**We Need a New Freight Plan**

# Much of the freight carried in and out of Melbourne and throughout Victoria generally was once carried by rail. Most freight traffic today is transported by road, despite the fact that rail is potentially far more efficient from an energy perspective and generates significantly fewer greenhouse emissions per TKm. Estimated reductions vary considerably but according to some researchers can be up to 16 times less than road freight per tonne Km travelled (VAGO Effectiveness of Rail Freight Support Programs Tabled: 27 June 2023).

The attached submission by Rail Futures Institute (RFI) to review the national rail and supply chain strategy provides a number of recommendations to address this challenge. Whilst recommendations proposed in the RFI submission do not include a financial analysis/ business case it is likely that the return on investment for rail upgrade projects would be high and carried out relatively quickly in a way that provides a quick return on investment. On this basis, investment risks based on a business as usual scenario are likely to be low, however the question that must be asked is whether these measures will be sufficient on their own to arrest the continuing decline of freight on rail, a trend that started many decades ago – not only in Victoria but throughout much of the world and continues today.

Freight is service industry where service needs such as convenience, reliability, marketing and other customer service issues as well as cost are critical. Whilst much of the infrastructure required to support rail freight has been severely neglected, ie poorly maintained and in urgent need of upgrading or renewal, there are many factors which have contributed to the decline in rail freight.

Institutional and political factors are also important. The current system has been given favoured treatment by government for many years putting rail freight at a significant disadvantage. This is reflected in rules, regulations and operating practices, procedures, standards and so on. These must be reviewed and redesigned or replaced in a way that promotes rail as the favoured freight carrier.

The system also includes subsidies and economic concessions, many of which are described as “externalities” - costs which road freight avoids paying or contributes very little but must pay to enable rail to compete on an equal footing. These include

* Impact on road safety, road trauma
* Cost of road and other supporting infrastructure including road maintenance
* Air/noise/water pollution etc and health/amenity impacts
* Nature and landscape impacts
* Upstream and downstream impacts
* Traffic congestion.

All of these issues must be addressed if rail freight potential is to be achieved but the problems are systemic, so resolving them requires a systems based approach in which there will be no simple single fix solutions.

It is argued this requires a review of the freight industry as a system, unpack it and identify levers that can be used to change the system in a way that increases rail’s modal share. There are many leavers that can be used for this purpose with varying degrees of effectiveness. It is argued the most powerful lever that can be used for this purpose is the mindset or paradigm out of which the system is designed and operates. From this come system goals, information flows, feedback loops, stocks, flows and everything else that drives the system.

The starting point must therefore be a change in government mindset, a mindset that must mandate rail freight as top priority and a key element in its emission reduction program supported by goals, power structure, culture, rules (incentives, punishments, constraints), information flow, feedback loops, subsidies, taxes, standards and so on. This must be reflected in government policies and requires a freight plan with implementation strategies to make it happen.

Fortunately there are indications the government mindset may be changing. The latest State government announcement **10th Oct 2023 of *“****A record-breaking trial run for the longest intermodal freight train will pave the way for regular, more efficient services between Merbein and the Port of Melbourne”* **Quoting Minister for Ports and Freight Melissa Horne**“We’re laying the groundwork now for this and other services to grow as part of our long-term strategy and commitment to move more freight by rail and reduce the number of trucks on roads.’’

This is a promising start but it is only the beginning and far more fundamental and far-reaching changes are required. There is growing pressure for all modes of travel and transport, including rail to rapidly reduce greenhouse emissions. This reinforces the need for a freight plan for the industry as a whole for the immediate, short and longer term. It must also be a plan that anticipates a rapidly changing world and future scenarios that have been discussed in an earlier blog and must be planned for.

