders are destroyed, and new orders are designed and implemented. Because of the increasing interdependence of states, caused by population growth and increasing connectivity, successive international orders contained increasingly far-reaching organizational arrangements.

The League of Nations (the arrangement following the third systemic war, the First World War, 1914-1918) was the maximal achievable arrangement that could be designed and implemented in the anarchistic System, before the anarchistic System ultimately collapsed, when it reached in 1939 the critical connectivity threshold. The ineffectiveness of the fourth international order (1918-1939, the League of Nations) shows that viable orders – that could effectively cope with the tensions that were produced in the System – could no longer be designed and implemented in an anarchistic System.

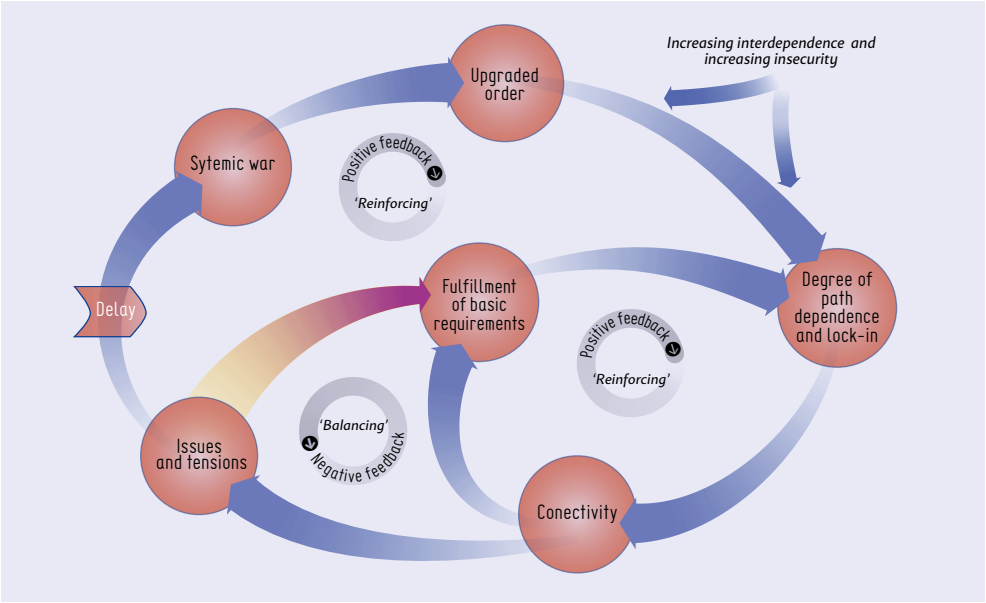

Figure 52 *This figure shows the relationships between variables in the System that produce a positive feedback mechanism that results in increasing path dependence and lock-in towards increasing interdependence of states and increasing levels of insecurity.*

An integral component of the path-dependent dynamic – during the unfolding of the finite-time singularity dynamic (1495-1945) – was the coevolution of states and international orders. This co-evolutionary process provided a mechanism that ensured that successive international orders contained increasingly far-reaching arrangements – structural stability – as required by underlying deterministic laws. This co-evolutionary mechanism also contained a positive feedback mechanism that I refer to as the 'powerful-get-more-powerful effect.'

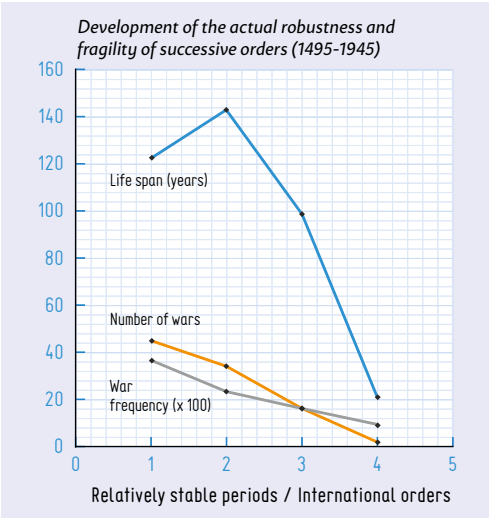

Figure 53
The robustness, structural stability, and fragility of successive international orders increased linearly over time, and reached 'absolute' levels when the System reached the critical connectivity threshold and collapsed in 1939. In this figure the development of the life spans of successive orders is shown in blue; this is a measure for the fragility of the System, and of the absolute number of non-systemic wars (eight expansion wars excluded) and of the war-frequency of successive international orders in respectively orange and grey; both measures for the robustness of the System.

9 The System (1495-1945) depicted as a sequence of phases with different dynamics and levels of criticality

9.1 Schematic depiction of types of dynamics and levels of criticality of the System during the 1495-1945 period

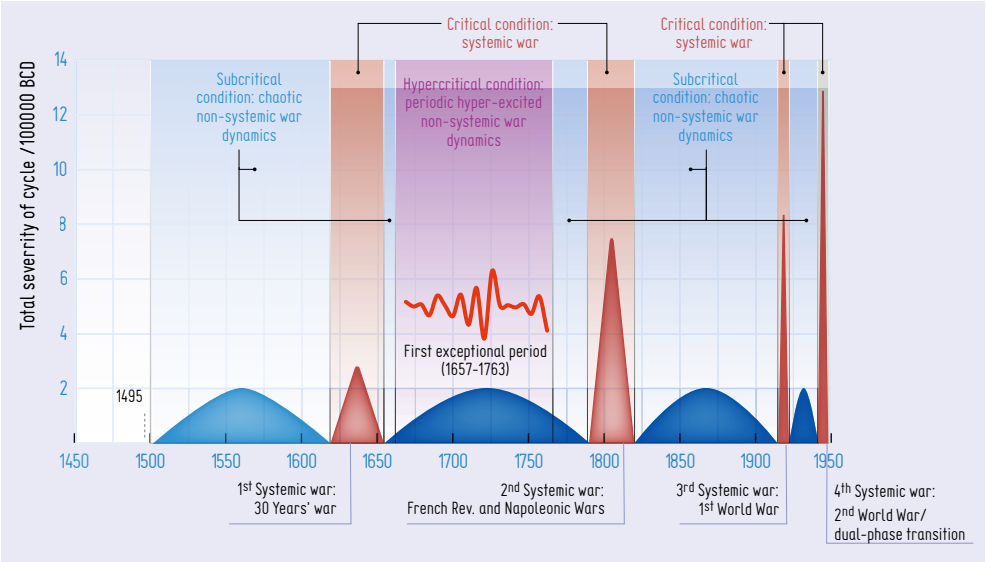

Figure 54 *This figure shows the different types of dynamics that can be identified during the unfolding of the first finite-time singularity dynamic (1495-1945), and with what levels of criticality they correspond.*

9.2 Explanation of the different phases

It is possible to identify different types of dynamics during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); different types of dynamics correspond with different degrees of criticality, as I explain in this paragraph.

During each of the four cycles consisting of relatively stable periods followed by systemic wars, the System, with one exception, produced similar dynamics. During relatively stable periods, non-systemic war dynamics were chaotic in nature; only during an exceptional period (1657-1763) within the second relatively stable period (1648-1792), chaotic dynamics were temporarily disturbed. Due to a decrease in the number of degrees of freedom in the System, attributable to the intense rivalry during the exceptional period, the System temporarily produced periodic dynamics, consistent with rules that govern dynamical systems.

The number of other states that states take into consideration regarding war decisions determines the number of degrees of freedom of the System. During the exceptional period, Great Britain and France dominated the System's dynamics completely. The temporary decrease in the number of

degrees of freedom from n > 2 (chaotic dynamics) to n = 2 (periodic dynamics), caused a 'downgrade' in the non-systemic war dynamics of the System from chaotic to periodic. Periodic war dynamics have fundamentally different properties (see table below).

Properties of chaotic and non-chaotic non-systemic war dynamics	
Chaotic	Periodic
Degrees of freedom > 2	Degrees of freedom = 2
Default non-systemic war dynamics	Abnormal non-systemic war dynamics
Intrinsically unpredictable	More regular and more predictable
More constrained in size and severities	More extreme in size and severities in case of periodic non-systemic war dynamics during the first exceptional period (1657-1763), subdued during the second exceptional period (1953-1989)
Contribute to the development of the System towards criticality	Hinder the development of the System towards criticality
Ensure optimality and efficiency	Cause delay and inefficiencies in the unfolding of the singularity dynamic; negatively affect optimality and efficiency

Table 47 *This table shows the different properties of chaotic and abnormal (periodic and subdued) non-systemic war dynamics.*

Whereas chaotic dynamics are intrinsically unpredictable, periodic dynamics are much more regular and predictable. Chaotic non-systemic war dynamics are also more balanced and less extreme than periodic dynamics. A third degree of freedom restrains states. As a consequence, non-systemic wars are more limited in size and less intense and severe.

Periodic non-systemic wars are not only more regular, but often are also more extreme. During periodic (n = 2) conditions war dynamics of the System reached higher unconstrained free energy states and became hyper-excited. The absence of a third degree of freedom and the inability of the System to produce chaotic non-systemic war dynamics this implied, negatively affected internal control properties of the System.

During relatively stable periods, the System was in a subcritical condition, except for the exceptional period (1657-1763) when the condition of the System qualifies as hypercritical (as I explain later, part VI where I discuss the term 'hypercritical' and potentially false interpretation).

Subcriticality implies that the correlation length of the System is lower than one; vulnerable issue clusters and wars the System produced were (for that reason) not system-wide. During subcriticality, system-wide communication, coordination, and planning, required for the design and implementation of new system-wide orders, are not possible ('enabled properties'). Non-systemic wars are local wars, with no significant impact on the order of the System.

As the war data of Levy shows, during the exceptional period (1657-1763) the System produced a number of system-wide and very intense wars. Despite the fact that these wars were system-wide, they do not qualify as systemic. These system-wide non-systemic wars were a consequence of the hyper-exited unrestrained state of the System during the exceptional period. These wars do not 'represent' criticality and were forced on the System as a consequence of the temporarily reduced degrees of freedom of the System that can be attributed to the intense rivalry between Britain and France.

The extreme dynamics the System produced during the exceptional period (1657-1763) are sometimes referred to as hyper-critical dynamics.

The dynamics and development of the System and finite-time singularity dynamic (1495-1945) suggest that chaotic non-systemic war dynamics are a prerequisite for the formation of vulnerable issue clusters with fractal structures, and a prerequisite for the System to become critical. Hyper-excited war dynamics lack restraint (during the first exceptional period 1657-1763), and contrary to chaotic dynamics, cannot produce (underlying) vulnerable issue clusters with fractal structures; the free energy (tensions) that are produced during hyper-excited conditions are 'immediately' released, and cannot be stored in the System.

