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Framing the MH17 disaster – more heat than light?

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In recent years the systems-thinking approach to safety management and accident investigation has gained traction with risk managers and those international bodies responsible for aviation safety (International Civil Aviation Organisation, 1995, 2013; Reason, 1990, 2008, 2013; Tochen & Tobin, 2013; Shorrock, Leonhardt, Licu & Peters, 2014). Watershed moments included:

The 1992 publication of The Honourable Mr Justice Virgil P. Moshansky's systems-thinking-informed analysis of the 1989 Dryden accident, in which wing ice brought down a Fokker F-28 passenger aircraft

The 2009 publication of Mr Charles Haddon-Cave QC's holistic analysis of the loss over Afghanistan of RAF Nimrod MR2 XV230 (Haddon-Cave, 2009), where a venerable airframe compromised by reactive patching (see Weir (1996) for a definition), and safety migration (see Rasmussen (1997) and Reason (1997) for definitions), was lost to an in-flight fire.

This paper has two objectives. First, to present a systems-thinking-informed analysis of the loss on 17 July, 2014, of a Malaysia Airlines Boeing 777-200 (Flight MH17) over Hrabove, Ukraine (Dutch Safety Board, 2014, 2015a, 2015b). Secondly, to investigate the degree to which subsequent political and press reaction drew on the systems-thinking-informed approach to accident investigation.

Theoretical basis

Systems-thinking takes in the interactive complexity, non-linear interactions and emergent behaviours of socio-technical systems (Dorner, 1996; Maurino, Reason, Johnston & Lee, 1998; Hollnagel, 2004; Johnson, 2005; Dekker, 2006; Black & Koopman, 2009; Miller, 2009; Shorrock, Leonhardt, Licu & Peters, 2014; Griffin, Young & Stanton, 2015). It focuses on the system-as-found and describes the 'lived reality' of the system in question. Systems do not always behave as expected. Non-linear interactions, where small inputs generate unexpectedly large outputs, or where large inputs generate unexpectedly small outputs, or where, through time, identical inputs generate qualitatively different outputs, render system behaviour unpredictable: "In complex systems, outcomes are often emergent, and not simply a result of the performance of individual system components. Hence system behaviour is hard to understand and often not as expected" (Shorrock, Leonhardt, Licu & Peters, 2014, p. 3).

According to Miller (2009), risk is a product of interactions at the systemic level. Hollnagel's (2004, p. xv) systems work leads him to conclude that "... accidents [should be] seen as emerging phenomena in complex systems

... the result of an aggregation of conditions ... ". Dekker (2006, p. 78) observes: "[I]t is critical to capture the relational dynamics and longer-term socio-organisational trends behind system failure". Turner (1978; 1994) argues that disasters incubate over time. "[A] multiplicity of minor causes, misperceptions, misunderstandings and miscommunications accumulate unnoticed during [the] incubation period....ready to contribute to a major failure" says Turner (1994, p. 216).

Actor-network theory's (ANT's) 'principle of generalised symmetry' transforms our understanding of the 'social'. It posits that all system components (animate or inanimate, tangible or intangible) have agency and *act*. In ANT's conception, the social is 'materially heterogeneous'. Socio-technical systems are purposeful, bounded assemblies of mutually-affecting animate and inanimate actants (philosophies, policies, laws, rules, computer software, blueprints, components, devices, machines, engineering tolerances, corporate financing arrangements, plant operators, shop stewards, managers, training plans, beliefs, practices, cultures, aspirations, prejudices, etc.) (Callon & Latour, 1981; Callon, 1991; Callon & Law, 1997; Risan, 1997). Actor-network theory reveals "how things are 'stitched together' across divisions and distinctions" (Murdoch, 1997, p. 321) to create goal-oriented systems ('hybrid-collectifs'). Purposeful systems (like that designed to deliver air service across international boundaries) emerge from a process of 'heterogeneous engineering', whereby human and non-human elements ('actants') are enrolled/co-opted ('translated').

Like all analytical devices, actor-network theory is not without its problems. There are arguments over ANT's treatment of social phenomena like power, gender, race and intentionality. Factors like these are either 'flattened' or backgrounded by the methodology. In the context of the analysis presented here, the most obvious difficulty is deciding the size and geometry (topography) of the aviation system network space - that purposeful assemblage of actants that delivers air service. Where does one draw one's analytical horizon? Where is the system boundary? The more restrictive one's survey, the greater the risk that key actants may be overlooked. The more generous, the greater the risk that the resulting picture fails to add anything of significance to one's understanding. The author reflexively acknowledges that his conceptualisation of the aviation system network space (and the resulting systems-thinking-informed analysis) may be considered too broad by some, and too narrow by others. Regardless of this problem, the author contends that actor-network theory makes an important contribution to our understanding of the origins of the MH17 shoot-down by suggesting that the disaster, rather than being a 'bolt from the blue', was in some degree *socially produced*. Acknowledging the systemic origins of disaster helps us develop effective responses (like institutional reforms or rule changes). Interventions that modify precepts and cultures may prove especially effective at preventing repeats.