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Background Notes etc

1. *. The goals of the system*

*Clearly defined goals and measurable targets are essential with a plan to achieve them. This must be documented in a Freight plan which includes all freight, and government commitment to fund it. The State government does not have a transport plan, nor does it have one for the freight sector within it.*

1. *The distribution of power over the rules of the system.*
2. *The rules of the system (incentives, punishments, constraints)*
3. *Information flows*
4. *Material flows and nodes of material intersection*
5. *Driving positive feedback loops*
6. *Regulating negative feedback loops*
7. *Constants, parameters, numbers (subsidies, taxes, standards).*

# As noted in the attached submission by Rail Futures to review the national rail freight and supply chain strategy September 2023 *“Rail is ideal for transporting bulk commodities and containerised cargoes, especially between regional terminals and ports. Less than 20 freight trains, each of 50 wagons, can fill a 50,000 tonne grain ship compared with at least 1,000 trucks. Freight trains save fuel, reduce road damage, emissions and road crashes. They also reduce residential amenity impacts, public health and other environmental effects. Increased use of rail freight as the freight task grows has significant economic benefits. Most trucking organisations also support greater use of rail. “The freight task is going to grow and we won’t have enough trucks to carry it. We need rail and we need the rail network to develop”. (Peter Anderson, CEO Victorian Transport Association,13 May 2015).”*

Despite opportunities for substantial savings in many areas trucks are still the most common mode of freight transportation, not just in Australia but globally. For example, trucking composes 77% of all freight transportation in Europe while rail only accounts for 8%.

Whilst much of the rail freight infrastructure required to support it has been severely neglected, ie poorly maintained and in need of upgrading or renewal, there are many factors which have contributed to this trend. Some of these are addressed in VAGO and RFI reports but most focus on the problem from an operations and efficiency perspective overlooking the fact that freight is service industry where service needs such as convenience, reliability, marketing and other customer service issues as well as cost are critical. These reports also overlook the extent to which road freight has been given favoured treatment by governments for many years to such an extent that it has put rail freight at a significant disadvantage. All of these issues must be addressed but the problems are systemic, so resolving them requires a systems based approach in which there will be no simple single fix solutions.

It is argued that this requires a review of the freight industry, to unpack the system and identify levers that can be used to change the system to increase the modal share from road to rail. It is suggested that some of the levers that could be used are as follows. It is proposed that these could include the following, listed in order of effectiveness.

1. The mindset or paradigm out of which the system.

Paradigms are the sources of systems. From them, from shared social agreements about the nature of reality, come system goals and information flows, feedbacks, stocks, flows and everything else about systems. The starting point must be a government mindset that rail freight must be the given top priority and that everything will done to ensure this happens ie goals, power structure, rules, culture and so on. This must be reflected in government policies. The current mindset which continues to favour road freight must change - there will be little change unless this happens

But there’s nothing physical or expensive or even slow in the process of paradigm change. In a single individual it can happen in a millisecond. All it takes is a click in the mind, a falling of scales from eyes, a new way of seeing. Whole societies are another matter — they resist challenges to their paradigm harder than they resist anything else.

So how do you change paradigms? Thomas Kuhn, who wrote the seminal book about the great paradigm shifts of science,[7](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#seven) has a lot to say about that. In a nutshell, you keep pointing at the anomalies and failures in the old paradigm, you keep coming yourself, and loudly and with assurance from the new one, you insert people with the new paradigm in places of public visibility and power. You don’t waste time with reactionaries; rather you work with active change agents and with the vast middle ground of people who are open-minded.

Systems folks would say you change paradigms by modeling a system, which takes you outside the system and forces you to see it whole. We say that because our own paradigms have been changed that way.

1. The goals of the system

Clearly defined goals and measurable targets are essential with a plan to achieve them. This must be documented in a Freight plan which includes all freight, and government commitment to fund it. The State government does not have a transport plan, nor does it have one for the freight sector within it.