When the intense rivalry between Great Britain and France was resolved in 1763, the System resumed chaotic war dynamics; the System after experiencing a temporary hypercritical period became subcritical again, formed underlying vulnerable issue clusters that percolated the System in 1792, resulting in the System's criticality and systemic war.

So, during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System was normally subcritical during relatively stable periods, and critical during systemic wars; during the exceptional period (1657-1763) the System was hypercritical.

Through a phase transition (the fourth systemic war, The Second World War, 1939-1945) the System experienced a dual-phase transition that resulted in the simultaneous implementation of two dedicated hierarchies in the core of the System (Europe), and the first global order at a (now) global scale of the anarchistic System.

Following the phase transition, the System initially resumed its default chaotic war dynamics until 1953, when – I argue – the System experienced a second exceptional period (1953-1989) as a consequence of the intense rivalries between the United States and the Soviet Union, and the respective hierarchies they controlled. Contrary to the first exceptional period (1657-1763) these intense rivalries did not produce a hyper-excited condition, instead the war dynamics were subdued. Following the collapse of the Eastern hierarchy (1989), the System resume chaotic war dynamics.

The condition of the System during the period 1945-1953 qualifies as subcritical, during the second exceptional period (1953-1989) as 'subdued', and during the period 1989- present as subcritical again.

10 The System depicted as energy transfers

10.1 The System depicted as energy transfers

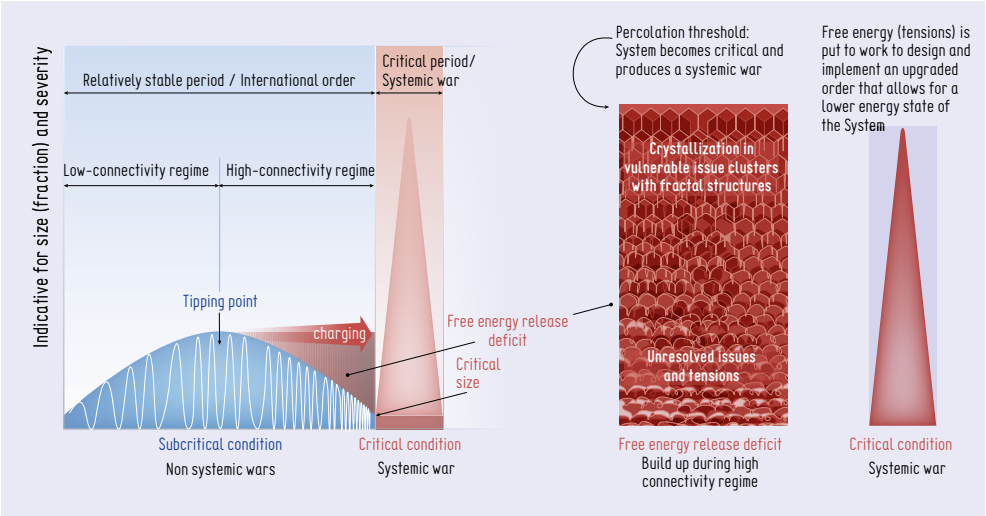

Figure 55 *This figure shows schematically the buildup of a free energy release deficit during the high-connectivity regime of a cycle. The deficit contributes to the formation of underlying vulnerable issue clusters that eventually percolate the System. Furthermore, the deficit enables a massive release of tensions and destructive energy when the System becomes critical and produces a systemic war.*

10.2 Free energy production and its use by the System

The intrinsic incompatibility between connectivity and security in anarchistic systems results in the production of free energy and tensions, in respectively the deterministic and contingent domain of the System. Free energy and tensions obey the second law of thermodynamics. In accordance with this law, tensions (free energy) are at a certain point put to work, to implement (upgraded) orders, that allow for lower energy states of the System. In the anarchistic System tensions are put to work through systemic wars. Tensions are transformed in alliance dynamics and destructive energy that is deployed during wars. I consider the severities of wars indications for the destructive energy that is deployed during these wars. I also assume that the destructive energy that is deployed during wars is indicative for the amount of free energy that is produced by the System.

The figure below shows the total severity of wars during successive cycles of the actual and theoretical finite-time singularity dynamic that unfolded in the anarchistic System during the 1495-1945 period; respectively in blue and red.

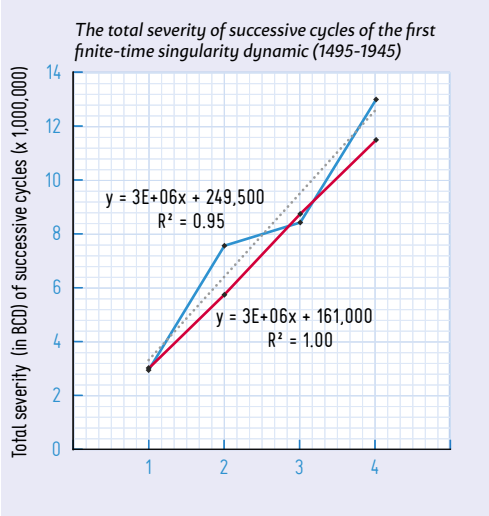

Figure 56
This figure shows the actual (blue) and theoretical (red) total severity of wars during successive cycles of the first finite-time singularity dynamic. The destructive energy deployed during successive cycles increased linearly, however because of the accelerating shortening of the life-span of successive cycles, its rate of production accelerated.

These distributions show that the total free energy production of successive cycles (during relatively stable periods and systemic wars that followed) increased linearly. Because the life span of successive cycles decreased at an accelerating rate, the free energy production and the increase in tensions, in fact increased at an accelerating rate when the factor time is taken into consideration.

Total severities and lifespans of cycles of the actual and theoretical finite-time singularity dynamics

	Actual finite-time singularity dynamic 1495-1945 (Calculations based on data from Levy (38))		Theoretical finite-time singularity dynamic. (Data derived from model)	
Cycle	Total severity	Life span	Total severity	Life span
1	2.976.000	153	3.036.000	168
2	7.550.300	167	5.750.000	154
3	8.425.080	103	8.720.000	103
4	13.003.300	27	11.500.000	22,5

Table 48 *This table shows total severities and lifespans of cycles of the actual (1495-1945) and theoretical finite-time singularity dynamics.*

The figure below shows the accelerating growth of the severity of successive cycles of the actual and theoretical model of the first finite-time singularity dynamic (1495-1945), an indicator for the destructive and free energy produced and put to work by the System, with the cycles' life spans taken into consideration.

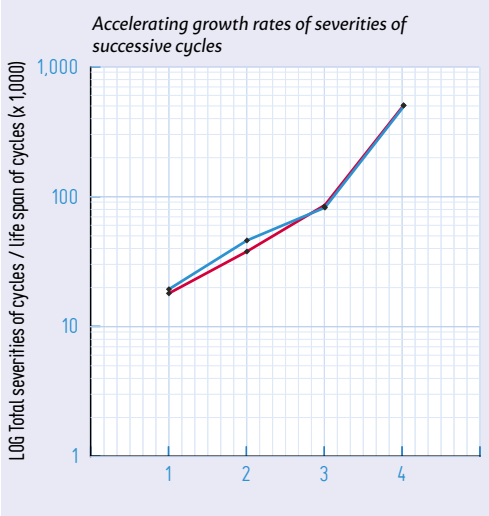

Figure 57
The figure shows the severities per year of wars during successive cycles (non-systemic and systemic) of the actual (blue) and theoretical model of the first finite-time singularity dynamic (1495-1945). I assume that the total severity is indicative for the free energy (tensions) that was produced during successive cycles, and for the destructive energy that is subsequently deployed.

10.3 Energy transfer: System-level.

From the perspective of this model, the dynamics and the development of the System are about the production, storage, transfer, and use of energy. Energy is needed to establish, maintain and change international orders. Physical laws, including the second law of thermodynamics and a number of principles related to this law (I refer to these principles as 'free energy principles'), also apply to the System and determine and shape its dynamics and development.

During the 1495-1945 period, the energy (tensions) levels, transfers and transformations in the System were 'regulated' by the finite-time singularity dynamic, which can be considered a product of the second law of thermodynamics.

The second law of thermodynamics and its principles determined when the System became (and will become) critical, for how long, and how much free energy had to be used to implement upgraded orders that could provide more structural stability to the System and allow for a lower free energy state. This law and its principles are the basis of the finite-singularity dynamic.

By demanding ever-higher levels of order, to accomplish lower energy states (a response to the accelerated amounts of free energy the System produced over time), the second law of thermodynamics 'facilitated' - in fact enforced - a process of social integration and expansion (SIE) in the System. The SIE process eventually, when the anarchistic System in 1939 reached the critical connectivity threshold, resulted in the simultaneous implementation of dedicated hierarchies in the core of the System (Europe), and the first global order at a global scale of the System. The two dedicated hierarchies in Europe order addressed in particular the 'European' situation (tensions); while the first global order addressed global tensions; both orders are closely related.

The second law of thermodynamics also determined when the critical

threshold (the singularity in finite time, 1939) of the anarchistic System was reached, and determined that the just mentioned dedicated hierarchies and first global order where adequate responses of the System to meet the law's requirements for a lower energy state.

Not only can the finite-time singularity be interpreted as an energy transfer dynamic; energy transfers can also take place at the level of cycles.

10.4 Energy transfer: Cycle level

Connectivity is not just the driver of energy production in an anarchistic system; it also shapes energy redistribution and transfers.

The finite-time singularity dynamic (1495-1945) was accompanied by four accelerating cycles. Each cycle developed according to a similar logic. A cycle consisted of a relatively stable period (international order) followed by a systemic war. During a systemic war the dysfunctional preceding order was destroyed and replaced by an upgraded order that allowed for a lower free energy state, or lower tensions, in the System. The accelerating growth rate of free energy in the System contributed to the acceleration of successive cycles. The life span of an international order was relatively long compared to the life span of the systemic war that followed. However, relatively stable periods and systemic wars accelerated with about the same rate during the unfolding of the finite-time singularity dynamic (1495-1945), except for the fourth systemic war, the Second World War, 1939-1945, which had an extended life span because of the global component of the dual-phase transition; see below figure.