This analysis assumes the ‘aviation system’ – a goal-oriented network of mutually affecting actants – to contain the following elements:

Table 1.

The aviation system network-space – an actor-network theory-informed (ANT-informed) conceptualisation.

The aviation system network-space
National governments
National regulatory authorities (e.g. Federal Aviation Administration)
Supra-national regulatory authorities (e.g. International Civil Aviation Organisation, European Aviation Safety Agency, Eurocontrol)
Representative bodies (e.g. The International Airline Passengers Association, European Cockpit Association, International Air Transport Association, The European Low Fares Airline Association)
Aircraft manufacturers
Airport authorities
Products (e.g. aircraft, flight service, loyalty schemes)
Passenger agendas and expectations
Investor and shareholder agendas and expectations
Airline employee behaviour (e.g. adaptability, flexibility, loyalty, commitment, integrity)
Airline and aviation infrastructure financing terms-and-conditions
Regulatory authorities’ risk perceptions
Airlines’ risk perceptions
Passengers’ risk perceptions
The airline cost base (e.g. the price of fuel, landing charges, salary costs, maintenance costs, in-flight catering costs, advertising costs, interest rates, etc.)
Inter-airline competition
Near-misses, incidents and accidents (like the De Havilland Comet disasters of the 1950s)
Media representations of the industry (e.g. safety, value for money, attractiveness when compared to other modes of transport like high-speed rail)

Reductionism is the antithesis of systems-thinking. Unlike systems-thinking, reductionism settles for simplistic explanations. Failure is linked to discrete actions (like a flight crew’s decision not to de-ice). The desire or, according to Horlick-Jones (1996, p. 66), “need” to blame, encourages reductionist analyses. Post-disaster reductionist analyses support blamism. In the aftermath of disaster, blamism and reductionism often become locked in a non-virtuous, unedifying dance. By individuating responsibility for failure,

blamism denies the contribution of wider societal and organisational factors like political self-interest, bureaucratic incompetence, under-funding, indoctrination, poor training and unrealistic deadlines. Blaming produces a 'fundamental attribution error' (Fiske & Taylor, 1984).

Analyses that settle for simple, reductionist answers to complex questions both represent and create latent errors:

Example 1: The reductionist tendency to blame the 2014 ebola outbreak on Africa's 'backwardness' meant that other factors, like the impoverishment of that continent by Britain, France, Belgium, Germany, China and other powerful, self-interested nations went undiscussed. In the case of the ebola outbreak, reductionism led to victim-blaming. Bennett (2014b) observed: "Seen in the context of global power-plays between countries like Britain, China, Russia and the United States, the ebola crisis is less a product of Sierra Leone, Liberia and Guinea's under-development and associated social, economic and political problems than of developed countries' greed and ambition. Seen through a systems-thinking lens, ebola is fundamentally a crisis of developed nations' exploitative behaviour. Ebola is a crisis of ideology".

Example 2: The reductionist tendency to blame US shootings on the perpetrators alone means that other salient factors, like the ease with which weapons can be purchased or the possible impact on behaviour of violent gameplay, go unchallenged. Analysing the case of Veronica Rutledge, the Walmart shopper slain by her infant son, Bennett (2015a) observed: "Viewed through a systems-thinking lens, US gun violence is primarily a social problem rooted in the belief that every citizen 'has the right to keep and bear arms'. Veronica Rutledge wasn't killed by her son. She was killed by the Second Amendment to the United States Constitution".

To summarise, systems-thinking, expressed in theories like ANT, is counter-reductionist. It examines the impact of contextual factors on decision-making and behaviour. It reveals the often complex and messy origins of failure. In so doing it rejects blamism – a morally dubious and unedifying indulgence (Browning & Shetler, 1992; Reason & Hobbs, 2003; Jeffcott, Pidgeon, Weyman & Walls, 2006; Woods, Dekker, Cook, Johannesen & Sarter, 2010). Reason and Hobbs (2003, p. 97) comment: "Blaming people for their errors is emotionally satisfying but remedially useless. Moral judgments are only appropriate when the actions go as intended and the intention is reprehensible. Blame and punishment make no sense at all when the intention is a good one, but the actions do not go as planned".

This paper presents a systems-thinking-informed analysis of the loss on 17 July, 2014, of a Malaysia Airlines Boeing 777-200 (Flight MH17) during a regional conflict that saw western-backed Ukrainian forces fighting Russian-backed Ukrainian separatists. Malaysia's 777 was probably destroyed by a surface-to-air missile (SAM). The conflict in eastern Ukraine, which intensified following Russia's annexation of the Crimea, was in some respects a proxy-war (see Ambrose (1985) for a definition of 'proxy-war') between Europe and Russia. The analysis presented here is deductive and inductive:

It uses systems theory (specifically the ANT iteration) to demonstrate that MH17's destruction originated in a range of socio-political and organisational factors

It treats the loss as a learning opportunity. For example, lessons are drawn from the political and journalistic reaction to MH17's shoot-down (an unedifying *mélange* of unsupported claim and counter-claim).

