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Exploration of Problem and Solution Types In Los Angeles County Smog Control 1943-1976

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Abstract

Aggregation dynamics looks for basic principles in the co-development of complex structures of any kind. Provided free energy and raw materials are available, it is hypothesised that complex structures result from a rigid natural state space and an inevitable lack of computational power and information at all levels of complexity.

One specific principle is the Innovation Illusion, it says that people are limited to fixed patterns of thought when identifying and solving problems. This article examines air pollution control in Los Angeles County between 1943 and 1976. It identifies different problem types and solution repertoires, including discord, unfamiliarity, and interference.

1 Introduction

People are busy all day long. What are they doing essentially? What all busy systems do: convert raw materials and energy into complex structures, garbage and waste heat. Aggregation dynamics looks for basic principles in the development of these complex structures. It makes no distinction between organic, inorganic and virtual beings. Aggregation dynamics is a systems theory that looks for basic principles that steer complexity growth.

Aggregation dynamics has a wide scope, with no exceptions, this makes it a total theory in the sense of Transmathematics [68]. One of its assumptions is that the world around us has certain fundamental properties that can be recognised both on a small scale, in molecules or unicellular organisms, and on a large scale, in a city or a large company. For that reason, Aggregation Dynamics can be described in terms of these different levels. You could say that Aggregation Dynamics studies how free energy in specific circumstances seeks a way out that leads to both entropy and complex structures. You could also say that Aggregation Dynamics is a form of ecology with a level playing field for organisms, inanimate objects and imaginary creatures. Closer to home, we could say that Aggregate Dynamics studies how people experience and solve

problems and what patterns this produces, like societies. These descriptions are all equivalent. The last interpretation of Aggregate Dynamics is typically used in studies in the human realm, as is the case in this paper.

The basic hypothesis is that complex structures are the result of rigid natural state spaces and an inevitable lack of brainpower and information when it comes to higher levels of complexity. A specific assertion that arises from this is the Innovation Illusion. This states that when identifying and solving problems, people are limited to fixed patterns: problem types with a fixed set of solutions, called the repertoire. The problem types and their repertoire are assumed to be context- and scale-free. These properties are meant as follows.

The realisation of a solution leads to changes and a new situation. If new inconveniences arise, these are again framed in a problem type. How one ended up in the current situation will be largely forgotten or will been recalled in a twisted way, hence the context-free nature. The current problem therefore appears as something new. The scale-free aspect is that problem types are about relationships between stakeholders. It does not matter whether such a stakeholder refers to a non-functioning bicycle light or a country that does not behave in a way a neighbouring country expects. Both involve imagined units that correspond in some way to external structures and about which a party believes there is something wrong. The effect of these two characteristics is that new problems are not recognised as old familiar ones, on the contrary.

Identifying the problem and choosing a solution are often experienced as clever and unique inventions. But therein lies the illusion: in the abstract, people tend to repeat themselves. This article is no exception. It is yet another attempt to gain more explanatory power by trying to simplify observations, here of people in problem-solution situations, in the hope that some patterns emerge. The form, an article, is not precisely new either.

The Innovation illusion may perhaps exaggerate; if so, however, it still leaves the question of what exactly innovation is. There are many more questions in this range. Can people escape the laws of ecology? What does the activity of people mean in the big picture? More specifically, what patterns emerge from the constant solving of the same types of problems? When do complex aggregations, or accumulations of solutions, become unstable? A current instance of this question is: how much regulation or complexity can a society handle?

I hope that working on such questions could lead to new perspectives on our own position in the world, our role and vulnerability. Maybe that could help to restore trust and cooperation, something that is dearly needed to counter climate change and loss of bio-diversity. Maybe that could help find use for new technology in a responsible and sustainable way. This article concentrates on Aggregation Dynamics, it does not offer any reflections on these aspirational topics.

The phenomenology of problems and solutions is part of the footwork of Aggregation Dynamics. This paper focuses on problem and solution types. It is accompanied by another paper. There the focus is on problem positions [72].

The case studied in both papers concerns the fight against air pollution in Los Angeles County in the period 1943-1976. The case was introduced concisely in the introductory 'Aggregation Dynamics: From problems and solutions to a generalised ecology' in order to illustrate the problem types of *discord* and *proliferation* [70].

Following James Krier and Edmund Ursin's Pollution and Policy, I would characterise this article as case essays rather than a case study because of its tentative, speculative, impressionistic character [28].

1.1 The article in a nutshell and key results

This article elaborates on an already identified problem type (discord) and introduces and explores several new problem types, repertoires, and terms. It seems practical to briefly indicate where to find what.

Theory and terms In Section 2, the picture given above of Aggregation Dynamics is completed. The basic terminology, some related work, and some new concepts are discussed in Section 3. Other new concepts are introduced as the argument proceeds.

Case A short version of the case history is presented in Section 4. A fuller version is in the second article on the case, which also contains more references to the sources [72].

Unknown problems Section 5 identifies two problem types and several novel concepts. Problem type *acute threatening unfamiliarity* occurs when a party experiences an unknown problem whose effects are perceived as acute and threatening. I assume this was the experience of many residents of the region who panicked because of the stench, fog and burning eyes and airways. Through different reactions to the situation, it can turn into another type: *controlled unfamiliarity*. The problem is then not gone and still not understood, but it is manageable, it can be lived with.

One of the solutions that startled residents applied was: calling for help. This action can be characterised more generally with the term *escalation*. Further analysis of this leads to several new notions surrounding the transference of a problem.

Isolated undesirability and interference Section 6 *Governments in search of answers* deals with the process of raising awareness of the air pollution problem. At first, air pollution was seen as a local incident. I characterise that as *isolated undesirability*. But solution attempts clashed with reality, the problem type changed to *interference* and with its resolution, *discord* emerged as the main subproblem, albeit for a relatively short period of time.

Resolving disagreement In Section 7 *Unification within the county* tracks how discord was overcome with unification. However, with the disagreement out of the way, the interference remained. People wanted to have their cake and eat it. The interference became chronic. This calls for a different type I think: *controlled interference*.

Disagreement and uniformity: a repeated pattern In Section 8 I show that disagreement and uniformity form a duo that applies more frequently.

Indeed, it could be argued that unification creates the conditions for its own reapplication; it is, what I call, an *invariant*.

New material In the second to last section 9 *Some leads for follow-up studies* I discuss a few aspects of the case that I consider candidates for follow-up studies.

Conclusion The article is concluded in Section 10. An account of sources and related work is given in Appendix A.

2 Aggregation Dynamics

Aggregation dynamics is modelled on ecology. Ecology studies the distribution and abundance of organisms and seeks explanations for this based on physical, chemical and biological properties and interactions [9].

Basic ecological processes convert matter and energy into structures, and on Earth this has resulted in complex ecologies such as the Amazon rainforest or the city of New York. How do ecologies come about? Much has been clarified, but much also remains unclear. For a deeper understanding, I think, notions as information, conceptualisation, interpretation and meaning should be given an explicit place in the interplay between energy and matter. An attempt to do so is to replace the conceptual category 'organism' from ecology with another category of players: aggregation.

One defines aggregations by that to which an aggregation thinks it relates. I have a house, go out with the dog, fill in a fiscal form for the government. These are all aggregations. Aggregations are defined in terms of themselves. I think about the dog, the dog thinks about me.

What motivates this replacement? From various disciplines, such as philosophy, biology and psychology, it has been argued repeatedly and with good reason that organisms, and hence humans, live in a self-generated projection [42, 31, 43, 25]. We do not see the real world but a brain-produced representation of it. Assumed parts of it are assigned roles. For instance, people speak of Mother Nature, or the Dutch Nitrogen Dossier or the government, as described for example in 'The state as person in international theory' for international organisations [75]. The phenomenon is referred to as reification.

Reification can be seen as an error of reasoning. Aggregation dynamics reverses that. Aggregation dynamics believes that the dynamics of living structures in a real world can be better understood by taking projected beings and their meanings seriously.

Many structures that people deal with cannot be pinpointed with 100% certainty. Often projected players are mixes of the virtual and the concrete. The word aggregation was chosen because its connotation matches for me the unwieldy multitude of unspecific clusterings we deal with the whole day, or we think deal with. Aggregation can also be understood as a process, as the clumping itself. Also nature is full of it. Cells absorb molecules; higher order cells are partly formed by the incorporation of other cells; birds form flocks. One could then say that Aggregation Theory would suffice as name for my study.