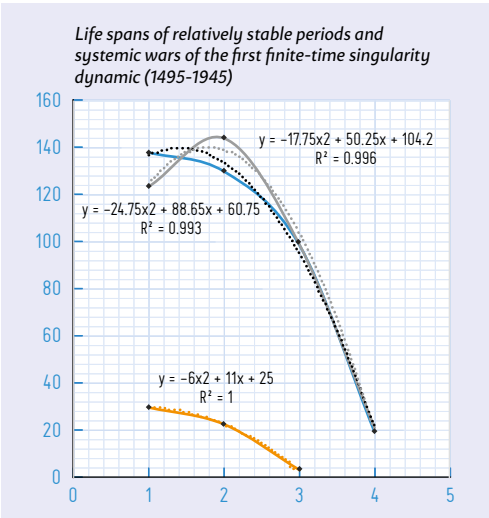

Figure 58

In this figure the life spans are shown of the actual relatively stable periods (international orders) in grey, of the theoretical (corrected) relatively stable periods (international orders) in blue, and of the first three systemic wars of the first finite-time singularity dynamic (actual), in orange; the fourth systemic war is excluded from this analysis because of a significant 'distortion' that can be attributed to the globalization effect. The correlation coefficient of the life spans of the first three relatively stable periods (actual) and of the first three systemic wars (actual) is 0.73, and the correlation coefficient of the first three relatively stable periods (theoretical) and of the first three systemic wars (actual) is 1.00.

Except for the exceptional period (1657-1763), non-systemic war dynamics were chaotic in nature; during the exceptional period non-systemic war dynamics were periodic, as explained.

During the life cycle of relatively stable periods (international orders), two regimes – a low- and a high-connectivity regime limited by a tipping point – can be distinguished. Typically, at the start of a relatively stable period, following a systemic war, the connectivity of the network of issues in the System is relatively low. When the connectivity increases, so does the production of free energy, and of the sizes of energy release events, that is, of non-systemic wars. During low-connectivity regimes of relatively stable periods, the sizes of release events – of non-systemic wars – is determined by its connectivity; increasing connectivity implies increasing average size of non-systemic wars.

When the tipping point is reached, the System reaches the high-connectivity regime of the relatively stable period. In the high-connectivity regime, the nodes (states) of the System become increasingly stable and the average sizes of non-systemic wars decrease as a consequence. This connectivity/local stability effect is caused by the nature of war decisions; war decisions qualify as binary decisions with externalities and thresholds.

However, although the average size of non-systemic wars decreases during high-connectivity regimes of relatively stable periods, the production of free energy (tensions) still continuously increases. Instead of being released, these tensions are 'stored' as unresolved issues in the System, and crystallize into underlying vulnerable issue clusters. These stored tensions, form a so-called free energy release deficit.

The moment the underlying vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. During systemic wars, the free energy release deficit complemented with free energy (tensions) that is produced, is put to work to implement upgraded orders that allow for lower energy states of the System.

The temporary storage of unreleasable free energy – in other words of high-connectivity regimes during relatively stable periods that enable such a storage of tensions – is a requirement for the System to be able to produce systemic wars that have enough destructive energy available to ensure destruction of the 'old' dysfunctional order (that precedes such a systemic war), and for the design and implementation of an upgraded order that meets the requirements of the second law of thermodynamics.

Because of the hyper-excited (abnormal) non-systemic war dynamics during the exceptional period (1657-1763), the System could not reach the tipping point of the second relatively stable period (the second international order, 1648-1792), and produce a free energy release deficit and underlying vulnerable issue clusters, that could percolate the System and cause it to become critical.

Because of the increasing structural stability of successive international orders, successive systemic wars required increasing levels of destructive energy to ensure the implementation of upgraded orders.

In figure 53 I show that the robustness, structural stability, and fragility of successive cycles consistently increased. I argue that increased robustness and structural stability of successive relatively stable periods, in combination with the production of free energy at an increasing rate, were responsible for the acceleration of the frequency of successive cycles and the simultaneous acceleration of the severity of successive systemic wars, indicative of the free destructive energy that was deployed.

10.5 Energy transfer: Shifts in the energy release distribution – the release ratio – during successive cycles

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the energy release distribution during successive cycles shifted in favor of systemic wars. I define the ratio of the severity of the systemic war of a cycle and the total severity of all wars during the cycle, as the release ratio of a cycle. I consider the severities of wars indicative for the destructive energy that is deployed during wars, for the amount of free energy that is released.

The change in the energy release distribution can be attributed to the increasing robustness of successive relatively stable periods of cycles. Ultimately, when during the fourth relatively stable period (1918-1939), the anarchistic System became completely robust, the release ratio became one, meaning that all energy was (and only could be) released during the fourth systemic war (the Second World War, 1939-1945).

However, the development of the release ratio shows a significant distortion during the second cycle (1648-1815).

Release ratios of the actual and theoretical finite-time singularity dynamic (1495-1945)

		Actual FTS (Severity in BCD)			Theoretical FTS (Severity in BCD)		
Cycle	Period	Severity systemic war	Total severity	Ratio	Severity systemic war	Total severity	Ratio
1	1495-1648	1,971,000	2,976,000	0.66	1,971,000	3,036,000	0.65
2	1648-1815	2,532,000	7,550,300	0.34	4,900,000	5,750,000	0.85
3	1815-1918	7,734,300	8,429,080	0.92	8,100,000	8,720,000	0.93
4	1918-1945	12,948,300	12,953,300	1.00	11,100,000	11,500,000	0.97

Table 49 *This table shows the release ratios of successive cycles of the actual and theoretical finite-time singularity which was accompanied by four accelerating cycles (1495-1945).*

If the ratios of the actual and theoretical finite-time singularity are plotted in a graph, the (just mentioned) distortion during the second cycle (1648-1815) is visible.

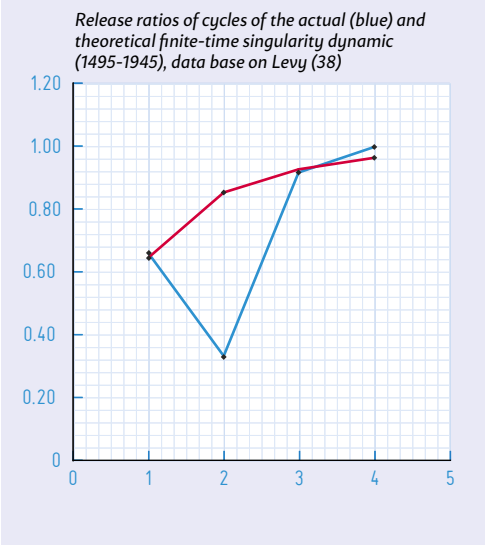

Figure 59
This table shows the release ratios of successive cycles of the actual (in blue) and theoretical (in red) finite-time singularity which was accompanied by four accelerating cycles (1495-1945). The distortion caused by the first exceptional period is clearly visible (1657-1763).

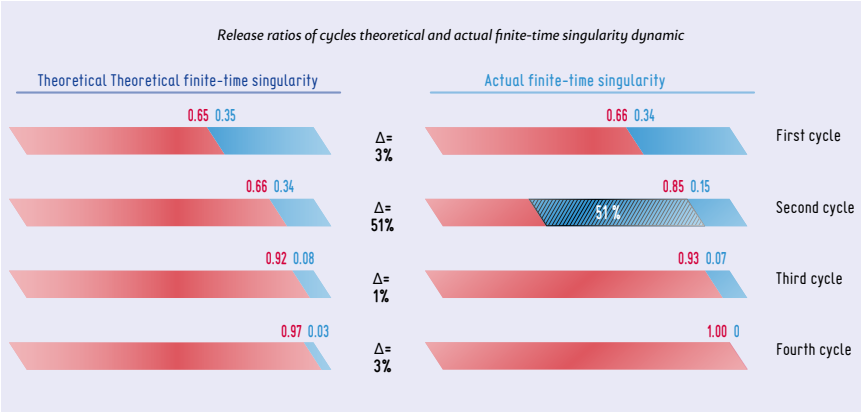

Figure 60 *In this figure the theoretical and actual release ratios are shown of the four accelerating cycles of the first finite-tvime singularity dynamic (1495-1945). This figure shows that ultimately (about) 100 percent of the free energy (tensions) was released through the fourth systemic war (the Second World War, 1939-1945). This effect can be attributed to the increasing robustness of successive relatively stable periods (international orders), as explained in this study. The distortion (51 percent) during the second cycle (1648-1815) is also clearly visible; this distortion I attribute to the abnormal (non-chaotic) non-systemic war dynamics during the first exceptional period (1657-1763).*

During the period 1657-1763 – I designated as the first exceptional period – the non-systemic war dynamics of the System were temporarily non-chaotic in nature, and produced a series of extreme non-systemic wars (in terms of size and severities), because the System during that specific period lacked a third – balancing – degree of freedom that would have produced chaotic non-systemic war dynamics.

The abnormal non-systemic war dynamics during the exceptional period

(during the second cycle) had a number of effects, including: (1) an 'over-production' of free energy (tensions), resulting in a series of 'extreme' non-systemic wars, (2) a shift in the energy release distribution of the System, and (3) a delay in the unfolding of the second cycle (see also:...).

1 ***Over-production of free energy***
The abnormal non-systemic war dynamics resulted in an increase of 0,92 percent of the total severity of the cycle (0,92% of the population size at the start of the second systemic war.

2 ***A distortion in the release ratio of the second cycle***
Significantly more energy was released through non-systemic wars during the relatively stable period of the second cycle), than would be the case if the non-systemic war dynamics were not disturbed, as the theoretical model of the first finite-time singularity dynamic suggests. It seems that the increase in the energy-release through non-systemic wars, was (at least to a degree) 'compensated' by a significant lower release during the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815); the actual release ratio was 0,34 instead of 0,85 (theoretical).

3 ***A delay in the unfolding of the second cycle***
This delay was about 13 years as this study suggests.

10.6 Energy transfer: Expansion of the core of the System

The finite-time singularity dynamic, accompanied by four accelerating cycles, had three system-level impacts: (1) the implementation of dedicated hierarchies in Europe when the singularity in finite time (the critical connectivity threshold) was reached in 1939; a dynamic that produced a process of integration in the contingent domain of the System, (2) the initiation of a process of expansion outside Europe, the core of System, and (3) the contribution to the implementation of the first global international order. The first and third impacts were achieved through the fourth systemic war (the Second World War, 1939-1945), which qualifies as a phase transition because of these two impacts. The first and third impacts, respectively the implementation of dedicated hierarchies (in the core of the System) and the contribution of the singularity dynamic to the implementation of the first global order (at a global scale), are the outcomes of a long-term process of social integration and expansion (SIE), that still is unfolding.

The implementation of the global order also involved energy transfers; five phases can be distinguished. Each phase can be associated with a fundamental change in energy transfers; see below table.