The MH17 disaster

Introduction

According to the Dutch Safety Board (2015a, p. 9): “The in-flight disintegration of the aeroplane ... was the result of the detonation of a warhead. The detonation occurred above the left-hand side of the cockpit. The weapon used was a 9N314M-model warhead carried on the 9M38-series [NATO designation SA-11 Gadfly series] of missiles, as installed on the BUK surface-to-air missile system”. Shrapnel ejected by the SA-11 Gadfly killed the flight-crew. The subsequent explosive decompression and disintegration of the 777 killed everyone else on board (Dutch Safety Board, 2015a). Both Ukraine and Russia operated the SA-11 Gadfly surface-to-air (SAM) missile. The SA-11 can carry a 70kg high explosive (HE) fragmentation warhead to 72,000 feet (22,000 metres) (Jane's Publishing, 2011). At the moment of its destruction, the aircraft was flying at 33,000 feet (10,000 metres), 3.6 nautical miles north of airway L980's centreline. A fragmentation warhead ejects shrapnel (metal spheres, cubes or rods). The thin, pressurised skin of an aircraft offers no resistance to shrapnel.

At the time of MH17's destruction, relations between Ukraine (and its European allies) and Russia were at a low ebb (Kuchins, 2015; Greene, 2015; Osborne, 2015). There was fighting on the ground and a war of words in the media. Sanctions, travel bans, import bans, asset freezes and other economic weapons had been deployed. There were fears of a new Cold War (Deutsche Welle, 2014; Levgold, 2014) and of a new Russian tactic – ‘hybrid warfare’ (Blair, 2015). A survey conducted in late 2014 (Levada Centre, 2014) confirmed a sharp difference of opinion between Ukrainian and Russian respondents over

the future of the disputed Donbass region of eastern Ukraine (sometimes referred to by Ukrainian separatists and Russians as Novorossiia). Russian President Vladimir Putin constructed the February, 2014 ousting of President Viktor Yanukovich as a fascist insurrection (thereby invoking the spirit of the USSR's 1941-1945 Great Patriotic War against Nazi Germany) (Blair, 2015). Kiev's pro-Western lobby constructed the ousting of their fourth president as a blow against a self-interested, interfering, backward-looking Russia. Social and political schism and armed conflict (Levada Centre, 2014; Gregory, 2014; Wintour & Doherty, 2014; Blair, 2015; Kuchins, 2015) formed the backcloth to the destruction of Malaysia Airlines Flight MH17. Since MH17's destruction, East-West relations have deteriorated further, with Russia withdrawing from the Conventional Armed Forces in Europe Treaty, the US deploying additional assets to NATO member states (BBC, 2015) and Syrian-based Russian warplanes bombing anti-Assad insurrectionists (some of whom had been armed and trained by the West) (Greene, 2015).

MH17 through a systems-thinking lens

Seen through the actor-network theory (ANT) lens, the MH17 disaster originated in history, politics, ethnic division, a regional war, risk miscalculation, denialism and interactions between the elements that comprise the commercial aviation system. Circumstance, as much as the person who pressed the button that launched the missile(s), destroyed the aircraft. The following actants contributed to the disaster (this is far from an exhaustive list):

- Russian leaders' distrust of the West (forged in the 1941-1945 Great Patriotic War and tempered in the 1947-1991 Cold War, this distrust is deep-rooted). By 2015 relations between Russia and the western powers were problematic (Kuchins, 2015; Greene, 2015; Osborne, 2015)
- The Ukrainian Parliament's (Verkhovna Rada's) 2014 decision to abolish the 2012 law on state language policy. The 2012 law allowed Ukraine's regions to designate languages other than Ukrainian as 'official' if they were spoken by over 10 percent of the local population. Following enactment of the 2012 law, thirteen out of Ukraine's 27 regions (most of them in the east of the country) adopted Russian as a second official language. Verkhovna Rada's 2014 decision drew significant criticism from Western politicians
- Russian President Vladimir Putin's determination to embrace the 25-million-strong Russian diaspora, the 'russki mir' (Garton-Ash, 2014)
- The incommensurate world-views and aspirations of western-facing Ukrainians (who sparked the Euromaidan insurrection of November 2013) and eastern-facing, Russian-speaking rebels
- The Euromaidan perception that Ukraine's Putin-endorsed President Viktor Yanukovich headed a corrupt puppet regime