However, what one then misses is disintegration, separation, and other changes. So, that's where the words dynamics comes in, to cover all forms of structural change. For example, a 'bus + no passengers' that leaves the depot turns into a 'bus + passengers' after stopping and after stopping again turns into a 'bus + a modified group of passengers'.

Projection is not something reserved for people. A speck of dust on the windowsill is not denied a representation of the windowsill. All of this does not mean that Aggregation Dynamics presupposes some kind of universal consciousness. It is about an abstraction with the aim of arriving at a simple model.

In summary, one could say that Aggregation Dynamics studies the role of the evolution shaped imagination in the reduction of energy differences in a world full of material obstacles and limitations. If there is sufficient free energy, this reduction process appears to be accompanied by an increase in complexity. The hypothesis is that the form of this increase can be explained by a lack of cognitive ability and information. The theory is weakly emergent and not a fundamental theory. How expressive the theory is has yet to be seen [23].

I will not be conducting a systematic discussion of the place of Aggregate Dynamics in the scientific discourse. There are similarities and borrowings, but also differences, both with the written discourse and with that in the form of art [71]. A reflection on this point is worthwhile but adds little here. I limit references to others to that which is directly relevant to the argument.

3 Terminology

I will first discuss the terms and concepts from previous work below [70]. I will then discuss a few new concepts; I will introduce the remaining new terms as I go along.

Problems and solutions I can be brief about problems and solutions. These are thought constructions that help people create order in the world around them. There is nothing difficult about them, the reader's intuition will suffice. I discuss some related work in Appendix A *Discussion of sources and related work*.

A solution can take the form of a proposal or an intervention that has been carried out. In the case of a proposal, it seems useful to distinguish between, on the one hand, a concrete, one might say, imperative or binding proposal for a change, and, on the other hand, a specification of requirements for a change if it is to be considered a solution. The latter is called a service specification, which leaves the details of the solution open. For example, you may want a drying rack to be less likely to blow over (service specification), and the solution may be to make the base heavier or to attach the rack to a wall. Both are good solutions. If a solution requires solving subproblems, then it is in any case partly a service specification because identifying a subproblem already indicates what a solution to it must fulfil [76].

Once a solution has been realised, it takes on a life of its own. Sometimes a solution can be clearly identified, for example as a distinguishable physical component. Sometimes a solution is documented and the interventions used to realise it can be reconstructed from it. Sometimes neither of these is the case.

Solutions, or steps towards them, often create new problems. I call these *follow-up problems*. Sometimes these are known and anticipated, sometimes they are unknown and are, as Tenner calls them, "unintended consequences" [45].

Opportunity I also interpret an *opportunity* as a problem. Both with a problem and an opportunity, there is friction between an existing world and a desirable world. The difference is that with a problem, the desirability of solving it is imposed. With an opportunity, it is a voluntary choice to perceive the non-reality of an optional though attractive world as a problem.

Problem type and repertoire The Innovation Illusion states that people depict disagreeable situations using a finite collection of problem types. A fixed collection of solutions, the repertoire, is assumed for each problem type. A problem type and the solutions from the repertoire are abstractions. In a concrete situation, they are filled in with concrete situations, players, data and arguments.

The repertoire is populated by solutions. A chosen solution can be implemented. That implementation leads to behaviour that leaves traces or can be observed. In general, the observable behaviour cannot be traced one-to-one to the solution that it serves, the repertoire or the problem type. For example, if you see someone walking into a train station, it could be to catch a train, but it could also be to pick someone up or buy some fries.

The representation of the relationship between problem types and repertoire probably comes across naturally to the reader: first 'identify' a problem, then 'solve it'. But that order can be deceptive. In the extreme, the solution takes precedence, the problem is constructed on the side.

Problem position A problem position can be as simple as 'we want to go from A to B and I think we should go straight there', but can also contain factual background information such as '1.5 is within the DIN-standard'; estimates, assumptions, opinions about the problem position of others involved 'what X says is not true', reasoning and arguments; suggestions for a solution or a *plan of action*. A problem position can also reflect on someone else's problem. A solution in a problem position is always a proposal, and therefore a form of specification. Of course, it is also possible to reflect on a previously realised solution that, for example, does not or did not suffice, but that solution is part of the status quo. A problem position is not reserved for one person. Composite units, such as the 'Ministry of the Interior', can also have a problem position. To abstract from these differences, I usually refer to parties as a general term for a stakeholder, or more abstractly, as aggregations.

Problem situation One or more parties are often involved in a problem. The combination of the parties' problem positions forms the problem situation.

Multiple problems can play a part in a problem position and situation. Even if a number of parties claim to be discussing the same problem, there are usually differences in interpretation. Readers will be able to confirm this from their own experiences. It is better to view shared problems as individual.

Chains and networks of problems and solutions A history can be imagined as a network of problem positions and situations in which solutions lead to new positions and situations. I call such a network a *problem propagation*. Where the network grows, that is where actions are carried out, I refer to as the *problem front*. The unravelling of the front can be reconstructed in the past, experienced in the present or projected into the future. A graphic presentation of a network is obvious, but not required. A simple form of propagation is linear and without branches, which I call a *problem-solution chain*:

$$\text{problem} \rightarrow \text{solution} \rightarrow \text{problem} \rightarrow \text{solution} \ldots$$

Problem-solution chains and problem propagations are free format. The strict problem-solution form does not have to be followed. More or less detail can be added as desired, and additional connectives and captions may also be used as long as all notations are provided with an explanation.

Some new terms It is practical to discuss some new terms here beforehand, and others during the argument, together with motivating examples.

Many problems are answered with a plan of action. This involves breaking down a problem into *subproblems* whose approach is phased over time and which may be interdependent.

I imagine the division into subproblems as a directed graph in which all paths lead to a single point called the *primary problem*. Points that are one step away are *secondary problems*, another step further are *tertiary problems*, and so on. To solve a primary problem, the secondary problems must be addressed, and to that end the tertiary problems, et cetera.

Subproblems are *instrumental* to the primary problem. It is clear that on the problem front, it is usually not the primary problem that is solved, but an instrumental problem, a problem that has *priority* at that moment.

4 Los Angeles Smog

On 9 July 1943, *The Los Angeles Times* reported that it was not lack of sleep that made the eyes of the Angelenos burn. Thousands had called the police station to ask what was going on. The police were able to refute some of the guesses, but the real cause remained a mystery [51]. On 27 July 1943, a reporter wrote about the "fumes" that irritated the eyes, nose and throat and deprived people of their sight. It was now the fourth "gas attack", and the worst one yet. The word "smog" was not yet the preferred term in that region at that time.

Since the beginning of the 20th century, parts of Los Angeles County occasionally had to deal with disturbing air pollution. But it was incidental, and government responses were limited to local and specific regulations against smoke, soot, and odour. In 1943, air pollution increased sharply in terms of haze, odour, duration, and physical discomfort. The authorities, with Los Angeles City and County at the forefront, were forced to take up the matter, but still in the old way. The prevailing feeling was that this "nuisance" could be effectively combated quickly. However, more research was considered necessary before targeted measures could be taken.

Investigations were quickly launched by experts from the City Health Department and engineers from Public Works [50]. The county also set up a commission of inquiry in October 1943: the Los Angeles County Smoke and Fumes Commission. Its assignment was to investigate the causes of smog and to advise on a permanent solution.

Enforcement was intensified by the police and the judiciary [62]. There was a naphtha cracker in Los Angeles City and it caused a lot of odour nuisance. The factory produced butadiene for synthetic rubber and was part of the federal war effort. A representative came from Washington D.C. to Pasadena to help investigate the odour nuisance and make decisions. In the smog season of 1944, the district attorney brought several cases against alleged offenders. Instituting legal proceedings proved difficult due to fragmented authority. Health legislation provided a county-wide scope, but it was unsuitable because it required irrefutable evidence of health damage, which would take years to demonstrate. To work more effectively, the county administration and the attorney searched for other legal options.

The attempts to combat the smog had no effect. In the late summers of 1944 and 1945, the smog reared its ugly head once again. The discussion about it did not abate, nor did the protests from citizens. All those involved, from citizens to politicians to industry, disagreed on the severity of the problem, who was responsible, and the course of action to take to combat it.