Further analysis of the war data reveals that the pace of the expansion of the core accelerated with the same rate as the integration of its core.

I determined the accelerating rate of expansion of the core, by determin-

ing which wars in Levy's dataset (38) correspond with the start of the five phases of the expansion process; see table 50.

The rate of integration of the core is determined by the acceleration of the cycles that accompanied the finite-time singularity dynamic (1495-1945).

As below figure shows, the acceleration rates of the process of integration and expansion are about the same.

Five phases of expansion from a European to a global System			
Phase	Timing	Characteristics	Triggers
(I) Core formation and integration: Initially (1495-1812): 'Internal core dynamics only'	Starting 1495	During the period 1495-1812 all Great Power war dynamics still take place within Europe, the core of the System.	During the period 1495-1812; internal core dynamics only.
(II) Core expansion: 'Power projection outside Europe'	Starting 1812	European Great Powers become involved in or start wars outside of Europe.	The War of 1812, 1812-1814, war 88 in Levy's dataset marks the beginning of this phase. Other wars that are part of phase two are 97, 99, 104, 105, 110, and 112 (38).
(III) Non-core involvement in European affairs	Starting 1914	Non-European Great Powers become involved in European war dynamics.	The United States' and Japan's involvement in the First World War (1914-1918) mark the beginning of this phase.
(IV) Non-European powers autonomously produce their own war dynamics	Starting 1931	Non-European Great Powers initiate their own Great Power wars outside of Europe, without the direct involvement of European Great Powers.	The Manchurian War (109, involving Japan and China) marks the beginning of this phase.
(V) Globalization of the System and merging of core and non-core	Starting 1941	War dynamics become connected on a global scale.	Japan attacks the United States (Pearl Harbor, 1941), and Germany (ally of Japan), declares war on the United States, connecting war clusters in Europe and Asia.

Table 50 *This table shows the five expansion-phases of the System that can be determined during the unfolding of the finite-time singularity dynamic (1495-1945). The start of each phase correspondents with a specific war, as explained in the column 'triggers'.*

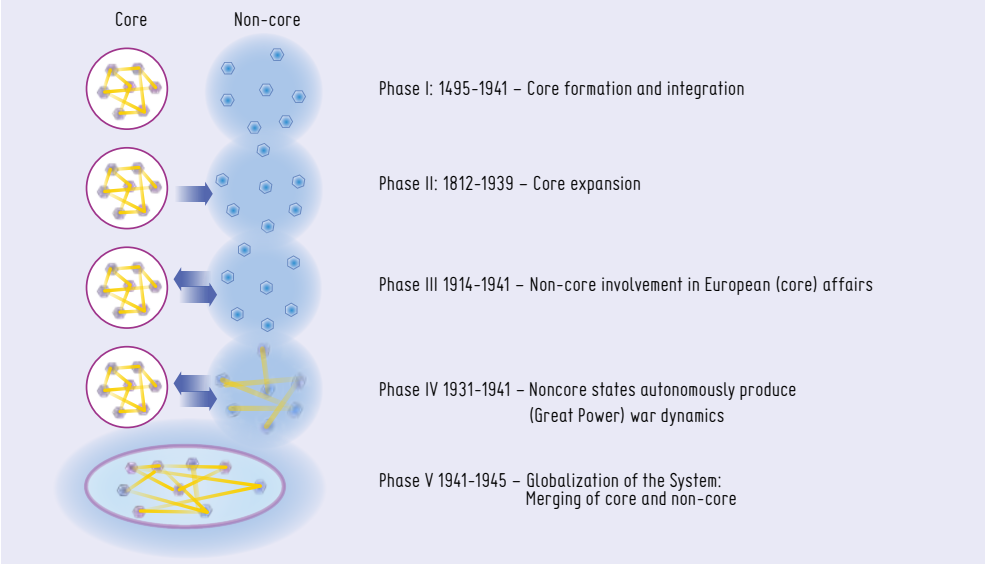

Figure 61 *This figure shows the energy transfers during respective phases that can be observed during the process of expansion.*

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)				
		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1812	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 51 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

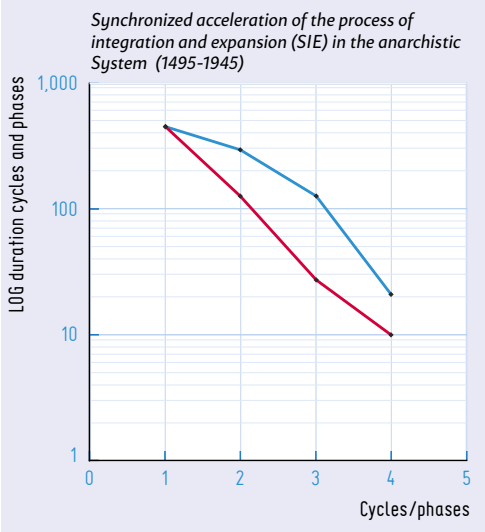

Figure 62
This figure shows the acceleration of the processes of integration (blue) and expansion (orange) in the anarchistic System. The data points related to the process of integration (blue) depict the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points related to the process of expansion (orange) depict the duration of the four phases that can be distinguished in the process of expansion of the core to the non-core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, and was to be expected given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the series is 0,92.

This is of course not a coincidence: both rates of acceleration – integration and expansion – are determined by the connectivity of the core (Europe) of the System. Connectivity is the driver of both – closely related – processes. Connectivity is a function of population size of the System, and sets its pace of life.

The same moment as the process of integration reached 'infinity', and the finite-time singularity dynamic produced cycles at an infinite frequency (1939, when the System reached the critical connectivity threshold), the process of expansion was also 'complete', in the sense that the first global order was implemented that formally marks the globalization of the System.

11 The System depicted as an interacting system of a deterministic and contingent domains, and accompanying variables

11.1 The System depicted as an interacting system of deterministic and contingent domains and variables

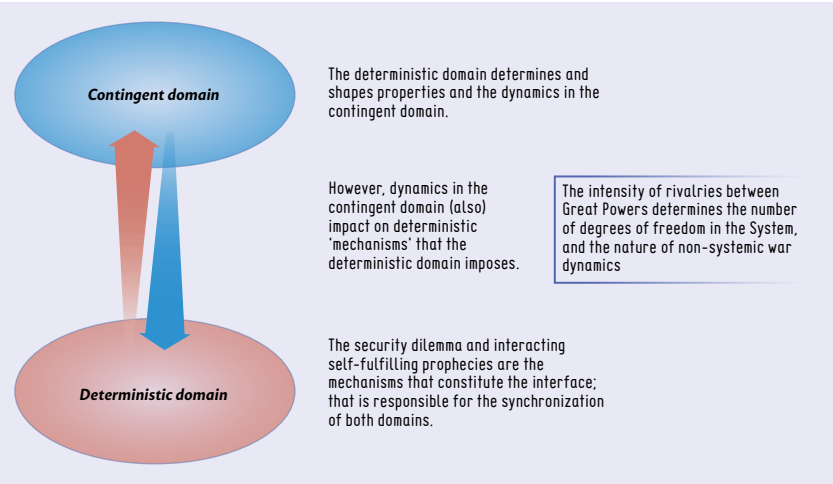

Figure 63 *This figure shows the contingent and deterministic domains of the System, which are connected through an 'interface'. The security dilemma and interacting self-fulfilling prophecies are the two mechanisms that constitute the interface.*

11.2 Explanation of the 'domain model'

It is possible to analytically distinguish between two 'domains' that together determine the dynamics and development of the System: respectively a deterministic and a contingent domain. Until now the 'underlying' deterministic domain was not identified; we were not aware of its existence, let alone of its deterministic – and decisive – impact on dynamics in and between social systems, and on what we depict as historical processes.

This study shows that the deterministic domain determined and shaped the dynamics and development of the System. The second law of thermodynamics and its accompanying principles, the singularity dynamic, non-systemic war dynamics, and connectivity effects are all parts – components – of the deterministic domain. The deterministic domain determines when energy will be released, that is, when wars start, their duration, their sizes, and their intensities and severities. The deterministic domain determines the critical connectivity threshold and, given the growth rate of the connectivity of the System, and the timing of when the System will experience an unavoidable phase transition.

How wars are fought (for example, with what technologies), why wars are fought, and what states will form alliances to fight each other are determined in the contingent domain of the System and by contingent variables. Laws that apply to the System determine that new dedicated hierarchies must be implemented at certain points (in Europe, 1939-1945), to ensure that the System and its dynamics comply with the second law of thermodynamics. The exact structure of the hierarchies and their political organization are contingent variables. The Western hierarchy that was introduced following the phase transition (1939-1945), was based on democratic and capitalist principles, whereas the Eastern hierarchy was authoritative in nature, and applied centralized economic planning principles. From the perspective of the second law of thermodynamics however, these contingent 'details' are not relevant; the point is that both orders reduced the energy state of the System, in compliance with the second law of thermodynamics.

In statement 229 I discuss some alternative scenarios regarding potential directions of development of the System following the phase transition (1939-1945) that also complied with the deterministic and contingent demands of both domains.

Both domains, of course, interact and together represent the System and its singularity dynamic. The abnormal war dynamics of the System during both exceptional periods (1657-1763 and 1953-1989) for example show how contingent developments - intense rivalries between respectively Britain and France, and the United States and the Soviet Union, determined the number of degrees of freedom in the System, and by doing so determined the nature of the non-systemic war dynamics.

From an analytical point of view, 'coordination' between the deterministic and contingent domains of the System is accomplished through interacting self-fulfilling prophecies between states and the security dilemma. These mechanisms are responsible for the production, storage, and deployment of free energy and tensions in respectively the deterministic and contingent domain of the System; free energy and tensions are equivalent.

I consider interacting self-fulfilling prophecies for that reason the interface between both domains: interacting self-fulfilling prophecies determine how the free energy that is produced crystallizes in underlying vulnerable issue clusters, and what meaning and justification states and populations give to energy releases – wars – the anarchistic System produces to comply with the second law of thermodynamics.

12 The dynamic System depicted as a change model (levels and mechanisms of change)

12.1 The System depicted as a change model.

Levels and mechanisms of change		
Level	Change	Mechanism
1	Change in the nature of the System from anarchistic to non-anarchistic.	Through the implementation of dedicated hierarchies in the core of the System (Europe) through a phase transition (the fourth systemic war, the Second World War, 1939-1945). This level of change was accomplished (in the contingent domain) by implementing the next level of SIE.
2	Change in the order of the System, without changing its basic (anarchistic/non-anarchistic) nature.	Through the implementation of new arrangements (upgraded international orders) through systemic wars.
3	Change in the nature of non-systemic war dynamics.	Through a change in the number of degrees of freedom in the System: $n > 2$ implies chaotic dynamics, $n = 2$ implies periodic dynamics. The intensity of rivalries between states determines the number of degrees of freedom in the System.
4	Change in the relationship of the System with its environment.	Through expansion of the System outside its core.