- The Russian State's perception that Yanukovich had been ousted in a thinly-disguised coup d'état
- A regional war fought on ethnic lines
- The transformation by the United States, European Union and Russia of a regional war into a superpower proxy-war
- The expansionist tendencies of the European Union
- The expansionist tendencies of NATO
- Russia's historic desire to influence, if not control, its 'near abroad'. Imperial ambitions persist on the fractious continent of Europe. East-West buffer states like Ukraine are under the greatest pressure
- The capabilities of the SA-11 SAM system (accuracy, reach, etc.)
- The 'normalisation' of shoot-downs since the *circa* 6 April, 2014 commencement of hostilities in Donbass (see Appendix). Although most of the downed machines were helicopters or ground-attack aircraft, larger machines, like the twin-engined Antonov 30 and four-engined Ilyushin 76 strategic transport, were also destroyed (Dutch Safety Board, 2015a). Whoever fired the missile(s) may have mistaken the Boeing 777 for a military jet transport
- Airway L980. MH17's off-centreline position (the aircraft had drifted 3.6 nautical miles north of airway L980's centreline) (Dutch Safety Board, 2015a) may have looked suspicious to a SAM missile crew (although off-centreline deviations for weather are not uncommon)
- The shrapnel ejected when the SA-11's warhead exploded in proximity to the Boeing 777
- The vulnerability of modern, pressurised aircraft like the Boeing 777 to shrapnel (Dutch Safety Board, 2015a)
- Governments' willingness to permit overflights of contested territory. The Dutch Safety Board (2015b, p. 14) notes: "In diplomatic circles, concerns were expressed about the [2014] armed conflict in the eastern part of Ukraine, and the shooting down of military aircraft However, none of the politicians, officials or services made a connection between the military developments in the region and the possible risks posed to overflying civil aeroplanes". Following the disaster, Malaysia's Transport Minister said: "[S]ince [Airway L980] is an approved route, it is safe" (Lai as cited in Neate & Glenza, 2014). Following the MH17 disaster, airlines may wish to reconsider how they read/interpret an 'official approval'
- Airlines' willingness to overfly contested territory. Rietsema (as cited in Halsey, 2014) claims: "Airliners overfly conflicted areas all the time". According to the Dutch Safety Board (2015b, p. 16), "In March 2014 ... one operator decided not to use the airspace above Ukraine Thereafter, as far as the Dutch Safety Board was able to ascertain, no other operators changed their flight routes ... ". However, according to Neate and Glenza (2014), prior to the Flight MH17 disaster, five airlines

(British Airways, Qantas, Cathay Pacific, Korean Air Lines and China Airlines) stopped transiting eastern Ukraine

- Malaysia Airlines's risk perception and risk calculation in the context of its post-MH370 cost-cutting policy. Malaysia Airlines's "high cost base" saw it "bleeding cash" even before the loss of Flight MH370 (Daga & Ngui, 2014). In the three years before the MH17 disaster, Malaysia had a negative operating cash flow: the carrier was unable to generate sufficient income to cover its day-to-day operating costs (Daga & Ngui, 2014; Hodgson, Al Haddad, Al Zaabi & Abdulrahim, 2015). According to the Dutch Safety Board (2015b, p. 15) "[Malaysia Airlines] did not perform any separate risk assessment for flying over the conflict area in the eastern part of Ukraine"
- Pilots' mores. Although a Captain can refuse to fly a route s/he considers unsafe, pilots' decisions balance several considerations, including the need to maximise operational efficiency. Captains know that diversions increase fuel costs and disrupt tightly-coupled timetables. Waste is anathema to an industry with "very low profit margins" (Quintana as cited in Neate & Glenza, 2014). Cook (2000, p. 2) notes of those who make decisions in complex, risk-laden production systems: "[S]ystem practitioners operate the system in order to produce its desired product and also work to forestall accidents. This dynamic quality of system operation, the balancing of demands for production against the possibility of incipient failure is unavoidable. *Outsiders rarely acknowledge the duality of this role ... [T]he outsider's view misapprehends the operator's constant, simultaneous engagement with both roles [my emphasis]*". Bodies that promote the industry to the public paint a different picture. Following the disaster, the CEO of the International Air Transport Association (IATA) claimed: "No airline will risk the safety of their passengers, crew and aircraft for the sake of fuel savings" (Tyler as cited in Neate & Glenza, 2014)
- The policies of supra-national bodies like the International Civil Aviation Organisation (ICAO), Eurocontrol and the European Civil Aviation Conference (ECAC) that countenance commercial flights over conflict zones. Such bodies rely on sovereign states (like Ukraine) to produce airspace risk-assessments. In its final report the Dutch Safety Board (2015a) urged greater caution in the matter of airspace management in times of crisis
- The risk-assessments of the State Aviation Authority of Ukraine and the Ukrainian State Air Traffic Service Enterprise that deemed it safe for commercial aircraft to transit the Donbass region at altitudes above 32,000 feet (MH17 met its fate at 33,000 feet), despite the fact that "two of [Ukraine's] military aircraft had been shot down at altitudes between 6,200 and 6,500 metres [20,300 – 21,300 ft.] *with powerful weapon systems [my emphasis]*" (Dutch Safety Board, 2015b, p. 15). The Chairman of the United Kingdom Flight Safety Committee (UKFSC)

notes: “MH17 was in airspace approved by ICAO. Its flight plan was approved by the Ukrainian authorities, as well as Eurocontrol” (Brady, 2014)