1. The distribution of power over the rules of the system.
2. The rules of the system (incentives, punishments, constraints)
3. Information flows
4. Material flows and nodes of material intersection
5. Driving positive feedback loops
6. Regulating negative feedback loops
7. Constants, parameters, numbers (subsidies, taxes, standards).

Note

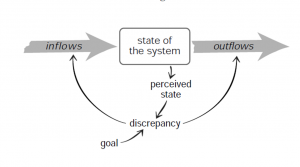
Freight Transport is a service industry, and industry where door to door service is critical for many freight deliveries – most of which are remote from a rail line which makes rail uncompetitive for most freight deliveries and this will continue. The challenge is to recapture freight which is ideally suited to rail, where rail should be competitive.

### PLACES TO INTERVENE IN A SYSTEM

(in increasing order of effectiveness)

12. Constants, parameters, numbers (such as subsidies, taxes, standards).  
11. The sizes of buffers and other stabilizing stocks, relative to their flows.  
10. The structure of material stocks and flows (such as transport networks, population age structures).  
9. The lengths of delays, relative to the rate of system change.  
8. The strength of negative feedback loops, relative to the impacts they are trying to correct against.  
7. The gain around driving positive feedback loops.  
6. The structure of information flows (who does and does not have access to information).  
5. The rules of the system (such as incentives, punishments, constraints).  
4. The power to add, change, evolve, or self-organize system structure.  
3. The goals of the system.  
2. The mindset or paradigm out of which the system — its goals, structure, rules, delays, parameters — arises.  
1. The power to transcend paradigms.

To explain parameters, stocks, delays, flows, feedback, and so forth, I need to start with a basic diagram.



The “state of the system” is whatever standing stock is of importance — amount of water behind the dam, amount of harvestable wood in the forest, number of people in the population, amount of money in the bank, whatever. System states are usually physical stocks, but they could be nonmaterial ones as well — self-confidence, degree of trust in public officials, perceived safety of a neighborhood.

There are usually inflows that increase the stock and outflows that decrease it. Deposits increase the money in the bank; withdrawals decrease it. River inflow and rain raise the water behind the dam; evaporation and discharge through the spillway lower it. Births and immigrations increase the population, deaths and emigrations reduce it. Political corruption decreases trust in public officials; experience of a well-functioning government increases it.

Insofar as this part of the system consists of physical stocks and flows — and they are the bedrock of any system — it obeys laws of conservation and accumulation. You can understand its dynamics readily, if you can understand a bathtub with some water in it (the state of the system) and an inflowing faucet and outflowing drain. If the inflow rate is higher than the outflow rate, the stock gradually rises. If the outflow rate is higher than the inflow, the stock gradually goes down. The sluggish response of the water level to what could be sudden twists in the input and output valves is typical — it takes time for flows to accumulate, just as it takes time for water to fill up or drain out of the tub.

The rest of the diagram is the information that causes the flows to change, which then cause the stock to change. If you’re about to take a bath, you have a desired water level in mind. You plug the drain, turn on the faucet and watch until the water rises to your chosen level (until the discrepancy between the desired and the actual state of the system is zero). Then you turn the water off.

If you start to get in the bath and discover that you’ve underestimated your volume and are about to produce an overflow, you can open the drain for awhile, until the water goes down to your desired level.

« [What Happens When You Believe the Prophets of Doom?](https://donellameadows.org/archives/what-happens-when-you-believe-the-prophets-of-doom/)

[Americans are the World’s Guinea Pigs for Bioengineered Foods](https://donellameadows.org/archives/americans-are-the-worlds-guinea-pigs-for-bioengineered-foods/) »

## Leverage Points: Places to Intervene in a System

[](https://www.facebook.com/DonellaMeadowsProject) [](https://twitter.com/Academy_Change)

### By Donella Meadows~

Folks who do systems analysis have a great belief in “leverage points.” These are places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything.