There was even disagreement over the simple question of whether to call in help from cities with experience in fighting smog, such as St. Louis. In mid-September 1944, the Los Angeles City Council met to discuss this question. Various arguments were discussed. Councilman Holland argued for the broadest possible research effort and expressed the hope that the new legislation that would result would be the strictest in the entire country. The proposal to seek advice was accepted. However, Councillor Carl Rasmussen, who was to implement the decision, was strongly opposed to the proposal. The newspaper feared that the proposal would be stifled in the implementation process.

There was also organisational chaos. The aforementioned county commission was disbanded at the beginning of 1945 to much praise [64]. Both the county and the city of Los Angeles set up an Air Pollution Control Department under their Health Department, which now had to try to clean up the dirty work. At an inter-city conference on smog in September 1945, county commissioner and former Caltech Professor W.H. Clapp had complained about the state of affairs. He felt that nothing had been done with the clear recommendations of

the committee. It led to an argument with Dr. H.O. Swartout, who headed the County Air Pollution Control Department. But the latter also had to admit something: the political will to tackle the problem was lacking.

Politics faced several obstacles. They were in cahoots with industry and did not want to take them on. Another problem for the county was its fragmented authority in the area of air pollution. Furthermore, the local legislation of cities and regions was not uniform. Finally, these cities and regions each had their reasons for blocking the county's attempts to work together.

At the end of 1945, the county attempted to gain more legal leeway with a voluntary and provisional model ordinance [54]. Almost a year later, the Times summarised the situation in a bitter editorial. Only eight of the forty-four relevant players had accepted the regulation. The attempt at voluntary unity had failed.

4.1 *The Los Angeles Times* takes action

At a public meeting of the board of city directors on 2 October 1946, 300 residents of Pasadena expressed their anger. They complained that the problem had been serious for five years and that it was still not clear what substances were causing the painful eyes. Many arguments and positions were expressed. Experts explained the state of affairs. Angry residents threatened to leave Pasadena. Colonel Charles Ketterman pleaded for patience and more research. Albert I. Stewart, Pasadena's representative in the House of Representatives, said that if he were re-elected he would try to push through legislation at the county level because he saw that as the solution to the smog problem [38].

The Los Angeles Times had kept its distance. It was a conservative newspaper, biased towards the establishment. When it came to the rise of Los Angeles in the world, it did not hesitate to take a position in the political debate. But with the smog problems they did not know what to do until they realised that Los Angeles was starting to get a bad name. The management took the initiative and made smog a permanent theme and took action. The leadership of the anti-smog campaign was given to Ed Ainsworth, a versatile and well-known editor, speaker and writer.

Ainsworth's campaign kicked off with a series of major articles on consecutive days. The first was published on 13 October 1946, and he wrote [4]: "The Times hopes, by presenting the facts and pointing to certain possible remedies, to lead the way toward a permanent solution of this blight which threatens the health and future of the metropolitan region." Downright activism was the appeal to readers to report in writing to the "smog editor" about any source of smoke or vapour they observed. That information would be forwarded to the appropriate authorities.

On 1 December 1946, it was announced that they had asked Professor R.R. Tucker of Washington University to investigate the situation in Los Angeles and write a report, at the newspaper's expense. Tucker had played an important role in curbing smog problems in St. Louis and was seen as a national expert [5]. Tucker came. He completed the report in January 1947.

Even before Tucker's departure, the newspaper set up an action committee, the Times Smog Advisory Committee, which soon after became known as the Los Angeles Citizens' Smog Committee [55, 59].

4.2 Assembly Bill No. 1

Albert Stewart had meanwhile worked with others on a model anti-smog law [33, 58, 32]. They submitted their bill, Assembly Bill No. 1, to the State legislature on 9 January 1947 [34].

At the same time, there was still considerable lobbying to overcome local and interregional divisions and opposition, for example, within the Chambers of Commerce [3]. In early 1947, the Los Angeles Chamber of Commerce was still advocating a voluntary programme to support the efforts of the city and county [56]. The State Chamber of Commerce, of California that is, was in favour of legislation at the county level [49].

Cooperation from the state was necessary for legal technical reasons. Only the state could elevate local legislation on air pollution to the county level. On 10 June 1947, Governor Warren ratified Assembly Bill No. 1 [57]. A county could introduce this after its administrators had convinced those present at a public hearing of the necessity. Los Angeles County immediately proceeded to a consultation with the people. The public agreed and so the first Air Pollution Control District (APCD) became a reality. The first action of Los Angeles County was to set up a department of the same name that would be responsible for implementation. The law prescribed such an administration [60].

4.3 McCabe and the Air Pollution Control District

McCabe was a geologist from Arkansas with a background in coal mining, analysis and combustion. He became the first director of the Air Pollution Control District (APCD) for Los Angeles County. Before moving to Los Angeles, he was head of the coal division of the U.S. Bureau of Mines.

McCabe's first activities involved establishing contacts with the industry and influential bodies, hearing from those involved and those who violated regulations, setting up investigations, and systematically informing administrators and the public. The first staff members came from the Air Pollution Control Department of Los Angeles County, which was absorbed into the new APCD. The City's department also merged with the APCD in early February 1948. McCabe immediately experienced the versatility of the issue.

McCabe regulated the incineration of waste at public dumps. In the municipality of Whittier, people wondered then what to do with the waste. The fire chief feared a fire hazard if people started burning waste in their backyards. Whittier threatened to leave Los Angeles County and join neighbouring Orange County. With financial assistance for the construction of an incinerator, Whittier eventually complied and amended the local city ordinance for controlling the burning of rubbish [67].

Under McCabe's leadership, the investigation into the causes of smog received a significant boost and a firmer institutional basis. McCabe had a new team of prominent scientific advisors, including industrialist and former Caltech Professor Arnold Beckman.

McCabe initially focused on lines of research familiar to him, with sulphur dioxide as the main pollutant. Older and ongoing research into other causes, such as car traffic, came under temporary pressure or was stopped.

The possible role of car traffic had not gone unnoticed [53]. McCabe's predecessors at the county and city health department had pointed out that in places with heavy car traffic, the eye irritating fumes occurred most clearly [17, pp. 46–47]. Even Tucker had pointed out the role of car traffic.

4.4 Arie Haagen-Smit

Beckman had advised McCabe to involve his friend Arie Haagen-Smit in the smog investigation [24, p. 71]. The Dutch chemist Haagen-Smit did not work in atmospheric air pollution but in a different field, namely the organic chemistry of plant hormones. Within Haagen-Smit's field of research, techniques had been developed to condense and concentrate very small amounts of volatile organic compounds from air fractions. He successfully applied this technique to smoggy air.

Based on this, McCabe came up with an entirely different theory. His organisation and Haagen-Smit had found organic peroxides in air samples, substances that they claimed were extremely irritating to the eyes [6]. Incomplete combustion of fuel was now identified by McCabe as a major cause of smog. It was clear to those in the know which form of combustion, among others, was meant.

The car industry remained silent. The oil industry, however, did not accept the new insights. Whereas previously their production process had been criticised, now the products themselves were being made suspect, an even more serious danger. On 27 September 1948, in a letter to McCabe, the chairman of the oil industry's trade association refuted the conclusions of the APCD report [61]. He did so on the basis of research by the Standford Research Institute. The latter even went so far as to discredit Haagen-Smit's research. The effect was counterproductive. Haagen-Smit now really dug his heels in to definitively prove that he was right [41].

In early 1950, Haagen-Smit concluded that Los Angeles County was experiencing photochemical smog: a solar-induced cyclical reaction with ozone and incompletely burnt oil products in the lead role. Moreover, temperature inversion in summers caused the foul air not to blow away, but to linger.

4.5 Anti-smog action committee

The fact that progress was being made on the scientific, legal and organisational fronts had not impressed the public, as the smog situation had not noticeably improved for the average citizen.

A number of citizens mockingly founded the Anti-Smog Action Committee. The committee organised a public hearing and in a newspaper announcement it was stated that politicians were not welcome. Those politicians were there, although they did not have the final say. The invitation to the meeting was titled "Let's Go, Little Guys" [39]. This was a clear allusion to the sentiment that the citizens, the "little shots", were being sacrificed and that the big shots were being spared. At the public hearing, which took place on 20 October 1954, the Anti-Smog Action Committee showed that it was not alone: Three thousand people filled the auditorium and another 1500 listened to the progress of the meeting in another room. The finger of blame was pointed at the industry, but also at the government, which was accused of not doing enough to protect the public. The Air Pollution Control District officials were criticised for not doing their job properly [44].