Table 52 *This table shows the levels of change and corresponding mechanisms that can be distinguished in the System during the 1495-1945 period.*

12.2 Explanation of the change model

It is possible to distinguish three levels and mechanisms of change *in* the System, and one level and mechanism of change of regarding the System's relationship with its environment.

1 ***Level 1 change: A change in the nature of the System from anarchistic to non-anarchistic***

A change in the fundamental nature of the System, from anarchistic to non-anarchistic and vice versa, was (and is) the most fundamental change the System could (and can) experience. Such a fundamental change was accomplished through the implementation of dedicated hierarchies in the core of the System (Europe). These dedicated hierarchies neutralized anarchy and the security dilemma, and stopped the production of tensions and free energy within respective hierarchies.

Level 1 change was accomplished through the finite-time singularity dynamic accompanied by four cycles (1495-1945), which constituted a step-by-

step process of increasing order in the deterministic domain, and a parallel and synchronized process of integration in the contingent domain of the System. The dynamics in both domains were determined and shaped by the second law of thermodynamics.

The ultimate implementation of dedicated hierarchies – non-anarchistic clusters of states – in the core of the System (Europe), constituted a phase transition. The three preceding cycles – relatively stable periods and accompanying systemic wars – can be considered precursory dynamics that announced this eventual and necessary phase transition in the System.

In the contingent domain of the System, level 1 change manifested itself through the implementation of the next level of social integration and expansion (SIE) in its core. This was a final step in a much longer SIE process, that started when the first humans and their tribes, 'integrated' into larger units to be able to better – collectively – fulfill their basic requirements and enhance their survival changes.

The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period is mere a specific phase in this long-term process. During this period (1495-1945) a sizeable collection of divers and loosely connected units in Europe (1495) transformed through the finite-time singularity dynamic into a highly integrated system of a relatively small number of highly standardized states with a fractal size distribution (1939), before ultimately transforming into two non-anarchistic dedicated hierarchies (1945). To achieve this, during the unfolding of the singularity dynamic the units of the System evolved into 'organizations' that were increasingly specialized in producing and deploying destructive energy; without this development the singularity dynamic could not have unfolded and achieved its ultimate purpose.

A reversed change, of a non-anarchistic social system (a state or dedicated hierarchy, including the European Union) to an anarchistic condition, also qualifies as a level 1 change. Such a fundamental change is the outcome of a process of social fragmentation; the reverse of the SIE process. Integration and fragmentation are continuously competing forces.

Initially the System produced two dedicated hierarchies through the phase transition (1939-1945); a Western hierarchy dominated by the United States, and an Eastern hierarchy dominated by the Soviet Union. As a consequence of internal unbalances that undermined the ability of the Soviet Union and Eastern hierarchy to ensure the balanced fulfillment of its basic requirements, that were further reinforced through the intense rivalry with the Western hierarchy, the Eastern hierarchy collapsed in 1989. This fragmentation process – the undoing of the SIE implemented by the phase transition in Eastern Europe – was followed by the integration of fragments of the Eastern hierarchy into the Western hierarchy.

In 1989, the Western hierarchy, which had been following a fundamentally different integration logic since its inception, had built up enough integrative capabilities in the contingent domain to integrate these fragments.

Through the high degree of connectivity of Europe, including the Eastern European states, and the local stabilities this implied, the 'European System' was too highly connected to produce non-systemic wars; these conditions of the deterministic domain enabled peaceful integration in the contingent domain. However, as current dynamics and developments in Europe (also) show, SIE – and a certain state of integration – cannot be taken for granted: Further developing and maintaining a certain level of integration – structural stability in a non-equilibrium system – require a constant input of energy to achieve this. If the fabric of such a system does or cannot accomplish this, or cannot efficiently transform the input of energy in supportive structures, fragmentation becomes unavoidable: the second law of thermodynamics will see to that.

2 ***Level 2 change: A change in the order of the System, without changing its basic (anarchistic/non-anarchistic) nature***

Level 2 change is less fundamental and preceded level 1 change. During the life span of the singularity dynamic (1495-1945), the System experienced level 2 change three times through three systemic wars (1618-1648, 1792-1815, and 1914-1918). New upgraded orders were periodically implemented without changing the anarchistic nature of the System. Through these upgraded orders the System lowered its energy state and ensure compliance with the requirements of the second law of thermodynamics.

Level 2 change was sufficient, as long as the upgraded orders that were implemented could deal with the increasing amounts of free energy (tensions) that were produced as a consequence of the intrinsic incompatibility between connectivity and security in the anarchistic System. In 1939, when the System reached the critical connectivity threshold and the degree of incompatibility in the anarchistic System reached infinity, level 1 change, a phase transition towards non-anarchistic structures to contain the production of free energy, became unavoidable.

3 ***Level 3 change: Change in the nature of non-systemic war dynamics***

Level 3 change does not imply a change in the structure of the System, but in the nature of its non-systemic war dynamics. A decrease in the number of degrees of freedom of the System, accomplished through the degree of rivalry between states in the System, from $n > 2$ to $n = 2$ caused the System to bifurcate from chaotic to periodic war dynamics (in 1657), and vice versa (1763). An (almost) similar change can be observed in 1953 and 1989 (defining the second exceptional period).

Level 3 change (as it manifested itself during the first exceptional period, 1657-1763) also implies a change in the predictability of non-systemic wars, from intrinsically unpredictable (chaotic) to more regular (periodic), and a change in the severities of non-systemic wars, from constrained (chaotic) to extreme all-or-nothing (periodic).

4 ***Level 4 change: A change in the relationship of the System with its environment***

Expansion of the System from its European core to the non-core of the System (1495-1945) was a gradual process. In this process I distinguish five phases, based on the 'nature' of the war dynamics (expansion wars) of the System. The expansion started with the awareness that a non-core existed (discoveries of other territories) that could be used or exploited to contribute to the fulfillment of basic requirements of states constituting the core. This led to a process of expansion in which European states acquired political control outside the core that led to interdependencies between the core and non-core. Eventually the non-core developed its own dynamics, including the 'autonomous' production of tensions and wars (not directly related to the dynamics of the core). The second law of thermodynamics of course also applied to the dynamics outside the core of the System. It was just a matter of time, before the second law of thermodynamics would demand 'order' at a global level (including the non-core) to allow for a lower energy state at a global scale of the (now) global System.

The fourth systemic war (the Second World War, 1939-1945) for that reason not only constituted a phase transition in the European core, but also marked the globalization of the System by implementing the first global international order, a development that also qualifies as a phase transition. Both developments, including both phase transitions, constitute coevolving dynamics; both phase transitions are necessarily linked.

13 The finite-time singularity depicted as a distinct phase in a long-term process of social integration and integration (SIE)