This idea is not unique to systems analysis — it’s embedded in legend. The silver bullet, the trimtab, the miracle cure, the secret passage, the magic password, the single hero who turns the tide of history. The nearly effortless way to cut through or leap over huge obstacles. We not only want to believe that there are leverage points, we want to know where they are and how to get our hands on them. Leverage points are points of power.

The systems analysis community has a lot of lore about leverage points. Those of us who were trained by the great Jay Forrester at MIT have all absorbed one of his favorite stories. “People know intuitively where leverage points are,” he says. “Time after time I’ve done an analysis of a company, and I’ve figured out a leverage point — in inventory policy, maybe, or in the relationship between sales force and productive force, or in personnel policy. Then I’ve gone to the company and discovered that there’s already a lot of attention to that point. Everyone is trying very hard to push it IN THE WRONG DIRECTION!”

The classic example of that backward intuition was my own introduction to systems analysis, the world model. Asked by the Club of Rome to show how major global problems — poverty and hunger, environmental destruction, resource depletion, urban deterioration, unemployment — are related and how they might be solved, Forrester made a computer model and came out with a clear leverage point[1](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#one): Growth. Not only population growth, but economic growth. Growth has costs as well as benefits, and we typically don’t count the costs — among which are poverty and hunger, environmental destruction, etc. — the whole list of problems we are trying to solve with growth! What is needed is much slower growth, much different kinds of growth, and in some cases no growth or negative growth.

The world’s leaders are correctly fixated on economic growth as the answer to virtually all problems, but they’re pushing with all their might in the wrong direction.

Another of Forrester’s classics was his urban dynamics study, published in 1969, which demonstrated that subsidized low-income housing is a leverage point.[2](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#two) The less of it there is, the better off the city is — even the low-income folks in the city. This model came out at a time when national policy dictated massive low-income housing projects, and Forrester was derided. Now those projects are being torn down in city after city.

Counterintuitive. That’s Forrester’s word to describe complex systems. Leverage points are not intuitive. Or if they are, we intuitively use them backward, systematically worsening whatever problems we are trying to solve.

The systems analysts I know have come up with no quick or easy formulas for finding leverage points. When we study a system, we usually learn where leverage points are. But a new system we’ve never encountered? Well, our counterintuitions aren’t that well developed. Give us a few months or years and we’ll figure it out. And we know from bitter experience that, because of counterintuitiveness, when we do discover the system’s leverage points, hardly anybody will believe us.

Very frustrating, especially for those of us who yearn not just to understand complex systems, but to make the world work better.

So one day I was sitting in a meeting about how to make the world work better — actually it was a meeting about how the new global trade regime, NAFTA and GATT and the World Trade Organization, is likely to make the world work worse. The more I listened, the more I began to simmer inside. “This is a HUGE NEW SYSTEM people are inventing!” I said to myself. “They haven’t the SLIGHTEST IDEA how this complex structure will behave,” myself said back to me. “It’s almost certainly an example of cranking the system in the wrong direction — it’s aimed at growth, growth at any price!! And the control measures these nice, liberal folks are talking about to combat it — small parameter adjustments, weak negative feedback loops — are PUNY!!!”

Suddenly, without quite knowing what was happening, I got up, marched to the flip chart, tossed over to a clean page, and wrote:

### PLACES TO INTERVENE IN A SYSTEM

(in increasing order of effectiveness)

9. Constants, parameters, numbers (subsidies, taxes, standards).  
8. Regulating negative feedback loops.  
7. Driving positive feedback loops.  
6. Material flows and nodes of material intersection.  
5. Information flows.  
4. The rules of the system (incentives, punishments, constraints).  
3. The distribution of power over the rules of the system.  
2. The goals of the system.  
1. The mindset or paradigm out of which the system — its goals, power structure, rules, its culture — arises.

Everyone in the meeting blinked in surprise, including me. “That’s brilliant!” someone breathed. “Huh?” said someone else.

I realized that I had a lot of explaining to do.