The county felt they should take visible action to win the public over and take the wind out of the sails of the troublemakers. McCabe's successor, Gordon Larson, was fired [10][17, p. 50]. Samuel Smith Griswold would succeed him.

4.6 Automobility

Although the protests seemed to indicate otherwise, the authorities had not been idle, quite the contrary. There was virtually no activity or process left untouched by the APCD inspectors. However, it was not enough, because the growth of the automobile society had continued very rapidly against all these efforts. Orange plantations were rapidly giving way to highways.

"Smog chief" Samuel Smith Griswold repeatedly stated that the "car exhaust" was the largest and also uncontrollable source of air pollution in the county. Smith Griswold vigorously continued the proactive line of control and research of his predecessors, but also paid much more attention to informing the public than his predecessors.

Smith Griswold noted that the number of cars per family was increasing, an average family had more than 1.5 cars at their disposal and 2 had been the fashion for years, he saw [69]. Aside from attempts to find short-term solutions, such as car pools, Smith Griswold and others repeatedly interpreted the smog problem as a problem of the car industry. He saw that the car would not disappear and was not opposed to car mobility. The solution had to come from a different angle, from the car industry.

With the increasing attention on the car industry, the situation changed for the oil industry. Initially, the public and the government had pointed to the oil industry's installations as the direct source of the smog. Thanks to the work of Haagen-Smit and others, that perspective shifted for and on them. The use of the products was the sticking point. Due to incomplete combustion in engines, mainly car engines, the reactants for smog were released into the air.

By the mid-1950s, the theory of photochemical smog in Los Angeles County had been clarified and accepted. The authorities understood the situation. However, the political battle with the public and the (car) industry over how to proceed had only just begun. In the years that followed, the Anti Smog Action

Committee lost momentum. However, other groups, such as Stamp Out Smog, with the acronym SOS for good reason, picked up the thread again with just as much vigour [24].

4.7 Regional clusters

In 1950, the smog problems in San Francisco were not immediately serious. However, alerted by the reports about Los Angeles, the city council could see the writing on the wall and wanted to stay ahead of the problems.

Mayor Robinson was quoted in The San Francisco Examiner on 17 December 1950. Together with smog experts, he believed that regional control was necessary and that Assembly Bill No. 1 should be drastically revised to that end. Robinson tried to prepare the ground for a regional approach. That did not happen by itself. Parties such as the neighbouring counties, industry, and the Chamber of Commerce all had their own ideas, with the latter advocating self-regulation.

In early 1955, a Californian state commission had recommended the formation of a Bay Area Pollution Control District, which would include the nine counties surrounding San Francisco Bay [46]. On 8 July, Governor Knight signed the law that established the Bay Area Air Pollution Control District.

Regional aggregation around Los Angeles County took longer to develop. In 1950, Orange County became an Air Pollution Control District, an APCD, after the consent of residents and other stakeholders was sought at a public hearing [66]. In 1953, San Bernardino County and Riverside County were present at a closed meeting with the governor of California. After much deliberation, the counties decided that the problem was local. They became APCDs in 1956 and 1959 respectively.

A regional regulation was in the works in 1957. It was cancelled because Los Angeles County would have had seven of the thirteen votes on the board in the proposed law; Orange, San Bernardino and Riverside the other six. The latter did not like that idea. In the years that followed, other complications blocked a regional solution.

By 1970, the Los Angeles APCD came under increasing fire from the public, the press and protest groups. It was clear that the APCD was starting to lose momentum. In the early 1970s, neighbouring counties became involved in the smog debate. In the summer of 1976 a state law disbanded the APCD and replaced it with a new organisation: the South Coast Air Quality Management District. This included the counties of Los Angeles, Orange, Riverside and San Bernardino [17, p.106-110].

4.8 The California Air Resources Board

In 1955, California established the Bureau of Air Sanitation within the Department of Public Health. This bureau served to support local governments and collect data. In the summer of 1960, California passed the California Motor

Vehicle Pollution Control Act. A new department was added, the Motor Vehicle Pollution Control Board. The board was tasked with working on emission standards and a smog control device for cars [65]. Six months later, a prototype was presented to the board.

In 1967 both departments were merged into a new agency, the California Air Resources Board (CARB). Arie Haagen-Smit became its director. CARB was of a different order than its predecessors. It was tasked with formulating air quality standards and establishing limits for motor vehicle emissions and other air pollution [12].

On 2 November of that year, the federal Air Quality Act also came into force. This gave California the option to deviate from the national standards – the waiver – provided that the local standards were more stringent. CARB repeatedly utilised this option [74]. In the decades that followed, the organisation grew into a leading national and international institution in the field of air pollution control.

4.9 Federal laws and international developments

In the late 1940s and early 1950s, the problems with air pollution found their way to Washington DC in various ways.

The first legislative proposals for a federal role were rejected, but an intergovernmental committee was formed to discuss the role of the federal government in the area of air pollution. McCabe, at that time back in a senior position at the Bureau of Mines, was a member. In his State of the Union address on 6 January 1955, President Dwight D. Eisenhower asked Congress to pay attention to the nation's air pollution problems. Senators Thomas H. Kuchel and Homer E. Capehart came up with a proposal: The Air Pollution Control Act. This law, with a duration of 5 years, was adopted after some amendments that year. The law provided for a modest federal role.

The law was first extended and amended until 1962 and then until 1964. In the meantime, air pollution had become a political theme. There were conferences, public hearings and proposals. In 1963, a replacement for the law was established, The Clean Air Act. This law remained modest in terms of federal control, but solved fiscal obstacles to research, provided procedures to settle interstate issues and had a much larger budget, sixty-five instead of five million US dollars.

After a few amendments, a fundamental change was realised in 1970. The 1970 amendments broke with federal restraint. From 1970 onwards, the federal government considered monitoring air quality throughout the nation to be its responsibility. There was now explicit federal direction and federal coercion, national science-based standards came into force for state programmes, as well as national emission standards for various sources. A new agency was set up to administer the new law, the Environmental Protection Agency, with a staff of 1000. The 1970 law had major consequences for implementation at all levels of government. The law set an international standard and marked a broadening of perspective, namely to 'the environment' [17].

5 Unfamiliarity

As described, in July 1943 thousands of civilians called the emergency services and asked for help. They were at a loss to explain the inexplicable stench and fog, the watery eyes and the painful respiratory system. Newspaper articles reveal panic, for example in a sentence such as: "(. . .) many of the callers are near-hysterical and seek advice of health authorities on what to do (. . .)" [63]. The quote concerned people who called Pasadena's Health Department. How did the panic turn into these citizens picking up the phone?

The distraught citizens did not know what to think about their situation. They had no plausible explanation for the situation they had ended up in. To describe their situation, I introduce a new problem type: *acute threatening unfamiliarity*. Based on a few newspaper reports in a single case, this type is still very speculative. However, it is clear that many citizens picked up the phone. Even a very vague circumstance apparently has a repertoire.

Let's imagine a caller, let's call him Jack. After making the call, he may have thought: 'It's not my problem anymore, I've passed it on.' Unfortunately, I did not find any such expression in my sources. I assume then that: the unfamiliarity became manageable by calling for help, but was still not understood. To distinguish it from the earlier unfamiliarity, the panic situation, I call it *controlled unfamiliarity*. The following problem-solving chain describes the speculative process:

Problem-solution chain 1 *acute threatening unfamiliarity → calling for help → controlled unfamiliarity → monitoring the authorities' handling of the situation.*

What was Jack's problem position before he started calling? Perhaps this:

Problem position 1 (Jack is considering calling for help)

1. *I can no longer see the end of the street, this is very scary. My eyes are burning and my throat hurts. I fear for my health and that of my family. These are my problems.*
2. *That stench and weird fog have to go.*
3. *I don't know who is causing it.*
4. *I am not the cause myself.*
5. *I do not know what I can do myself.*
6. *I am part of the city of Los Angeles. The agreement is that the city council provides protection and ensures order.*
7. *I consider the stench and strange fog to be a danger and a problem of public order. The city council is therefore the problem owner.*

8. *The agreement between citizens and the government stipulates that I report problems to the government.*
9. *The police are part of the government and are the point of contact in these matters.*
10. *I could alert the police and ask for help.*

This is the only problem position that I elaborate on in this article. The term has been used before, and this example is purely to give the reader an impression of this genre. This example and even more problem positions can be found in a second article about the case [72]. That article explores the genre of problem positions using the same case much deeper.