13.1 The System depicted as a step in a long-term SIE process

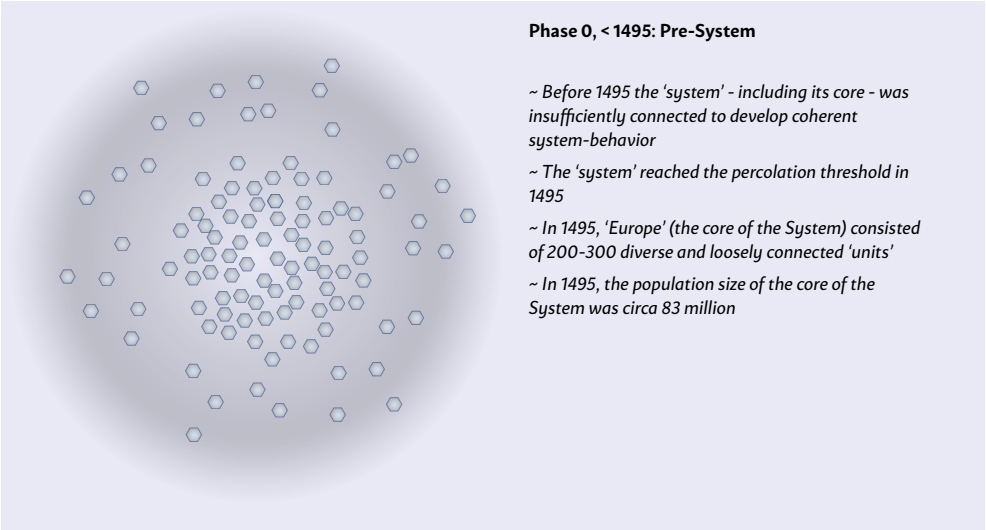

Figure 64 *Phase 'o' SIE.*

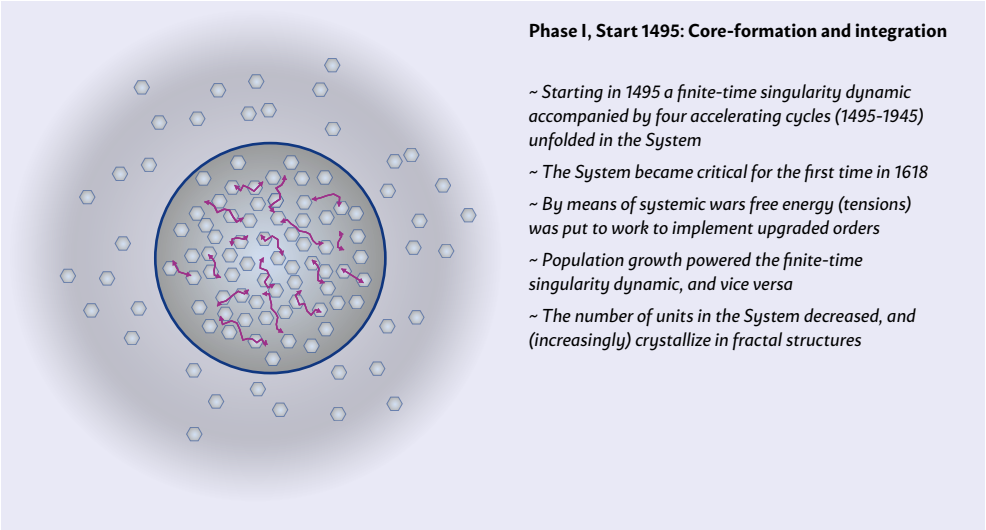

Figure 65 *Phase I SIE.*

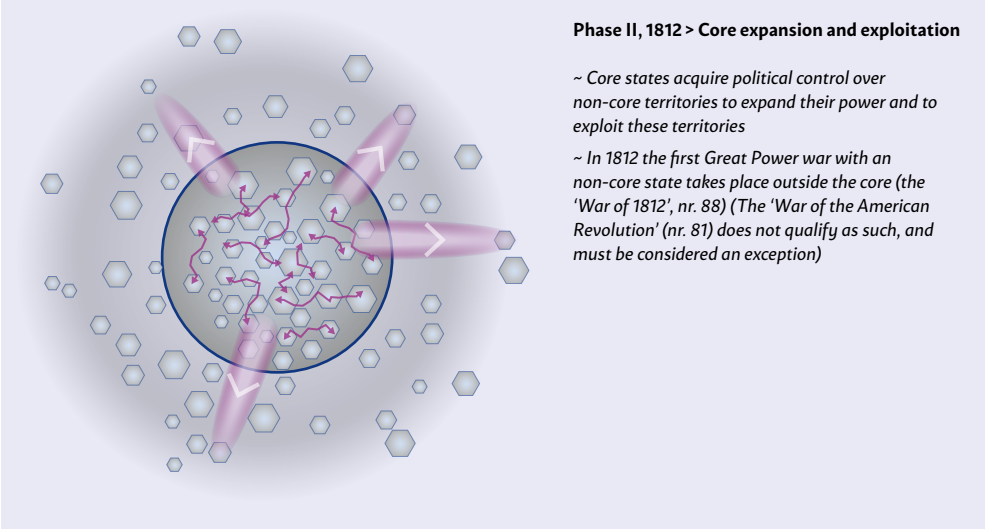

Figure 66 *Phase II SIE.*

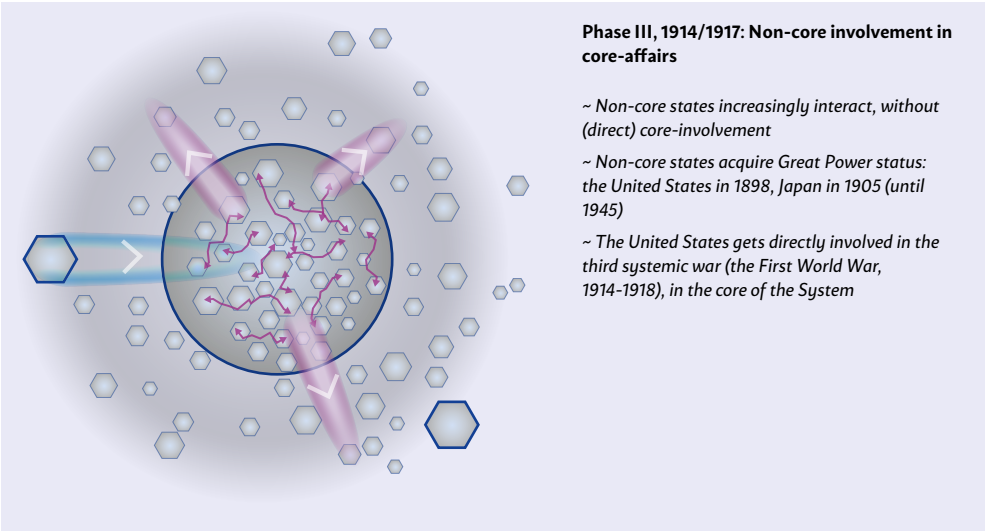

Figure 67 *Phase III SIE.*

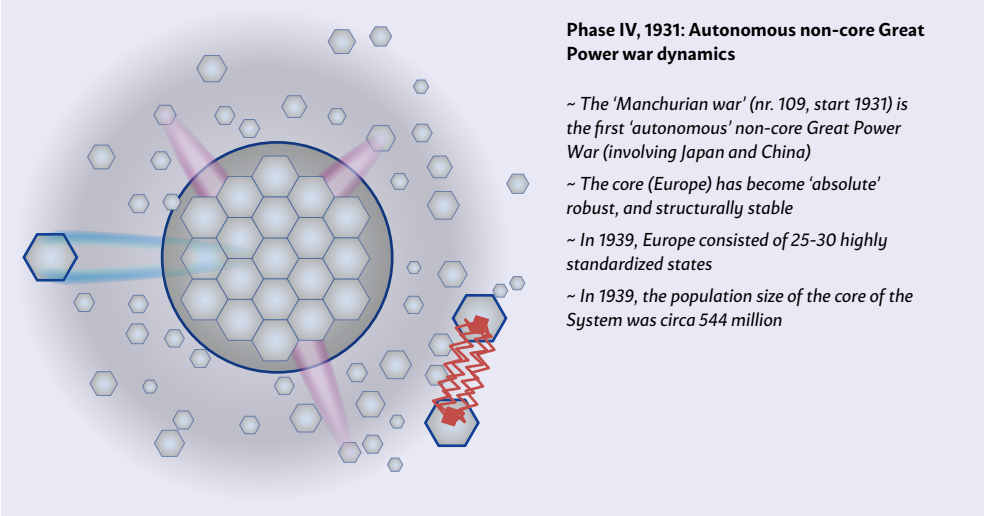

Figure 68 *Phase IV SIE.*

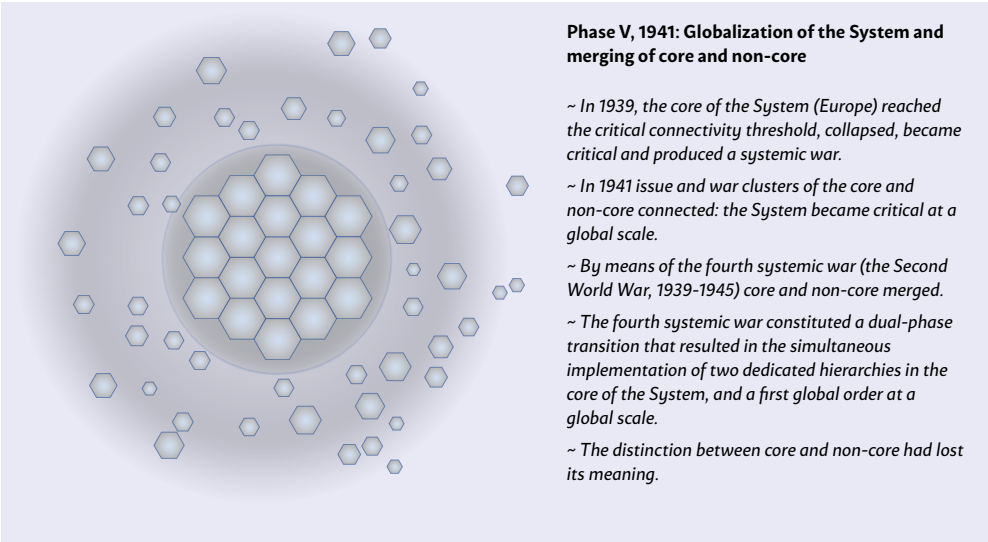

Figure 69 *Phase V SIE.*

13.2 Explanation of the SIE model

The SIE model is closely related to the energy transfer model that describes the same process from a somewhat different perspective. The SIE process can be depicted as a crystallization process. It started millennia ago when families and tribes started cooperating to ensure the fulfillment of their basic requirements. Cooperation allowed for the development and exploitation

economies of scope and scale. This process is still ongoing; the finite-time singularity dynamic the System developed during the 1495-1945 period, causing the integration of Europe and the expansion of the System to a global scale, is just a phase in the long-term SIE process.

In this particular period of SIE (1495-1945), I distinguish five phases:

1 ***Phase I: Core formation and integration***

During the formation and consolidation of the core in Europe, humans and social systems clustered into units and states. These clusters had to become stable to avoid collapse. Depending on various conditions, states have a minimum critical size. The development of the sizes of states in the System shows that the minimal critical size of units (states) increased over time. Size and survival (avoiding internal collapse and external take-over) are related properties. The development of the core of the System during the 1495-1945 period, from a large number of loosely connected and highly divers units, to a highly integrated system of highly standardized states, also shows that the size distribution of states could eventually (shortly before the anarchistic System's collapse in 1939) be best described with a power law. The fractal structure of the System is highly optimized, and ensures that the (unavoidable) production of tensions (free energy) in the anarchistic System was minimized, while at the same time enabling the optimal distribution of destructive energy during systemic wars to upgrade orders of anarchistic System to a next level, consistent with the demands of the second law of thermodynamics.

Through a combination of conditions in the core of the anarchistic System, including: the production of free energy, the intensities of interactions between units (states) in the System, the structure of networks they formed, and physical laws (such as the second law of thermodynamics) that apply to these dynamics - the System produced a highly regular self-organized finite-time singularity dynamic accompanied by four accelerating cycles; Consistent with the demands of the second law of thermodynamics, the accelerating cycles produced increasing levels of internal order.

In fact, the singularity dynamic 'fed on itself', and 'harbored' a self-reinforcing mechanism: the singularity dynamic – powered by free energy produced by the increasing connectivity of the System – enabled again-and-again (four times), further connectivity growth during relatively stable periods; the increasing amounts of free energy that was produced during these successive relatively stable periods were then put to work at an accelerating rate, to ensure compliance with the demands of the second law of thermodynamics. This process could continue at an accelerated rate until the anarchistic System reached the critical connectivity threshold (the singularity in finite time), then as a consequence produced infinite amounts of free energy (tensions), and collapsed as a consequence. A dual-phase transition was the ultimate outcome of this particular phase of SIE in the System.

Through the singularity dynamic and the interactions between states

that underlay it, uneven states (states with different interests and power) could fulfill their basic requirements in an anarchistic System, ensuring their (collective) survival.

The singularity dynamic also ensured the evolvability of the System: its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars, to ensure 'sufficient' performance of the System (during relatively stable periods).

2 ***Phase II: Core expansion and exploitation***

States have to fulfill basic requirements to ensure their survival. In their quest for resources, states also expanded outside the core (Europe) and established political control in territories in the non-core. The expansion of the core to the non-core can be considered an extension of European dynamics. Both control, and the dynamics and tensions between states in the core of the System, were extended or exported. It was a matter of time before states of the core (Europe) established similar state-like structures outside the core, to effectuate their control and ensure maximal exploitation.

Because of the overflow of tensions from the core to the non-core and the contribution of non-core exploitation to power positions and influence of states in the core, the non-core increasingly became connected to the core. Starting in 1812 (with the 'War of 1812'), states deployed destructive energy in response to local tensions outside the core.