I also had a lot of thinking to do. As with most of the stuff that come to me in boil-over mode, this list was not exactly tightly reasoned. As I began to share it with others, especially systems analysts who had their own lists and activists who wanted to put the list to immediate use, questions and comments came back that caused me to rethink, add and delete items, change the order, add caveats.

In a minute I’ll go through the list I ended up with, explain the jargon, give examples and exceptions. The reason for this introduction is to place the list in a context of humility and to leave room for evolution. What bubbled up in me that day was distilled from decades of rigorous analysis of many different kinds of systems done by many smart people. But complex systems are, well, complex. It’s dangerous to generalize about them. What you are about to read is a work in progress. It’s not a recipe for finding leverage points. Rather it’s an invitation to think more broadly about system change.

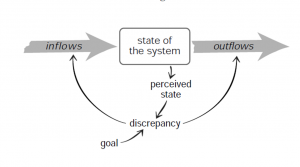
Here, in the light of a cooler dawn, is a revised list:

### PLACES TO INTERVENE IN A SYSTEM

(in increasing order of effectiveness)

12. Constants, parameters, numbers (such as subsidies, taxes, standards).  
11. The sizes of buffers and other stabilizing stocks, relative to their flows.  
10. The structure of material stocks and flows (such as transport networks, population age structures).  
9. The lengths of delays, relative to the rate of system change.  
8. The strength of negative feedback loops, relative to the impacts they are trying to correct against.  
7. The gain around driving positive feedback loops.  
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3. The goals of the system.  
2. The mindset or paradigm out of which the system — its goals, structure, rules, delays, parameters — arises.  
1. The power to transcend paradigms.

To explain parameters, stocks, delays, flows, feedback, and so forth, I need to start with a basic diagram.



The “state of the system” is whatever standing stock is of importance — amount of water behind the dam, amount of harvestable wood in the forest, number of people in the population, amount of money in the bank, whatever. System states are usually physical stocks, but they could be nonmaterial ones as well — self-confidence, degree of trust in public officials, perceived safety of a neighborhood.

There are usually inflows that increase the stock and outflows that decrease it. Deposits increase the money in the bank; withdrawals decrease it. River inflow and rain raise the water behind the dam; evaporation and discharge through the spillway lower it. Births and immigrations increase the population, deaths and emigrations reduce it. Political corruption decreases trust in public officials; experience of a well-functioning government increases it.

Insofar as this part of the system consists of physical stocks and flows — and they are the bedrock of any system — it obeys laws of conservation and accumulation. You can understand its dynamics readily, if you can understand a bathtub with some water in it (the state of the system) and an inflowing faucet and outflowing drain. If the inflow rate is higher than the outflow rate, the stock gradually rises. If the outflow rate is higher than the inflow, the stock gradually goes down. The sluggish response of the water level to what could be sudden twists in the input and output valves is typical — it takes time for flows to accumulate, just as it takes time for water to fill up or drain out of the tub.

The rest of the diagram is the information that causes the flows to change, which then cause the stock to change. If you’re about to take a bath, you have a desired water level in mind. You plug the drain, turn on the faucet and watch until the water rises to your chosen level (until the discrepancy between the desired and the actual state of the system is zero). Then you turn the water off.

If you start to get in the bath and discover that you’ve underestimated your volume and are about to produce an overflow, you can open the drain for awhile, until the water goes down to your desired level.

Those are two negative feedback loops, or correcting loops, one controlling the inflow, one controlling the outflow, either or both of which you can use to bring the water level to your goal. Notice that the goal and the feedback connections are not visible in the system. If you were an extraterrestrial trying to figure out why the tub fills and empties, it would take awhile to figure out that there’s an invisible goal and a discrepancy-measuring process going on in the head of the creature manipulating the faucets. But if you watched long enough, you could figure that out.