The vast majority of citizens did not pick up the phone. I have found no information about their considerations. There were, however, callers who inquired about the health risks. In my opinion, that is different from panicking and asking for help. Is it reasonable to assume that these citizens, after some contemplation and investigation, and possibly an informative phone call, were able to manage the unfamiliar situation on their own? They may have argued that the stench and the fog were worse than ever, but they had survived a similar fog in '1942' after all [17, p. 40]. And hadn't they also experienced such phenomena in even earlier years? An informative phone call can be considered consultation rather than calling for help. Citizens could also have consulted each other. Let me just assume all that, so consultation and contemplation & inventory are part of the repertoire of acutely threatening unfamiliarity.

The problem-solving chain for citizens who, based on information gathering or their own considerations, decide to park the problems and follow the developments:

Problem-solution chain 2 *acute threatening unfamiliarity → consultation or contemplation & assessment → controlled unfamiliarity → parking the unknown problem & monitoring further developments.*

Another repertoire I can imagine is apathy and flight, but I have no evidence for these two.

5.1 Escalation

The county is an existing multi-layered hierarchical organisation. A structure that I refer to in a general sense with the term 'umbrella' as earlier [70]. More precisely it concerns multiple umbrellas here. In this layered situation, the action of the callers in need of help could be further refined by the term: *escalation*.

In contrast to reports about the citizen in need calling for help, explicit reports about the escalation of the problems experienced to higher levels of government are scarce, at least in the sources I have found. There are though many reports that show that the fumes had become an issue at the top administrative levels. For example, on 27 July 1943, the Los Angeles Times wrote: "Councilman Carl Rasmussen demanded that the Health Commission make a report

on what could be done about it" [50]. But how did the problems end up on Rasmussen's plate?

Protest meetings were a platform for escalation, as the administrators could hear the citizens' grievances directly. An article from 2 October 1946 reports that the chairman of Pasadena's Chamber of Commerce had brought the matter to the attention of Governor Earl Warren and the State Health Officer at a regular board meeting [38]. I think this statement explains the administrative escalation: regular meetings and escalation on that occasion. It is also likely that newspapers were not informed of every meeting, and regular meetings are not considered exciting. That could explain why I did not find any reports about them in my sources. I expect then that deviations did receive attention.

The case of the butadiene factory seems to prove this. It was identified as an important source in the late summer of 1943. Expectations were high: was this factory the big culprit? Intervening in the production process was not possible under local jurisdiction because the factory was being used for the national war effort. The federal government thus became involved. The newspaper followed the escalation process closely in this case.

Based on my assumptions about the regular meetings, I assume that escalation very often played a role in the involvement of all levels of government. So, from police to administration, from administration to county and from county to state (here California) and federal state (Washington D.C.). And in this case, these escalations always led to responsibility being taken.

Is escalation as simple as 'passing the buck'? Suppose a citizen escalates a problem p to the police. I want to keep open the possibility that this citizen is manipulating the wording of p. That is why it seems better to assume that a variant was being communicated, which I will refer to as the *escalated problem*. Furthermore, the police will have first rephrased the escalated problem into their own words, and second, picked out the aspects relevant to act upon for them. I call the rephrased escalated problem the *interpreted problem* and what the police believe is their problem in this context as the *re-situated problem*. It appears even more complicated when we realise that more citizens called, and that 'the police' is an aggregation. A citizen who called was spoken to by an operator, then perhaps by another officer. A little later, the problems were perhaps discussed at a meeting. The corps formed an opinion, a problem position. But it was emergent and different for each officer. In the case of the butadiene factory, one could infer that the problem escalated from a complaining caller to five subsequent organisational layers: first to the police, then to local government, then to the county, then to the state, then to the federal government. This undeniably created a range of derivative problems. This proliferation was further reinforced by parallel escalation movements, for example via Chambers of Commerce. Moreover, the civil servants also experienced the air pollution themselves and finally there was also interference: the new problem collided or competed with ongoing issues.

The above raises questions. For example, one may wonder if a problem can mutate during or because of escalation. Could an acute and threatening problem transform as it rises into a great opportunity? Albert Stewart seized the

problems for his re-election [38]. That could be an example. What happens if a party somewhere in the chain declares an 'escalated problem' inadmissible? Delegating is the reverse movement, which is briefly discussed below in Section 9.1. Another question concerns complexity growth as escalation which hints at a combinatorial explosion. I will set aside such questions for now.

6 Governments in search of answers

In 1943 and 1944, many local governments in the county became aware of the problems caused by air pollution. They can be roughly divided into two groups. There were governments that took action, albeit often hesitantly and with some reluctance. There were also governments that initially looked the other way. The latter were reminded of their responsibility by other authorities and that laid the foundation for an administrative impasse that was broken by Assembly Bill No. 1 in 1947.

The authorities in the first group, e.g., Los Angeles City and Pasadena, took responsibility. I believe that the position of these authorities was initially characterised by *isolated undesirability*; yet another new problem type. The undesirability here was: watery eyes and painful airways, stench and poor visibility, the loss of the "blue skies". The general hypothesis that I assume comes along with the problem type is: 'this is a local and isolated problem, this is an incident'. Instantiated this gives: 'the air pollution comes from a few large sources, if we tackle those, the problem will be solved'.

The police were sent out, the attorney was given more powers. The health services were considering whether the burning lungs would heal quickly and whether permanent health damage could occur. If it was no more than a nuisance, they had time. If not, certain factories would have to be temporarily shut down. The public was kept informed of the progress. For now, I sum up the repertoire with: seeking causes, assessing severity and prioritising accordingly, and keeping the public informed of the energetic approach.

However, it turned out that it was impossible to find those few major sources. The inspectors found plenty of smoking and smelly factories and the authorities often thought they had caught the culprits. But, for example, tackling the butadiene factory made no difference at all. The approach used in the past — find the source, intervene, done — had been exhausted.

The search for sources had highlighted a new problem: fragmented authority of governments and a lack of cooperation. A typical example is that government inspectors of A had no authority to investigate an alleged source that fell under government B. Inspectors also had limited access to factory premises. Access could simply be refused. Mutual recriminations were the result. The only legislation with county-wide clout – health legislation – ran aground on the very complex and time-consuming burden of proof of conclusive health damage. Proving this would take years, and the people involved felt they did not have that kind of time. These insights changed the problem type to *interference*, also

a new type, and the subproblem of *discord* became the prioritised problem. I summarise the problem-solution chain as follows:

Problem-solution chain 3 *acute threatening unfamiliarity → contemplation & assessment → controlled unfamiliarity → contemplation & assessment → isolated undesirability → failed interventions → interference → follow-up problems, including discord*

The lack of cooperation, or more specifically the discord, brings me to the second group. The authorities in the second group tried to duck and dodge the problems. I would characterise their problem as the aforementioned controlled unfamiliarity. Their repertoire appears to include making excuses and not responding to questions from neighbours, but I guess I can categorise this behaviour under the aforementioned 'parking'. Ultimately, with their noses pressed against the facts by the neighbours, they could no longer avoid the problems.

6.1 Interference

I had previously identified interference as a phenomenon [70], but it was not recognised as an independent problem type, but I do so here.

Interference is meddling. In interference two or more problem propagations cross each other's paths. The repertoire in interference is rearrangement of hypotheses, priorities and relationships between old and new issues. After rearrangement, a known or a new problem may have become primary. Interference is an interesting phenomenon because the problem of a party becomes a subproblem of a larger system in which parties and problems previously unknown to this party appear.

There are more instances of interference in the case. For instance, the Los Angeles City board did not want to seek Pittsburgh's help because that would expose its lack of understanding (details are in [72]). Similar is the proposal, brought with much fanfare, by a member of the Los Angeles City Council to set up a department to come up with a report in 90 days. In this way, they hoped to buy time and disguise their own lack of direction [52]. A third example played out a decade later. The Los Angeles county government was arguably serious and sincere about smog control in the 1950s. But, the public saw no change for the better. A bad press and demonstrations came up as a problem in the critical path of smog-fighters. In 1954, this problem became so important that it led to the fall of the then smog chief Gordon Larson. Interference is very common it seems.

It remains to be seen whether interference as a type is so common that it offers no distinguishing characteristics. Perhaps it is practical to divide interference into a number of subtypes. Interference between existing structures, activities and expectations could then be called *direct interference*. The case of Gordon Larson's fall could then be called *auto-interference* because public information was part of the APCD's duties and, in retrospect, had not received

enough attention, which led to misunderstanding and discontent. Misconceptions about new terminology also fall under this, see the example about *interstate stream* in Section 9.3. A potential third subtype, *controlled interference*, is discussed in Section 7.1.