3 ***Phase III: Non-core involvement in core-affairs***

It was also a matter of time before state-like structures outside the core started to develop their own autonomous (intra non-core) dynamics and interests. This could cause tensions with the core-state that controlled them (in some cases leading to independence as for the United States in 1776), but also caused tensions between units clusters in the non-core. From a crystallization perspective, during phase III the non-core developed increasingly autonomous nucleation and cluster growth.

It was just a matter of time before states in the non-core of the System achieved Great Power status (the United States in 1898, Japan in 1905 and China in 1949, (38). Because of their increasing interdependence with core states, these Great Powers became involved in what used to be internal core dynamics, and had an increasing interest in the upgraded orders that systemic wars – the singularity dynamic – in the core could produce. These dynamics and developments caused the United States, a non-core Great Power, to get involved in the third systemic war (The First World War, 1914-1918) in the core of the System, to ensure the implementation of a favorable upgraded international order, that would also serve the interests of the United States.

From this perspective the First World War (the third systemic war, 1914-1918) was – contrary to the Second World War (the fourth systemic war,

1939-1945) – not a 'world war', but still an European war; the System was not yet globalized at that stage. The First World War constituted an intermediate war, and was a manifestation of the intermediate stage of development of the System at that stage; from a European to a global System.

4 ***Phase IV: Autonomous non-core Great Power war dynamics***
The Manchurian War (war nr. 109, involving Japan and China) marks the beginning of this phase. The Manchurian War is indicative for the autonomous dynamics in the non-core.

However, despite the development of autonomous intra non-core dynamics, the core and the non-core were intimately connected. European states controlled increasingly large amounts of non-core territory, leading to the implementation of an increasing number of state-like structures. "European states held political control over about 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914" (70) From network and energy-transfer perspectives, this implies increasing connectivity in number and intensity of core and non-core connections, and increasing energy transfers between core and non-core.

5 ***Phase V: Globalization of the System and merging of core and non-core***
The order that was implemented by means of the third systemic war (the First World War, 1914-1918) addressed, or tried to address, free energy and tensions in the core and non-core of the (already) extended System. However, the League of Nations, the order that was implemented to ensure a lower energy state in the extended System, was not effective in restraining tensions. The third order did not solve the incompatibility between increasing connectivity and anarchy, and increasing connectivity still produced free energy and tensions at an accelerating rate: No order in the (by then highly connected) anarchistic System, would have been able to prevent the production of ultimately infinite tensions and its eventual collapse in 1939.

It seems that this particular order – the League of Nations – in the contingent domain of the System, provided (so to say) insufficient order in the core of the System, and too much order (at that stage) outside of the core (Europe); both shortcomings contributed to its (already) limited legitimacy.

However, whatever the shortcomings of the League of Nations were, any order that would (or could) have been implemented following the third systemic war (the First World war, 1914-1918), would not have been able to deal with infinite tensions that would be produced by the anarchistic System: any order was doomed to fail. Collapse was unavoidable for whatever order, when the anarchistic System in 1939 reached the critical connectivity threshold, and as a consequence produced infinite amounts of tensions (free energy).

The core of the System became critical in 1939, and the System produced a systemic war in Europe to re-establish order (to meet the demands of the second law of thermodynamics). In 1941, the vulnerable issues- and war clusters that had formed in the core, and issues and wars that that were

produced autonomously in the none-core (in Asia), connected, and the System now became critical at a global scale, producing the first systemic war with a global reach. Because the System became critical at a global scale and involved all Great Powers, a global international order was designed and implemented that contained a specific solution (necessary to meet the demands of the second law of thermodynamics) for the non-core: the implementation of dedicated hierarchies in Europe.

Through the fourth systemic war (The Second World War, 1939-1945), the dysfunctional third order was destroyed, and a global order was designed and implemented. The second law of thermodynamics ensured that both interdependent orders, the first global order and the upgraded European order, were consistent and 'merged'. Through these developments – the process of merging – the distinction between core and non-core lost its original meaning.

The SIE process, powered by population growth and the rivalry between states (and other clusters that populations form), did not stop here. In the current (now global) System, that is anarchistic at a global scale, connectivity (interdependence) and security still are intrinsically incompatible. Increasing connectivity of the (now) global anarchistic System – of which population growth is the main driver – still results in the production of increasing amounts of free energy (tensions); it is just a matter of time, before the second law of thermodynamics will put the free energy to work – through a systemic war – to establish an upgraded order that (again) enables a lower energy state in the System.

Accelerating expansion of the System (1495-1941)		
Phase	Start date	Time to globalization (1941 - start date)
(I) Core formation and integration	1495	446
(II) Core expansion	1812	129
(III) Autonomous non-core formation and involvement in European affairs	1914	27
(IV) Non-European powers autonomously produce their own war dynamics	1931	10
(V) Globalization of the System and merging of core and non-core	1941	0

Table 53 *This table shows the accelerating expansion of the System (1495-1941).*

13.3 Synchronization and interaction

During the 1495-1945 period, the SIE process, developed very regularly:

1 ***Synchronization and mutual reinforcement of the integration and expansion of the System (1495-1945)***

The process of integration of the core (Europe), through successive upgrades of its order, and the expansion of the core to the non-core, and the development of autonomous non-core dynamics, accelerated with the same rate. I assume that the processes of integration and expansion reinforced each other.

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)

		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1812	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 54 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

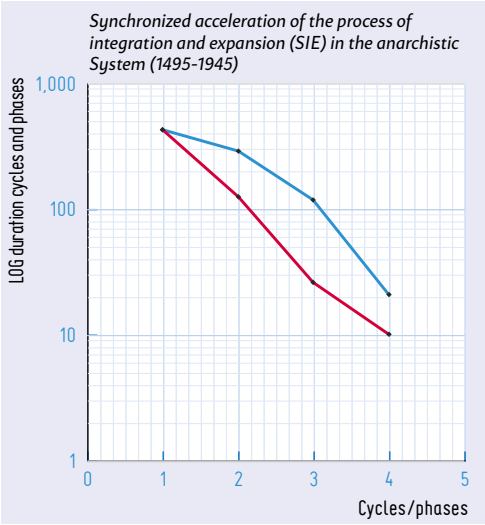

Figure 70

This figure shows the acceleration of the processes of integration (blue) and expansion (red) in the anarchistic System. The data points concerning the process of integration (blue) concern the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points concerning the process of expansion (orange) represent the duration of the four phases that can be distinguished in the process of expansion of the core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, but was also to be expected, given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the time series is 0,92.

2 ***Acceleration of the fraction of expansion wars during successive cycles of the first finite-time singularity dynamic***

During successive cycles of the first finite-time singularity dynamic (1495-1945) the System produced respectively 45 - 34 - 21 - 6 non-systemic wars (total 106). Respectively 0 - 1 - 4 - 4 of these wars qualify as expansion wars.

During successive cycles of the first finite-time singularity dynamic, the fraction of expansion wars increased exponentially.

The correlation coefficient of the number of wars during successive cycles, and the fraction of expansion wars is - 0,93.

Expansion wars: Fraction of non-systemic wars (1495-1945)			
Cycle	Non-systemic wars (total)	Expansion wars	Fraction (Expansion wars)
1	45	0	0
2	34	1	0.029
3	21	4	0.190
4	6	4	0.667

Table 55 *This table shows the fraction of expansions wars during successive cycles of the first singularity dynamic (1495-1945).*

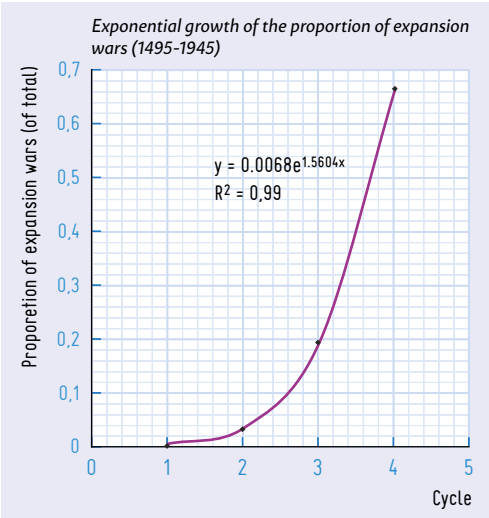

Figure 71
This figure shows the exponential growth of the proportion of expansion wars during successive cycles of the first finite-time singularity dynamic (1495-1945).

I argue that the growth rate of the fraction of expansion wars is related to the increasing robustness of successive cycles of the first finite-time singularity dynamic, and the accelerating expansion of the System. I assume that the increasing connectivity (population growth) of the System is the 'driver' of these dynamics.

13.4 Lynchpins

So-called 'lynchpins' were instrumental in the synchronization of the process of integration and expansion in the System, during the 1495-1945 period.

During the process of integration, political control of core states (European states) over non-core territories (I refer to their colonies, and related

interests), ensured synchronization and interaction; during the process of integration, core-states acted as lynchpins.

As a consequence of the re-alignment of the System through the fourth systemic war (the Second World War, 1939-1945), that constituted a dual-phase transition, the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System. Both orders were complementary, and the two dedicated non-anarchistic hierarchies became integral components of the global order. The integration of the 'European order' in the global order, was accomplished through the United States and the Soviet Union, which respectively controlled the Western and Eastern hierarchy, and also had established themselves as 'Superpowers' with a global reach: The United States and the Soviet Union now acted as the lynchpins of the System, ensuring 'synchronization' of both orders. See figures: 24, 25 and 26.

14 The first international order of the System depicted as a damped oscillator

14.1 The first international order of the System depicted as a damped oscillator

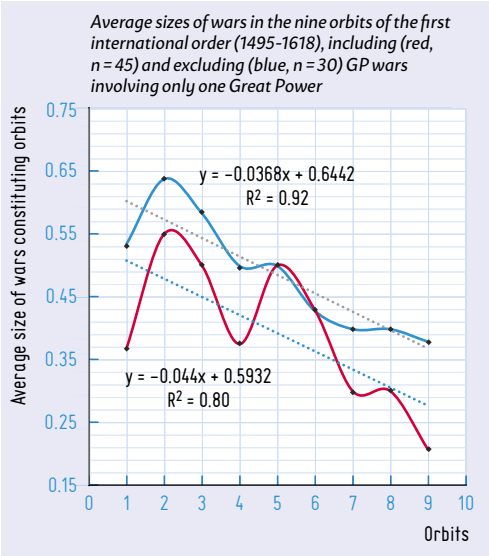

Figure 72
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).