Very simple so far. Now let’s take into account that you have two taps, a hot and a cold, and that you’re also adjusting for another system state — temperature. Suppose the hot inflow is connected to a boiler way down in the basement, four floors below, so it doesn’t respond quickly. And you’re making faces at yourself in the mirror or distracted by studying the instructions for the [generic Viagra](https://foresthistory.org/sildenafil-citrate-buy-generic-viagra/) and not paying close attention to the water level. And, of course, the inflow pipe is connected to a reservoir somewhere, which is connected to the whole planetary hydrological cycle. The system begins to get complex, and realistic, and interesting.

Mentally change the bathtub into your checking account. Write checks, make deposits, add a faucet that keeps dribbling in a little interest and a special drain that sucks your balance even drier if it ever goes dry. Attach your account to a thousand others and let the bank create loans as a function of your combined and fluctuating deposits, link a thousand of those banks into a federal reserve system — and you begin to see how simple stocks and flows, plumbed together, make up systems way too complex to figure out.

That’s why leverage points are not intuitive. And that’s enough systems theory to proceed to the list.

### 12. Constants, parameters, numbers (subsidies, taxes, standards).

“Parameters” in systems jargon means the numbers that determine how much of a discrepancy turns which faucet how fast. Maybe the faucet turns hard, so it takes awhile to get the water flowing or to turn it off. Maybe the drain is blocked and can allow only a small flow, no matter how open it is. Maybe the faucet can deliver with the force of a fire hose. These considerations are a matter of numbers, some of which are physically locked in and unchangeable, but most of which are popular intervention points.

Consider the national debt. It’s a negative bathtub, a money hole. The rate at which it sinks is called the annual deficit. Tax income makes it rise, government expenditures make it fall. Congress and the president spend most of their time arguing about the many, many parameters that open and close tax faucets and spending drains. Since those faucets and drains are connected to us, the voters, these are politically charged parameters. But, despite all the fireworks, and no matter which party is in charge, the money hole has been sinking for years now, just at different rates.

To adjust the dirtiness of the air we breathe, the government sets parameters called ambient air quality standards. To assure some standing stock of forest (or some flow of money to logging companies) it sets allowed annual cuts. Corporations adjust parameters such as wage rates and product prices, with an eye on the level in their profit bathtub — the bottom line.

The amount of land we set aside for conservation. The minimum wage. How much we spend on AIDS research or Stealth bombers. The service charge the bank extracts from your account. All these are parameters, adjustments to faucets. So, by the way, is firing people and getting new ones, including politicians. Putting different hands on the faucets may change the rate at which the faucets turn, but if they’re the same old faucets, plumbed into the same old system, turned according to the same old information and goals and rules, the system isn’t going to change much. Electing Bill Clinton was definitely different from electing George Bush, but not all that different, given that every president is plugged into the same political system. (Changing the way money flows in that system would make much more of a difference — but I’m getting ahead of myself on this list.)

Parameters are dead last on my list of powerful interventions. Diddling with the details, arranging the deck chairs on the Titanic. Probably 90, no 95, no 99 percent of our attention goes to parameters, but there’s not a lot of leverage in them.

Not that parameters aren’t important — they can be, especially in the short term and to the individual who’s standing directly in the flow. People care deeply about parameters and fight fierce battles over them. But they RARELY CHANGE BEHAVIOR. If the system is chronically stagnant, parameter changes rarely kick-start it. If it’s wildly variable, they don’t usually stabilize it. If it’s growing out of control, they don’t brake it.

Whatever cap we put on campaign contributions, it doesn’t clean up politics. The Feds fiddling with the interest rate haven’t made business cycles go away. (We always forget that during upturns, and are shocked, shocked by the downturns.) After decades of the strictest air pollution standards in the world, Los Angeles air is less dirty, but it isn’t clean. Spending more on police doesn’t make crime go away.