7 Unification within the county

By the end of 1944, the county knew which direction it should take: uniform legislation and centralised control by the county [54]. I use the term *problem scene* to refer to a relatively long fragment of history that is characterised by a certain problem.

In the problem scene of 1944-1947, the primary problem was still 'society is suffering severely from air pollution', the instrumental problem had changed from 'we don't know what is going on' to 'we don't know exactly what is going on, we have a plan for cooperation and a systematic approach'. But not all the necessary parties wanted to cooperate. That was the prioritised problem on the problem front for the county council. I refer to it as *discord*.

Discord is a type of problem characterised by a situation in which two or more parties: 1. have shared interests and an ongoing partnership; 2. are faced with new interrelated problems in which one party, objectively speaking, is sometimes a victim and sometimes a cause; 3. experience and deal with these problems differently; 4. have a conflict about responsibilities and who should do what. This definition is a refinement of the one in [70, p. 6].

The county government first attempted to cooperate with local authorities by means of a model ordinance that they were free to accept or reject. This proved to be a dead end in early 1946. Some argued that such legislation should be imposed by the State of California. I would classify such legislation as a type of solution: the adaptation of an existing umbrella, in this case the county, by a higher order umbrella, in this case the state. It was the route that was ultimately followed. In the event of discord, as a subproblem of a primary problem, the repertoire thus included standardisation on a voluntary basis in a consultative structure, and standardisation imposed from outside (a response to escalation).

Other arguments were also presented, particularly by the parties that had previously looked the other way. In their arguments, the previous excuses echo. I believe that six groups of solutions can be distinguished. First, no structural or behavioural change by dismissing or denying the problem (cities such as Vernon and Santa Clarita). Secondly, no structural or behavioural change, but recognising the problem. Several positions came along with it. Accepting the problem as an unavoidable consequence of prosperity and economic growth. Or, fighting the problem with voluntary and self-determined improvements (Los Angeles Chamber of Commerce). Or, hoping for a quick technical solution (butadiene factory). Thirdly, recognising the problem but postponing the choices about structural or behavioural change. This includes advocating for more research (Colonel Charles Ketterman). Or, intensifying the effort with existing resources from the police and judiciary. Or, postponement by making the problem subor-

dinate to another current issue, in this case the war effort (councilman Holland). Fourthly, breaking up the existing partnership. It is true that only after the introduction of Assembly Bill No. 1, Whittier threatened to defect to Orange County. But I don't think that detracts from this solution as a type. Residents who were threatening to move also set an example. Fifth, questioning basic assumptions of society, you could call this backtracking. Councilman Holland wondered if Los Angeles should be a city for heavy industry. Sixth, recognising the problem and arriving at bilateral structural or behavioural change.

The forces that argued in favour of Assembly Bill No. 1 won. In this case, the standardisation involved an expansion of an existing umbrella, after all, the county already existed as an umbrella. I could summarise the problem propagation with the following problem-solution chain:

Problem-solution chain 4 *discord → voluntary standardisation via a model bylaw → discord → standardisation imposed after public consultation → follow-up problems*

The imposed standardisation was successful in the sense that a systematic approach was initiated, and it was effective in the sense that it led to real insights and proven methods for improvement. However, a somewhat noticeable improvement in air quality for the public was not achieved more than ten years later because society and economic activity grew and with it the number of sources, even though they were perhaps less polluting than in previous years.

I believe that discord, the solutions to it and the emotions and visions involved form a familiar pattern. One indication of this is that the risks of the model ordinance approach in Los Angeles were known. We can deduce this from what Ainsworth wrote: "St. Louis tried "education" and "co-operation" for about 15 years without any appreciable results; then it clamped down seriously and produced a remarkable improvement in very short order" [3]. Moreover, Dewey, Krier and Ursin all discuss similar patterns in which an attempt at voluntary action precedes regulation [17, p. 15 ff.], [28].

Model regulations are, I believe, comparable to the covenants that the Dutch government has entered into with companies and industries, either itself or within a European framework, over the past decades. Some of these covenants were a success, others failed or were changed. One example is the agreement with the Dutch packaging industry. The government's goal has long been to reduce packaging waste and increase material recycling. The Dutch government loosened the reins under specific conditions in an agreement for the years 2013-2022 (*Raamovereenkomst 2013-2022*). Among other things, this included the abolition of deposits on PET bottles. In 2022, after disappointing results, it tightened the reins, including the reintroduction of deposits and now on many more beverage containers [26, 35].

7.1 Controlled interference

What type of problem characterised the problems after the discord had been settled? The realisation had dawned that smog was not an isolated undesir-

ability. The interference came about from the interaction of various autogenic processes. Various activities in society were getting in each other's way, but at the same time people did not want to let go of them. It was a case of trying to have your cake and eat it. I would like to reserve the term interference for problems that crop up unexpectedly, or are temporary. In the smog case at hand the problems linger on. The term 'chronic problem' by the American thinker Edward Tenner seems useful, but I think it is better suited as a name for a broad category of problem types [45]. For the time being, I will use the type *controlled interference*.

As mentioned, a lot of work was done to combat smog and a lot was achieved, but it was not enough. That is the hallmark of chronic problems, in this case controlled interference.

I see the emergence of the Anti-Smog Action Committee (Section 4.5) as a *figure* in this context. I use the term figure for a pattern that I think I recognise without trying to explore it further. The figure is that many citizens did not see that the APCD, led by Gordon Larson, was doing good work, making progress and was acting in good faith. These citizens also did not see the delicate situation of interference, let alone their own role in it. The citizens were whipped up into a protest and Larson was sacrificed by the county council.

8 Unification at supra-county level

In the section above, I discussed the standardisation of air pollution control legislation in cities and regions within Los Angeles County. The case involves more processes that led to the creation of umbrellas. For instance, the cooperation between counties in the fight against air pollution. I will discuss two of these cases. Here, the similarity with the standardisation of cities and regions within Los Angeles County is striking. This similarity forms the basis for the discussion of the invariance property of some solutions.

8.1 Supra-county level

The history about the San Francisco Bay Area bears strong similarities to the previously discussed positions from Los Angeles county. In 1950, San Francisco Mayor Robinson grumbled about the unwillingness of neighbouring counties to cooperate: "What good would it do for San Francisco to watch over its own industry while winds blow pollution over the city from the East Bay". Some stakeholders, for example a Chamber of Commerce, argued for a voluntary programme. Sounds familiar, doesn't it?

There seems to be a difference though. The discussion around San Francisco Bay played out at the *county* level. In contrast, in the 1943-1947 issues that played in Los Angeles County, the scene was characterised by disagreements between smaller units like cities and regions within the county. Aggregation Dynamics abstracts from this scale difference to arrive at a pattern. What one sees after abstraction is: parties dependent on each other arguing over a common

problem. In my view, both pieces of history nicely illustrate the context- and scale-free nature of problem types and repertoire, in this case discord answered by unification.

However, there is another subtle difference, but in my view, aggregation-dynamically, it is also not essential. The group of nine counties around San Francisco Bay formed a new umbrella. When Los Angeles county became a county on air pollution control, the county organisation was already there, it was just extended with new powers. Based on this, I expand the repertoire in case of disagreement and then it includes both solutions: strengthening an existing umbrella, and formation of a new umbrella.

As mentioned, Robinson grumbled at Assembly Bill No. 1 and classified it as "worthless". That this bill did not provide for county clusters he thought was a mistake. I want to dwell on that characterisation because I think I see an aggregation dynamic phenomenon in it. I see a figure in it. In "worthless" echoes a position that I want to paraphrase as 'those blockheads who formulated Assembly Bill No. 1 in 1947 could surely have figured out that you want to make agreements between counties too?' No doubt the reader will recognise this way of reacting, and will also have been described somewhere, but as yet I don't know where. One might call it *situation retro extension*: it is thought that the present situation and the experiences and insights with it were also valid and evident in the past. The phenomenon may be akin to the shifting baseline [40]. But a closer look here takes us too far.

The neighbouring counties of Los Angeles also formed a larger district in 1976, the South Coast Air Quality Management District. This formation is comparable to the one around the San Francisco Bay in 1955, so it took place about 20 years later, but that is not so relevant in terms of Aggregation Dynamics. The argument for creating this umbrella of counties was similar to previous umbrella organisations.