- The failure of national and supra-national regulatory authorities to learn from past events, like the 1983 destruction by a Soviet Su-15 fighter of Korean Air Lines Flight KAL007, or 1988 destruction by a ship-launched missile of Iran Air Flight IR655. In both cases, commercial airliners were routed near or over known troublespots. Viewed through Toft’s (1992) isomorphic learning prism, the KAL007 and IR655 shoot-downs created a space for active learning
- The Flexible Use of Airspace concept, which holds that “airspace should no longer be designated as military or civil airspace, but should be considered as one continuum” (Eurocontrol, 2014)
- The shareholder agenda (maximise profit and dividend)
- The passenger agenda (generally to pay as little as possible for a ticket)
- The conscious post-1970s engineering of a liberalised and highly competitive global aviation system (Zellner & Rothman, 1992; Crandall, 2008). Robert Crandall, CEO of American Airlines, argued that aviation is “intensely, vigorously, bitterly, savagely competitive” (Crandall as cited in Sherman & Chaganti, 1998, p. 93). He observed: “American’s [American Airlines’s] success depends on moving quickly from one advantage to the next” (Crandall as cited in Sherman & Chaganti, 1998, p. 93)
- The difficulty of consistently making a profit in such a volatile industry. Commercial aviation is plagued by upswing and downswing (Petzinger, 1995)
- The aviation system's cost-reduction culture. Cost reduction is a key objective of most airlines (Lawton, 2002; Massachusetts Institute of Technology, 2011; Franke & John, 2011). Today, even state-subsidised airlines are expected to pare down costs (Kennedy, 2015)

Viewed through a systems-thinking lens, the actions of the SAM missile crew were but one element of a *complex* of failures (like allowing commercial aircraft to overfly war zones where protagonists possess advanced anti-air weaponry). With reference to Turner's (1978) six-stage model of failure we can see that the *incubation period* for the disaster stretched back to (at least) the Great Patriotic War of 1941-1945.

The aviation system actant-component of the MH17 disaster

Systems-thinking argues that the origins of disaster are complex and messy. “[I]t is better to think of a problem of understanding disasters as a 'socio-technical' problem with social organization and technical processes interacting to produce the phenomena to be studied” says Turner (1978, p. 3). Further, in an open system there are *n* routes to disaster: “[S]ystems theory predicts that

any open system ... can arrive at a given end state ... via different routes” (Toft, 1996, p. 103). This peculiarity of system behaviour is known as equifinality.

The behaviour of the aviation system contributed to the loss of MH17. It was a *systems accident* (see Reason (2013) for a definition of ‘systems accident’), the causes of which included both an error of judgement – a missile crew mistaking Malaysia’s 777-200 for a hostile aircraft – and policy decisions, including Ukraine’s decision to allow passenger aircraft to overfly a war-zone and Malaysia Airlines’s decision to take advantage of the Ukrainian authorities’ concession. *The origins of the MH17 disaster are to be found in the commercial aviation network-space* (see table above). With reference to Turner’s (1978; 1994) work on incubation and system vulnerability, and Reason’s (1990) work on latent conditions (resident pathogens), the commercial aviation network-space (governments, regulatory authorities, airlines, shareholders, customers, etc.) incubated the MH17 disaster until, on 17 July, 2014, a missile crew added Turner’s ‘trigger event’ and Reason’s ‘active failure’.

Attributing the disaster solely to a missile crew’s error of judgement is too simplistic. The causes of the MH17 disaster lie not only with the decision to fire the missile(s), but also with the politics, economics and risk calculations of the aviation system’s component parts. Specifically, in the agendas of its regulatory agencies, air navigation service providers, airlines, customers and investors. It was the *aviation system* that put MH17 in contested airspace. It was the aviation system that exposed MH17’s 298 passengers and crew to the risk of shoot-down. The launching of the missile(s) was just one of a number of errors-of-judgement that brought down the 777. *Had MH17 not been in eastern Ukraine it would not have been shot down.* Had the aviation system internalised the lessons of past incidents and accidents, it probably would not have allowed flights through contested airspace. Systems-thinking, which finds expression in Toft’s theory of passive and active learning (Toft, 1992; Toft & Reynolds, 1997), encourages us to think of past events not as footnotes in the historical record but as potentially life-saving learning opportunities. Passive learning describes a situation where there is knowledge but no remediation. Active learning where there is remediation.

The passive learning actant-component of the disaster

Lagadec (1982, p. 495) observed: “The disaster must not be seen like a meteorite that falls out of the sky on an innocent world; the disaster, most often, is anticipated, and on multiple occasions”. Most often, disasters are foretold. This is certainly the case with that type of aviation disaster known as the shoot-down. Speaking about the loss of MH17, the Chief Executive of the United Kingdom Flight Safety Committee (UKFSC) claimed: “The previously unthinkable has happened” (Whittingham, 2014). In fact, the destruction of

MH17 was far from unthinkable. Rather, it ‘was anticipated, and on multiple occasions’. Harbingers included the following losses and near-misses:

The destruction of Flight KAL007. In September 1983, a Soviet Su-15 fighter shot down a Korean Air Lines Boeing 747. Flight KAL007, *en route* from Anchorage to Seoul and carrying 269 passengers and crew, strayed into Soviet airspace around the time of a U.S. military reconnaissance sortie. KAL007 was at 35,000 feet when the Su-15’s missile hit. The Soviets initially denied responsibility. KAL007’s flight-plan saw it skirt some of the Soviet Union’s most sensitive military installations, specifically those on Sakhalin Island and the Kamchatka Peninsula (Johnson, 1986). Although not war-zones, Sakhalin and Kamchatka were hot-zones that should not have been overflown. The Soviets claimed that KAL007 “flew deep into Soviet territory for several hundred kilometres, without responding to signals [radio calls] and disobeying the orders of interceptor[s]” (Sputnik, 1983). It is possible that wider events, like Reagan’s tub-thumping rhetoric (Ambrose, 1985; Johnson, 1986; Troy, 2009), the US deployment of Pershing II missiles to Europe and NATO’s imminent Exercise Able Archer, skewed perceptions of KAL007, increasing the likelihood of a shoot-down. The cultural milieu (composed of myriad events of diverse nature) shapes perceptions (Douglas & Wildavsky, 1982). Our beliefs, experiences, prejudices and memories – concentrated in cognitive ‘short-cuts’ called heuristics – influence how we interpret and react to objective reality (Williams, 2007). Heuristics have positive and negative aspects. On the plus side they speed information processing. They are ‘fast and frugal’ (Gigerenzer, Todd & The ABC Research Group, 1999). On the minus side they can cause us to misinterpret signals. Misinterpretation may have severe consequences for both subject and object: “[Heuristics] can lead to severe and systematic biases that influence the search for information and subsequent interpretations, often resulting in less rational ... decision-making. This is particularly pertinent when making ... uncertain or risky decisions” (Williams, 2007, p. 45). Less rational decision-making is especially problematic in life-or-death situations, as when a missile crew has to interpret a radar plot, or a fighter pilot has to determine an aircraft’s intentions.

The destruction of Flight IR655. In 1988, a missile fired from the *USS Vincennes* brought down an Iran Air A300 Airbus *en route* from Tehran to Dubai. All 290 passengers and crew were killed. The aircraft was intercepted in Iranian airspace over the Strait of Hormuz. Prior to the shoot-down, there had been a confrontation between Iranian small boats and the *Vincennes*’s helicopter. The shoot-down occurred in the context of the long-running Iran-Iraq war (that saw the United States favour Iraq), attacks on United States warships and attacks on commercial vessels transiting the Strait. These events may have persuaded the *USS Vincennes*’s crew that they were watching a military aircraft flying an attack profile rather than a civilian aircraft navigating an airway. Crewmembers said they believed they were tracking an Iranian F14

Tomcat fighter (Bennett, 2001). Events shape perceptions. In hindsight, regional aviation authorities should have diverted aircraft around the Strait of Hormuz hot-zone.

The destruction of Flight SB1812. In 2001, Siberia Airlines Flight 1812 was destroyed by an errant Ukrainian surface-to-air missile. The missile, fired during a military exercise, is thought to have overshot a target drone. It exploded close to the TU-154M. Seventy-eight passengers and crew perished. Following this incident, Ukraine reportedly banned the testing of such systems for a period of seven years. Flight 1812, from Tel Aviv to Novosibirsk, was intercepted at an altitude of 36,000 feet. Some Russian commentators interpreted the MH17 disaster through the lens of the 2001 Siberia Airlines shoot-down. By reminding the public of the 2001 Siberia Airlines Flight SB1812 shoot-down, commentators were able to present the MH17 disaster as an example of passive learning.

The near-destruction of European Air Transport (EAT) Airbus OO-DLL. In 2003, a EAT Airbus cargo aircraft departing Baghdad International was hit by a short-range man-portable 9K34 Strela-3 (SA-14 Gremlin) missile at about 8,000 feet. With all flight controls disabled and the aircraft on fire, the three-person crew used asymmetric thrust to land the aircraft.

The three shoot-downs were system accidents. While those who pushed the firing button were the instigators, it was the *aviation system* (see Figure 1) that placed the aircraft in jeopardy. Each and every component of the aviation system was in some way implicated in the shoot-downs. Had those aircraft not been overflying hot or live-firing zones, they would not have been destroyed.

A systems-thinking interpretation of the KAL007, IR655, Flight 1812 and MH17 shoot-downs suggests that risk-taking is an emergent property of an aviation system predicated on free-market competition and associated profit-seeking behaviours. Other things being equal, the shorter an airliner's route, the more profitable the service. *Perforce*, airline managers must strike a balance between two imperatives – safety and profit (International Civil Aviation Organisation, 2002; Bennett, 2014a). Seen through Hollnagel's (2009) efficiency-thoroughness trade-off (ETTO) prism, the behaviour of the aviation industry network-space is unexceptional. An aviation industry that was excessively risk-averse or excessively risk-seeking would flounder. Aviation wrestles with numerous difficult operational questions, including: 'How much involuntary risk should passengers bear?' Such questions have ethical and economic dimensions. As Cook (2000) notes, those who manage complex production systems (like commercial aviation) devote considerable energies to balancing production and safety goals in an uncertain and unforgiving environment.