Since I’m about to get into some examples where parameters ARE leverage points, let me stick in a big caveat here. Parameters become leverage points when they go into ranges that kick off one of the items higher on this list. Interest rates, for example, or birth rates, control the gains around positive feedback loops. System goals are parameters that can make big differences. Sometimes a system gets onto a chaotic edge, where the tiniest change in a number can drive it from order to what appears to be wild disorder.

These critical numbers are not nearly as common as people seem to think they are. Most systems have evolved or are designed to stay far out of critical parameter ranges. Mostly, the numbers are not worth the sweat put into them.

Here’s a story a friend sent me over the Internet to makes that point:[3](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#three)

When I became a landlord, I spent a lot of time and energy trying to figure out what would be a “fair” rent to charge.

I tried to consider all the variables, including the relative incomes of my tenants, my own income and cash flow needs, which expenses were for upkeep and which were capital expenses, the equity versus the interest portion of the mortgage payments, how much my labor on the house was worth, etc.

I got absolutely nowhere. Finally I went to someone who specializes in giving money advice. She said: “You’re acting as though there is a fine line at which the rent is fair, and at any point above that point the tenant is being screwed and at any point below that you are being screwed. In fact there is a large grey area in which both you and the tenant are getting a good, or at least a fair, deal. Stop worrying and get on with your life.”

### 11. The sizes of buffers and other stabilizing stocks, relative to their flows.

Consider a huge bathtub with slow in and outflows. Now think about a small one with very fast flows. That’s the difference between a lake and a river. You hear about catastrophic river floods much more often than catastrophic lake floods, because stocks that are big, relative to their flows, are more stable than small ones. In chemistry and other fields, a big, stabilizing stock is known as a buffer.

The stabilizing power of buffers is why you keep money in the bank rather than living from the flow of change through your pocket. It’s why stores hold inventory instead of calling for new stock just as customers carry the old stock out the door. It’s why we need to maintain more than the minimum breeding population of an endangered species. Soils in the eastern U.S. are more sensitive to acid rain than soils in the west, because they haven’t got big buffers of calcium to neutralize acid.

You can often stabilize a system by increasing the capacity of a buffer.[4](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#four) But if a buffer is too big, the system gets inflexible. It reacts too slowly. And big buffers of some sorts, such as water reservoirs or inventories, cost a lot to build or maintain. Businesses invented just-in-time inventories, because occasional vulnerability to fluctuations or screw-ups is cheaper (for them, anyway) than certain, constant inventory costs — and because small-to-vanishing inventories allow more flexible response to shifting demand.

There’s leverage, sometimes magical, in changing the size of buffers. But buffers are usually physical entities, not easy to change. The acid absorption capacity of eastern soils is not a leverage point for alleviating acid rain damage. The storage capacity of a dam is literally cast in concrete. So I haven’t put buffers very high on the list of leverage points.

### 10. The structure of material stocks and flows and nodes of intersection (such as transport networks, population age structures, flow of nitrogen through soil).

The plumbing structure, the stocks and flows and their physical arrangement, can have an enormous effect on how the system operates. When the Hungarian road system was laid out so all traffic from one side of the nation to the other has to pass through central Budapest, that determined a lot about air pollution and commuting delays that are not easily fixed by pollution control devices, traffic lights, or speed limits.

The only way to fix a system that is laid out wrong is to rebuild it, if you can. Amory Lovins does wonders of energy conservation by straightening out bent pipes and enlarging too-small ones. If we let him do energy retrofits on all the buildings of the nation,we could shut down at least half of our electric power plants.

But often physical rebuilding is the slowest and most expensive kind of change to make in a system. Some stock-and-flow structures are just plain unchangeable. The baby-boom swell in the U.S. population first caused pressure on the elementary school system, then high schools, then colleges, then jobs and housing, and now we’re looking forward to supporting its retirement. Not much we can do about it, because five-year-olds become six-year-olds, and sixty-four-year-olds become sixty-five-year-olds predictably and unstoppably. The same can be said for the lifetime of destructive CFC molecules in the ozone layer, for the rate at which contaminants get washed out of aquifers, for the fact that an inefficient car fleet takes 10-20 years to turn over.