8.2 Invariance

The notion of invariance was introduced in [70] and briefly illustrated there. It can be explored more broadly with the extensive case description in this article.

The South Coast Air Quality Management District is, I believe, a strong example of what I see as a characteristic of discord and unification: invariance. Invariance means that a solution creates conditions for its own reapplication. The cities in Los Angeles County were in a situation of discord. They formed an umbrella to transcend that discord. This suddenly made them different from their neighbours in the region, in terms of their attitude and approach to a particular issue, but also in terms of their massiveness. The internal issues shifted to similar issues but now on the outskirts of the county. The peripheral parties mobilised and also formed county districts. Then conflicts arose between the counties. The counties transcended this by forming an umbrella organisation at county level. This pattern was already visible in the formation of several of the discussed umbrellas, but here it is probably a clear case because it concerns the same 'building blocks'.

I believe that the cluster formation on the state, federal and international level is comparable to the cases described above, in which standardisation creates the conditions for its own reapplication.

9 Some leads for follow-up studies

The case as described in Section 4 and in more detail in the counterpart of this article offers leads for follow-up studies [72]. Some of these are briefly discussed below.

9.1 Delegation

Above, I mentioned several times how problems bubble up from society to higher levels of government. I called this escalation. From these levels of government, a reverse movement also takes place: the delegation of the handling of problems to subordinate parts. For example, the attorney was sent out with broader powers.

I believe that here, too, as with escalation, there is no simple delegation. A board with a problem p delegates a variant that I call the *delegated problem*. The receiving party has its own interpretation of this through the *interpreted problem* and distils its problem from this, the *re-situated problem*. Organisational units that get stuck on their re-situated problem can (partially) escalate that again as a problem. There are several examples of this in the case. For example, the model ordinance rebounded.

An interesting phenomenon is that delegation can lead to new substructures, a subordination of a new umbrella organisation that then had to take on a delegated task. The example here is, of course, McCabe's APCD. Other examples are the investigative committees and the departments within the City and County Health Departments that preceded the APCD and were absorbed by it. This an interesting aggregation-dynamic in itself.

9.2 Action groups, committees, departments and commissions

In addition to established governments and government services, other organisations also play a role in the case. I believe I can distinguish the following categories: 1. advisory committees such as the Los Angeles County Smoke and Fumes Commission; 2. lobby groups from an establishment such as The Times Smog Advisory Committee and the Southern California Air Pollution Foundation; 3. grass roots action groups from the citizenry such as the Anti-smog Action Committee and Stamp Out Smog; 4. existing interest groups such as various Chambers of Commerce; 5. new government institutions such as the Los Angeles APCD and CARB. The classification has no deeper meaning as yet, it provides an overview and thus illustrates the point that a lot of aggregation took place.

The organisations mentioned can also be classified as umbrellas. They have a board and members and so on. However, their history of origin varies. So the umbrella as a structure can be a solution in different ways. For example, dissatisfaction with government policy will have played a role in the Stamp Out Smog action group, and not disagreement between the founders. I will briefly discuss two examples in more detail to get started on a study of umbrellas in general. The general question about the origin of organisational structures, and the possible recursive patterns therein, goes too far.

The Los Angeles County Smoke and Fumes Commission brought together representatives from different sectors of society, such as industry, government and science. There are several things I find interesting about it. Firstly, the structure. The commission has links to groups in society such as industry, government and science, and in a sense is above them, and the commission channels information flows between the government and these groups. But the commission does not manage the groups. Furthermore, the commission itself is relatively flat, there is no significant staff. Secondly, the county council established the committee, which could therefore be seen as a temporary department of the county organisation, directly under the council. A problem was delegated to the committee. Thirdly, the lifespan of the committee was short, and that was the intention. This is different from a government organisation. Fourthly, the board probably wanted to buy time and hear that the air pollution was not that bad. But the committee did not say that, quite the contrary. The mudslinging between Clapp and Swartout shows that the committee members have their own problem positions and their own priorities. That is not surprising, of course. But it becomes interesting when one sees the argument as the result of a violation of some kind of tacit agreement among the committee members. The county council had let the committee down, and Clapp now felt he no longer had to keep to the agreement. An organisational structure such as a committee is then the embodiment of an agreement, an aggregation par excellence.

The APCD was the department that took the lead in the fight against air pollution for Los Angeles County in 1947. Its internal dynamics are only partially addressed in my treatment of the case, but can provide material for the search for repetition of moves on a different scale. The internal affairs rustle with power struggles, arguments, misunderstandings, confusion of general and personal interests, and corruption [24]. Papers like *Regulatory Agencies — The Challenges of Balancing Agency Autonomy and Political Control* [13] and *The Life Cycle of Regulatory Agencies: Dynamic Capture and Transaction Costs* [30] offer starting points for further research.

9.3 Water pollution

As stated above (Section 8.2), I believe that uniform movements of states and the federal government can also be seen as forms of invariance. Another form of invariance is perhaps the following. There were parallel movements on other environmental issues.

Sooner than was the case for air pollution, a federal law was passed for the control of water pollution, the Federal Water Pollution Control Act of 1948. This law also gave the federal government hardly any power. Increasing problems demanded more forceful intervention and led, as in the case of the fight against air pollution, to amendments. That led to familiar discussions. In 1955, the discussion centred on the extent to which the law gave the federal government the power to supersede the rights of the states and what the effect on industry would be [47, 48].

The first federal law on air pollution was also passed in 1955, as discussed earlier in Section 4.9. In a short article reporting on a proposal to that effect, I find the clause 'modeled after the present water pollution law' [7]. This again points to a parallel between the two legislative processes. In 1972, a major step was taken with a new law: the Clean Water Act. It would be interesting to look for similar processes within EU legislation.

Another interesting aspect popped up in the water pollution debate. Allen E. Mather stumbled over the interpretation of the term 'interstate stream'. Mather thought it referred to waterways that crossed a boundary between a state and a neighbouring state. But then he realised that it applied to any stream that flowed into the ocean. I suspect that unification often leads to new or abstract terms that cause confusion. Moreover, I suspect it may lead to segregation between people who know a term and how to use it, and people who don't.

10 Conclusion

Aggregation Dynamics is a total systems theory modelled after ecology. Aggregates replace organisms. Aggregations extend organisms into the domain of the inorganic and into the virtual. See the Introduction and Section 2 for more on it.

One assumption of aggregation dynamics is that living structures have a recursive structure. Each level at which a researcher breaks into these structures can lead to insights into both the larger and the smaller. The human situation is such a level. If we look at the human situation, problems and solutions appear to be central notions to study in order to understand the interactions between humans and the aggregates they assume they deal with. Problems and solutions then are the typical focus point in human-level case explorations.

The case used, the smog abatement in Los Angeles County between 1943 and 1976 was discussed very briefly in an earlier article to illustrate the problem types of discord and proliferation. In the present article and a supplementary article, I elaborate on aspects I left out earlier. In the present article, the focus is on problem types: discord is worked out in more detail and several other types are suggested and explored. In the other article, I work out a number of problem positions [72]. Below I summarise the problem types that were discussed.

Section 5 *Unfamiliarity* deals with situations in which a party experiences a problem but does not know how to deal with it. *Acute threatening unfamiliarity* occurs in a panic situation. The established repertoire is *calling for help* and

contemplation & assessment. Both lead to a new type: *controlled unfamiliarity*. The problem is not gone and still not understood, but it is manageable and can be lived with. This new type's repertoire includes *parking*, but also *contemplation & assessment*.

Section 6 *Governments in search of answers* deals with the process of becoming aware of the air pollution problem. At first, air pollution was seen as a local incident. I characterise that as *isolated undesirability*. The repertoire is to investigate, find the cause and remove it. But the attempts to solve it failed. The problem turned out to be much more complicated. The type of problem changed to *interference*. The repertoire for interference is to rearrange hypotheses, priorities and relationships between the issues at stake. After rearrangement, a different or new problem may have become the most important.

Section 7 *Uniformity within the county* examines how uniformity can overcome discord. But this solution did not come for free. Other routes were proposed and to some extend tried out. By further elaborating the case study, the repertoire has been considerably expanded.

However, with the discord out of the way, the interference remained. People wanted to have their cake and eat it. The interference became chronic. I think that calls for a different type: *controlled interference*. It might be wise to refine the notion of interference even further. Interference between structures, activities and expectations that were already propagating in parallel would then be called *direct interference*. The term *auto-interference* might be useful if, during a solution process, different lines of activity are initiated that are initially seen as independent, but that later come into conflict.