Political and press reaction to the MH17 disaster

Politicians' analysis of the MH17 disaster was generally reductionist and blamist. Kiev blamed Moscow. Moscow blamed Kiev. Russian President Vladimir Putin commented: "The government over whose territory it occurred is responsible for this terrible tragedy" (as cited in Stout, 2014). Surveying Western reaction, Dejevsky (2014) alleged a "rush to judgement", citing Swedish Foreign Minister Carl Bildt's account: "Bildt may have been arguing in good faith, but his script was peppered with weasel words and phrases, such as 'clearly' and 'there is little doubt', that allowed assumption to masquerade as fact" (Dejevsky, 2014). Official communiques were more inflammatory than analytical.

Media analysis was generally reductionist and blamist: "In all, the state-aligned and state-owned Russian media coverage of the disaster carried a conspiratorial, anti-Western tone, pointing to the Ukrainian government as the party at fault and Washington as a puppet master" (Yablokov, 2014). In her analysis of media reporting of the MH17 disaster, Oates (2014) investigated how two news outlets, *Vremya*, "the flagship news program on the state-run First Channel in Russia" (Oates, 2014, p. 1), and *BBC Online*, "one of the most popular worldwide news sites" (Oates, 2014, p. 1) reported the story. According to Oates, coverage generally concerned itself with the question of *who* shot the 777 down. She observed of the BBC's coverage: "Little blame attached to Malaysia Airlines for flying through a conflict zone; the airline was primarily framed as a victim" (Oates, 2014, p. 12). Coverage had an 'episodic rather than thematic' flavour, said Oates. The question of *who* pulled the trigger dominated. According to Koshkin (2014), media coverage amounted to nothing more than a one-dimensional blizzard of unsupported claim and counter-claim. The unedifying and noisy argument that accompanied the destruction of Malaysia Airlines Flight MH17 is unsurprising given that, as Iyengar (1991) notes, conflicts and disasters generally foment coverage that is episodic and trite.

Following publication by the Dutch Safety Board on October 13, 2015, of its final report into the MH17 disaster, the war of words between Ukraine and Russia continued. On the Russian side, the company that manufactured the SA-11 Gadfly claimed that the Malaysia Airlines 777 had been destroyed by a SAM launched from Ukrainian-held territory: "Two full-scale experiments by the Almaz-Antey defence company aimed at recreating the MH17 crash conclude the missile that downed the flight was an old BUK model fired from a Ukraine-controlled area ... " (RT.COM, 2015). Russia's deputy foreign minister impugned the integrity of the Dutch Safety Board, calling its final report an "attempt to draw a biased conclusion and carry out political orders" (Ryabkov as cited in Yeatman, 2015). On the Ukrainian side, Arseny Yatseniuk, Ukraine's Prime Minister, blamed Russian soldiers (possibly aided and abetted by 'drunken' separatists) for the downing: "In our opinion it was carried out solely

from territory controlled by Russian fighters [T]here is no doubt that drunken separatists are not able to operate Buk systems [T]his means these systems were operated solely by professional Russian soldiers" (Yatseniuk as cited in EurActiv, 2015).

Blamism revisited

On 24 March, 2015, a Germanwings First Officer dived his Airbus passenger aircraft into a mountain, killing all on board (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, 2015). Lubitz used the Airbus aircraft to commit suicide (Bennett, 2015c). When details of Andreas Lubitz's medical history began to emerge, much of the press rounded on the pilot. In Britain, front-page headlines from 28 March, 2015 included:

Table 1

British tabloid and broadsheet reporting of the Flight 4U9525 disaster.

<i>The Guardian</i>	A picture emerges of a man disturbed and ill. Yet allowed to fly.
<i>The Times</i>	Killer pilot 'had made plans to go down in history'. Girlfriend was scared of his erratic behaviour.
<i>The Daily Telegraph</i>	Doctor had ordered killer pilot to stay off work on day of disaster
<i>The Independent</i>	Pilot 'had a sick note' for day he killed 149 people
<i>Financial Times</i> <i>Weekend</i>	Co-pilot destroyed sick note declaring him unfit to fly
<i>i on Saturday</i>	Co-pilot hid illness from his employers
<i>Daily Express</i>	Death crash pilot was depressed and ripped up his sick notes
<i>The Sun</i>	Kill pilot tore up flight-day sicknote
<i>Daily Star</i>	Killer pilot's secret gay torment

In failing to reference the broader context to the disaster (pilot indebtedness, roster volatility, the possibility of roster-induced acute and chronic fatigue, the potential for operations in congested airspace to induce stress, some pilots' belief that reporting sick may be viewed with suspicion, etc. (Bennett, 2014a, 2015c)) the press again committed the fundamental attribution error. By focusing on the First Officer rather than the industry, the Fourth Estate distracted attention from potentially relevant factors like pilots' deteriorating employment conditions (Bennett, 2014a, 2015b). Here we have further evidence for the need to propagate the systems-thinking approach to accident investigation.