14.2 Explanation of the workings of the damped oscillator

Non-systemic wars during international orders (during relatively stable periods of cycles, that precede systemic wars) are instrumental in maintaining a certain functional balance.

During the first international order (1495-1618) the anarchistic System produced 45 non-systemic wars. Analysis of these non-systemic wars shows that these 45 non-systemic wars made up nine circular trajectories – orbits – in phase state (defined by size and intensity). The average size of wars constituting respective orbits developed very regularly, and in fact made up a damped oscillator.

As Sterman explains: "In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots, and so on. The overshooting arises from the presence of time delays in the negative loop. The time delays cause corrective actions to continue even after the state of the system reaches its goal, forcing the system to adjust too much, and triggering a new correction in the opposite direction" (69). Different types of oscillations can be distinguished, including 'damped' oscillations. The equilibrium of a damped oscillator is said to be locally stable. "Perturbations will cause the system to oscillate, but it will eventually return to the same equilibrium... While many oscillatory systems are damped, the equilibriums

of other systems are locally unstable, meaning that small disturbances tend to move the system farther away from the equilibrium point" (69).

The amplitude of successive oscillations (orbits) - corrections by the System – decreased regularly: Shortly before the 'collapse' of the international order – shortly before the System became critical in 1618 and produced a systemic war (the first systemic war, the Thirty Years' War, 1618-1648) - the first international order reached its equilibrium state.

The dampening effect is however misleading: although the international order eventually reached the equilibrium state, the tensions (free energy) the System produced, increased at the same time. I attribute the 'dampening' of oscillations to the connectivity/local stability effect.

15 The System depicted as a set of early warning signals

15.1 The System depicted as a coherent set of early warning signals

With the help of regularities in the dynamics and development of the anarchistic System during the 1495-1945 period – the period when the first finite-time singularity dynamic accompanied by four accelerating cycles unfolded – a number of deterministic and contingent indicators can be identified that could provide clues for the assessment and prediction of the dynamics and developments of the current order.

1 *Deterministic indicators*

The following deterministic indicators can be identified:

Deterministic indicators for assessment and prediction

	Indicator	Clarification
1	Rate of population growth.	Determines the free energy that will be produced in the System and its connectivity.
2	The number of degrees of freedom of the System.	Determines whether non-systemic war dynamics are chaotic or non-chaotic. Chaos is a precondition for the System to form underlying vulnerable issue clusters and to become critical.
3	Average size of non-systemic energy-releasing wars.	Determines if the System is in a low- or high-connectivity regime.
4	Development of the frequency of non-systemic energy releases.	Determines if the System is in a low- or high-connectivity regime.
5	Changes in centrality of nodes (development of Great Power status dynamics).	Indicator for the structural stability – organizational permanence – of the System.
6	Changes in the size and form of nodes (states).	Indicator for the structural stability – permanence of political control – in the System.
7	The nature of the size distribution of states in the System; the level of fractality of the System.	Indicator for the performance of the System, and the efficiency of free energy production and (re-)distribution in the System.
8	Robustness of the System.	Determines the System's sensitivity to perturbations and its ability to release free energy through non-systemic release events. This property is closely related to the System's fragility.
9	Fragility of the System.	Determines the life span of relatively stable periods. This property is closely related to the System's robustness.
10	The durations of relatively stable periods and of critical periods (respectively the life span of international orders and systemic wars).	Indicator for the connectivity and pace of life of the System. Decreasing durations mean the System is approaching the critical connectivity threshold.

Deterministic indicators for assessment and prediction		
11	Amount of destructive energy that is deployed during critical periods, for which severities of systemic wars is an indicator.	Indicator for the connectivity and pace of life of the System. Increasingly higher – and ultimately infinite – amounts of destructive energy means the System is approaching the critical connectivity threshold.
12	The rate of acceleration of the System.	Indicator for the connectivity and pace of life of the System. Increasing and ultimately infinite acceleration means the System is approaching the critical connectivity threshold.

Table 56 *This table shows deterministic indicators.*

2 *Contingent indicators*

The following contingent indicators can be identified:

Contingent indicators for assessment and prediction		
	Indicator	Clarification
1	Development of the power flux (CINC-index).	The development of the CINC-indices indicates whether states produce destructive energy.
2	Development of alliance dynamics.	The development of alliance dynamics indicates whether states are concerned with their security and try to hedge risks.
3	Development of tensions in the System.	Tensions are manifestations of free energy, and are transformed into destructive energy.
4	The number of issues in the System and their interconnectedness.	The number of issues is indicative of the war potential of the System.
5	The number and nature of unresolved issues and their interconnectedness.	The number and nature of unresolved issues are indicative of the buildup of underlying vulnerable issue clusters.
6	Ideological reach, outspokenness, and radicalization.	Ideological developments are indicative of the mobilization potential and ultimately war preparedness of states.
7	Perceived unpredictability of wars and their properties.	The perceived unpredictability of wars, including unexpected escalation and unexpected de-escalation and containment, are indicative of the chaotic nature of these dynamics.
8	The willingness of states to get involved in non-systemic wars.	The willingness of states to engage in wars is indicative whether the System is in a low- or high-connectivity regime, and of the chaotic or non-chaotic nature of war dynamics. Chaotic war dynamics cause restraint because of the intrinsic unpredictability of these types of wars.
9	The level of representativeness of the current order.	To what degree the actual centrality of states is reflected in its order determines the level of functionality and legitimacy of the global order. The degree to which the order's rules and institutions are undermined by states with special privileges is indicative of its ability to maintain the status quo.

Table 57 *This table shows contingent indicators.*

15.2 Explanation of the EWS-model

With the help of both sets of indicators the condition of the System can be assessed, and its behavior be predicted.

This study shows that the power flux and alliance dynamics of the System are not useful indicators: both are contingent indicators and have short lead-times.

The structural stability of the System (Great Power status dynamics, and changes in physical structures of states in the anarchistic System), the System's robustness and fragility on the other hand, are very useful indicators, that (at an early stage) provide valuable information about the condition of the System, and its future behavior.

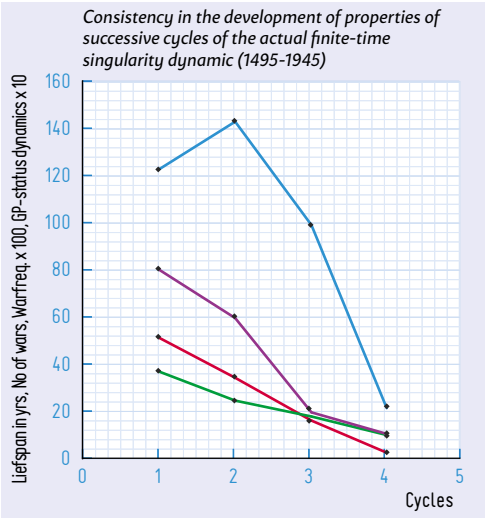

Figure 73
This figure shows (1) the development of the life spans of successive cycles (in blue) of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), indicative for the System's increasing fragility, (2) the development of the structural stability (the number of Great Power status dynamics, in purple) of the System, (3) the development of the absolute number of non-systemic wars the System produced during successive cycles (in red) and (4) of the war frequency (in green) of successive relatively stable periods. During the fourth cycle, shortly before the anarchistic System's collapse in 1939, the fragility, structural stability and robustness of the anarchistic System reached 'absolute' levels. These indicators concern the core of the System (Europe); expansion wars are excluded. Calculations based on data from Levy (38).

This study also shows, that the size development of non-systemic wars during cycles provides accurate information about the proximity of the System to a critical point: Typically – as a consequence of the connectivity/local stability effect during high-connectivity regimes of relatively stable periods – shortly before the System becomes critical and produces a systemic war, the sizes of non-systemic wars decrease to a 'critical fraction'. This study suggests that the critical fraction is in the range of 0.17 - 0.30.

Assuming the war database is correct, the first cycle (1945-...) of the second finite-time singularity dynamic now is in its high-connectivity regime, and will become critical around 2020 when it reaches the critical fraction.

'Critical fractions' of moving averages		
International order		Critical fractions of moving averages of five successive non-systemic wars
1	1495-1618	0.18
2	1648-1792	0.30
3	1815-1914	0.19
4	1918-1939	0.17

Table 58 *This table shows the (critical) values of the moving averages of sizes of five successive non-systemic wars immediately before the System became critical during the first finite-time singularity dynamic.*

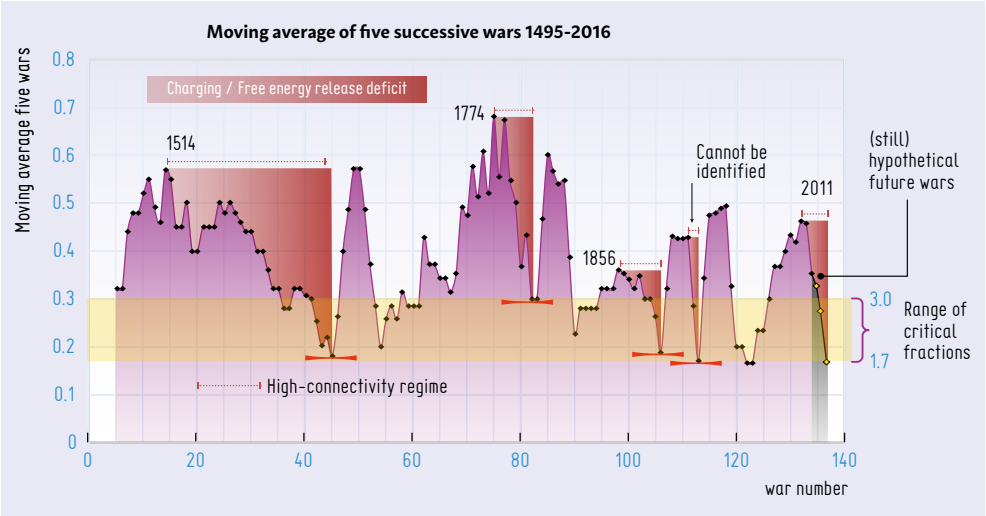

Figure 74 *This figure is an extension of figure 31: Three still hypothetical future wars with a size of one Great Power participating, are now added. This study suggests that the present order (1945-...) reached its tipping point in 2011, and is now in its high-connectivity regime and 'charging' for a next systemic war. It takes about 2-3 non-systemic wars (baseline 2014) for the current order to reach the 'critical fraction-range'. This study suggests that the System will become critical around 2020 and produce a systemic war to implement an upgraded order that allows for a lower energy state (a new relatively stable period) of the System.*