What has also been mapped is how the solution of uniformity repeatedly returns in history. I identify this as a characteristic of the solution and refer to it as *invariance*. By this I mean that the solution creates the conditions for its reapplication. Only conditions, the future remains unpredictable. I elaborate on two examples: the clustering of counties around San Francisco Bay in 1955 and around Los Angeles County in 1976.

As the argument progressed, I identified two *figures*. I use the term figure to refer to a pattern that I think I recognise without attempting to explore it further. Mayor Robinson grumbled about Assembly Bill No. 1 of 1947 in 1950 and classified it as 'worthless'. It is always easy to talk in hindsight. I introduced the term *situation retro extension* for this. The second figure shows the course of events surrounding Gordon Larson's resignation: the public complains unjustly, politicians want to appear forceful and shift the blame to the wrong person.

The article introduces a number of new terms. I argue that the escalation and delegation of problems in a hierarchical organisation will be accompanied by differences in interpretation, deliberate omissions and selection. This calls for additional terms to distinguish between variants of problems. This results in: the *escalated problem*, the *interpreted problem* and the *re-situated problem*. I believe something similar happens with delegation. Here it makes sense to talk about the *delegated problem*, and again for the same reasons as before, an interpreted and a re-situated problem.

Problems rarely come alone. Some expressions are well understood, but I think it would be useful to explicitly introduce the following: *primary problem*; *subproblem*; *secondary problem*, *tertiary problem* and so on; *instrumental problem*; *priority problem*. I use the term *problem scene* to refer to a relatively long section of a history that is characterised by a certain problem. For instance, the problem scene was characterised by discord for at least a year.

Finally, Section 9 discusses a few aspects of the case that I consider relevant for follow-up studies.

What use are case studies and the laborious search for problem types and their repertoire? It is the footwork for searching for answers to deeper questions. What does the activity of people mean in the big picture? How complex can societies become? When does a complex aggregation become unstable? What patterns emerge from the constant solving of the same problem types? Ultimately, I am interested in finding an answer to these questions.

My hope is an aggregation-dynamic style of viewing can contribute to a thoughtful and sensible style of operation in the human attempt to shape the future. Of a particular concern to me are: climate change, the loss of biodiversity, and lack of reflection with the application of new technology.

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A Discussion of sources and related work

A.1 Sources

The sources are the newspaper archive www.newspapers.com, various books, documents on archive.org, www.sciencehistory.org, and websites of organisations, or their successors, that played a role in the case history, such as the California Air Resources Board. (Note that the website archive.org is blocked in the UK and may be blocked in other jurisdictions.) The newspaper archive is very extensive and has a good search engine. In addition to major titles such as *The Los Angeles Times*, it also includes small and local newspapers. Two books deserve special attention.

Smogtown: The Lung-Burning History of Pollution in Los Angeles by Chip Jacobs and William J. Kelly covers the period from the mid-1940s to the first years of the current millennium. The story details the issues that played out in Los Angeles County and follows the protagonists closely. Step by step, it zooms in on the fight with the car manufacturers in Detroit, the State of California and the Federal government. It also shows how the issue has broadened from air pollution to air quality and climate change [24]. It is a detailed, tasty and exciting story about the fight against air pollution. What struck me in this book was the process of discord that was resolved through unification; the authors do not draw attention to this though.

Don't Breathe the Air: Air Pollution and U.S. Environmental Politics, 1945-1970 by S.H. Dewey covers a shorter period and describes the fight against air

pollution in three regions: Los Angeles City, New York City and central Florida [17]. The book is a chronicle, like the previously discussed work. This author does notice the unification, which I will return to below.

A.2 Problems

The American philosopher and pioneer in the field of operations research, Russell L. Ackoff, said that problems are "abstract subjective constructs" [1]. In relation to solutions, he stated that "Problems are conceptual constructs abstracted from complex situations that are systems of problems, messes. Solutions are also abstractions. No problem is ever finally put to rest. Therefore, solutions require control: continuous maintenance and improvement" [2]. Ackoff clearly indicates that problems and solutions are abstractions from systems of problems. He then calls them messes, so these systems are confused and disordered in his opinion. I suspect that he did not mean 'system' in the technical sense of a rational and precisely designed mechanism, but in the physical sense of a collection of interacting components.

The systems theorist and later top manager N.J.T.A. Kramer wrote: "A problem is generally defined as a difference between a desired and an actual situation," referring to yet other authors [27, p. 37]. The organisational expert M.M.H. van Dijk stated that solutions are changes, made according to a rigid plan or incrementally, which eliminate this difference. Changing also includes adjusting the problem conception [18]. These three authors express well how I understand the notions of problem and solution.

Kramer also defines a notion of a problem situation as the combination of a problem holder, a problem solver and an environment [27, p. 49]. However, that corresponds more closely to my notion of problem position.

A.3 Problem types

Dewey observed similarities between the way parties united in the fight against air pollution in three regions: the states of California and Florida and the city of New York. He wrote: "Early in the fight against air pollution, activists recognised the need for intergovernmental solutions. Because air was mobile, no single jurisdiction could address problems alone" [17, p. 13]. *Recurring cycles* is the telling title of a chapter that deals with the history of the fight against air pollution in the period before 1945. One example of a pattern is that regulation is often preceded by an attempt at voluntary control. However, these kinds of patterns are not Dewey's focus. The common thread in the book is the emergence of the environmental movement in relation to federal environmental policy.

The case essay *Pollution and Policy* by James Krier and Edmund Ursin has the same scope as my argument in terms of government organisations, regions and period [28]. However, it elaborates on the history in much more detail. It differs from the previous works in that the authors attempt to determine the characteristics of air pollution as a problem and the characteristics of the

behaviour of the parties involved. In the introduction, the authors discuss six phenomena that resemble my observations. For example, they write: "Intervention tended to consist in curative rather than preventive measures, and was designed to preserve so far as possible the prevailing social patterns – whether of business practice, citizen behavior, or the distribution of authority among local, state, and federal governments." and "(...) the fixations of pollution policy on technological solutions imposed through the direct, quick, but also generally crude means of regulation." I believe these statements have lost none of their relevance.

The authors mentioned thus see patterns that I also notice, but I go a step further in isolating and abstracting them and giving them a model-based meaning.

A.4 Cooperation

In the case study, I repeatedly describe how parties arrive at forms of cooperation. Examples of this are: citizens forming protest groups, cities and rural areas submitting to new county legislation and management, counties themselves clustering in the field of air pollution control. This process of autonomy and/or division towards a form of unity has received attention in various disciplines, for example in biology, management theory and legal sciences. The treatment varies from general considerations to specific problem situations to agent-based simulations and the focus is either on the formation of collectives themselves or related aspects such as consultation [29], trust [73], (international) law [15], decision-making [8], positioning [11], negotiating [22], volunteer organisations [77]. An overview of case studies is provided by [21]. All this work provides leads to refine my discussion. For example, in *The paradox of collective action: Linking interest aggregation and interest articulation in EU legislative lobbying*, claims about the differences between problems faced by protest groups and groups pursuing business interests are investigated [16]. It goes back to Mancur Olson's work on *Collective action theory* [36, 37]. At the time of writing I have the impression that the standardisation processes as I describe them, in a process-based manner, have not been documented or commented on, except by Dewey.

With regard to invariance, an interesting case study is *Multilevel Organisational Adaptation: Scale Invariance in the Scottish Healthcare System* [14]. It studies the change of the entire national healthcare system in Scotland, starting in 2004. It concerned a multi-layered organisation. "At each level, three coupled feedback loops determine how local agents modify their cognitive representations to include uncovered interdependencies and synchronise their adaptive search across organisational boundaries: a 'boundary work loop', a 'small wins' loop, and a 'parochialism' loop. Our results also point to the scale-dependency of the strength of dissipative processes across levels." I also recognise this type of scale phenomenon, albeit in a different way. The 'cognitive representation' clearly is kin to my aggregation. The article also provides methodological leads for follow-up work.

I use the word ‘umbrella as a general term for forms of cooperation such as a protest group, a committee, or an extension of a county organisation. As far as I can see, there is literature on umbrellas in the narrower sense [78, 19]. What I have not come across is the formation of an umbrella as an abstract process, and vice versa, how clusters can partition internally, or disintegrate. Perhaps the collection-theoretical modelling in [20] could be useful for further work here.