Conclusion

As an antidote to the blizzard of recrimination that followed the Malaysia Airlines Flight MH17 disaster, and to reduce the risk of recurrence, this paper has presented a systems-thinking-informed analysis (specifically an actor-network theory-informed analysis). Actor-network theory teases out the interactive complexity, relationality, latent and emergent properties of complex socio-technical systems like that which supplies commercial air service across international borders. The theory of emergence holds that systems phenomena like positive synergy, negative synergy, incomprehensibility, miscommunication and non-linear interactions may cause complex socio-technical systems (for example, the system that provides commercial air service across international borders) to behave in unexpected ways. The paper suggests that on 17 July, 2014, unexpected and risky behaviours within the European commercial aviation network-space led to the destruction over Hrabove, Ukraine, of Malaysia Airlines Flight MH17. Several of the systemic origins of the Flight MH17 disaster were highlighted in the Dutch Safety Board's (2015a) final report. Amongst other suggestions, the Board urged a more cautious approach to airspace management and utilisation in times of conflict. According to the Board, the current 'default' position of states and airlines is that flight is always possible: "The international system for civil aviation is based on the assumption that, in principle, civil aviation is always possible This system can provide an incentive to keep ... airspace open if potential dangers to air traffic are not yet entirely clear. Flying is also the default for operators" (Dutch Safety Board, 2015a, p. 250). During crisis or conflict, aviation's 'default position' may be considered a latent error.

The paper suggests that in the aftermath of the MH17 disaster, blamism served identifiable political ends for actors like the Russian Federation, Ukraine's warring militias, the United States, the European Union, the North Atlantic Treaty Organisation (NATO), national and international regulatory agencies, air navigation service providers (ANSPs) and the airline industry. Following Russia's annexation of the Crimea, the West has used MH17 to frame Russia as a paranoid and unpredictable state, and President Putin as a loose cannon whose geopolitical ambitions induce him to promote disaffection with Western values and provide material support to regimes with dubious human rights records (Bashr Al-Assad's Syria, for example). Russia's revamped Middle East policy, which in the Autumn of 2015 saw it launch air strikes in support of Syria's President Bashr Al-Assad (Greene, 2015), would seem to confirm the West's reading of Putin's politics. The East has used it to frame the USA and the European Union as expansionist powers with designs on Russia's near abroad. The Russians construct NATO as the armed wing of Western imperialism. NATO is Russia's *bête noire*.

The paper argues that in the context of systems accidents like the destruction of Flight MH17 (and the loss of Germanwings Flight 4U9525), blamism serves to distract attention from the broader *systemic* origins of disaster. The paper argues that only systems-thinking-informed deconstructions of incidents, accidents and near-misses can provide the sort of fine-grained, nuanced analysis essential for effective and durable mitigations. As Gherardi and Nicolini (2000) explain, safety is an emergent property of the actor-network. Safety emerges as “the outcome of the quotidian engineering of heterogeneous elements: competencies, materials, relations, communications, and people that are integral to the work practices” (Gherardi and Nicolini, 2000, p. 11).

It is hoped that the philosophy and practice of systems-thinking (grounded in reflective practice) will appeal to those actors - politicians, civil servants and warfighters - who have a direct and immediate influence over our lives. Realistically this will not happen when simplistic reductionist analyses of disasters like Malaysia Airlines Flight MH17 and Germanwings Flight 4U9525 provide antagonists with easy political capital. If politicians can bring themselves to see disasters not as a means of furthering some political ambition, but as learning opportunities, the world will become safer. Unfortunately, like KAL007, MH17 has become a political football. The Great Game is afoot, with truth its victim.

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Appendix

Aircraft destroyed		
Date	Aircraft	Specification and Role
16/07/14	Sukhoi Su-25M1	Single-seat, twin-engined ground-attack
16/07/14	Sukhoi Su-25M1	Single-seat, twin-engined ground-attack
14/07/14	Antonov 26	Twin-turboprop transport
12/07/14	Mil Mi-24	Helicopter gunship
02/07/14	Sukhoi Su-25M1	Single-seat, twin-engined ground-attack
02/07/14	Sukhoi Su-24	Twin-seat, twin-engined supersonic strike
01/07/14	Sukhoi Su-25UB	Single-seat, twin-engined ground-attack
24/06/14	Mil Mi-8TV	Twin-engined transport helicopter
21/06/14	Mil Mi-8T	Twin-engined transport helicopter
14/06/14	Ilyushin 76MD	Four-jet strategic transport
06/06/14	Antonov 30	Twin-turboprop photographic reconnaissance aircraft
05/06/14	Mil Mi-8	Twin-engined transport helicopter
04/06/14	Mil Mi-24RhR	Helicopter gunship
04/06/14	Mil Mi-24VP	Helicopter gunship
04/06/14	Mil Mi-24VP	Helicopter gunship
04/06/14	Mil Mi-24VP	Helicopter gunship
03/06/14	Mil Mi-24VP	Helicopter gunship
29/05/14	Mil Mi-8MT	Twin-engined transport helicopter
05/05/14	Mil Mi-24P	Helicopter gunship
02/05/14	Mil Mi-8MT	Twin-engined transport helicopter
02/05/14	Mil Mi-24P	Helicopter gunship
02/05/14	Mil Mi-24P	Helicopter gunship
25/04/14	Mil Mi-8	Twin-engined transport helicopter
22/04/14	Antonov An-30B	Twin-turboprop photographic reconnaissance aircraft
Note: All the above aircraft were operated by the Ukrainian armed forces		
Source: Aviation Safety Network (2014)		