Physical structure is crucial in a system, but rarely a leverage point, because changing it is rarely quick or simple. The leverage point is in proper design in the first place. After the structure is built, the leverage is in understanding its limitations and bottlenecks, using it with maximum efficiency, and refraining from fluctuations or expansions that strain its capacity.

### 9. The lengths of delays, relative to the rate of system changes.

Remember that bathtub on the fourth floor I mentioned, with the water heater in the basement? I actually experienced one of those once, in an old hotel in London. It wasn’t even a bathtub, it was a shower — no buffering capacity. The water temperature took at least a minute to respond to my faucet twists. Guess what my shower was like.

Right, oscillations from hot to cold and back to hot, punctuated with expletives.

Delays in feedback loops are critical determinants of system behavior. They are common causes of oscillations. If you’re trying to adjust a system state to your goal, but you only receive delayed information about what the system state is, you will overshoot and undershoot. Same if your information is timely, but your response isn’t. For example, it takes several years to build an electric power plant, and then that plant lasts, say, thirty years. Those delays make it impossible to build exactly the right number of plants to supply a rapidly changing demand. Even with immense effort at forecasting, almost every electricity industry in the world experiences long oscillations between overcapacity and undercapacity. A system just can’t respond to short-term changes when it has long-term delays. That’s why a massive central-planning system, such as the Soviet Union or General Motors, necessarily functions poorly.

Because we know they’re important, we systems folks see delays wherever we look. The delay between the time when a pollutant is dumped on the land and when it trickles down to the groundwater. The delay between the birth of a child and the time when that child is ready to have a child. The delay between the first successful test of a new technology and the time when that technology is installed throughout the economy. The time it takes for a price to adjust to a supply-demand imbalance.

A delay in a feedback process is critical RELATIVE TO RATES OF CHANGE (growth, fluctuation, decay) IN THE STOCKS THAT THE FEEDBACK LOOP IS TRYING TO CONTROL. Delays that are too short cause overreaction, “chasing your tail,” oscillations amplified by the jumpiness of the response. Delays that are too long cause damped, sustained, or exploding oscillations, depending on how much too long. At the extreme they cause chaos. Overlong delays in a system with a threshold, a danger point, a range past which irreversible damage can occur, cause overshoot and collapse.

I would list delay length as a high leverage point, except for the fact that delays are not often easily changeable. Things take as long as they take. You can’t do a lot about the construction time of a major piece of capital, or the maturation time of a child, or the growth rate of a forest. It’s usually easier to SLOW DOWN THE CHANGE RATE, so that inevitable feedback delays won’t cause so much trouble. That’s why growth rates are higher up on the leverage-point list than delay times.

And that’s why slowing economic growth is a greater leverage point in Forrester’s world model than faster technological development or freer market prices. Those are attempts to speed up the rate of adjustment. But the world’s physical capital plant, its factories and boilers, the concrete manifestations of its working technologies, can only change so fast, even in the face of new prices or new ideas — and prices and ideas don’t change instantly either, not through a whole global culture. There’s more leverage in slowing the system down so technologies and prices can keep up with it, than there is in wishing the delays away.

But if there is a delay in your system that can be changed, changing it can have big effects. Watch out! Be sure you change it in the right direction! (For example, the great push to reduce information and money transfer delays in financial markets is just asking for wild gyrations)

### 8. The strength of negative feedback loops, relative to the impacts they are trying to correct against.

Now we’re beginning to move from the physical part of the system to the information and control parts, where more leverage can be found.

Negative feedback loops are ubiquitous in systems. Nature evolves them and humans invent them as controls to keep important system states within safe bounds. A thermostat loop is the classic example. Its purpose is to keep the system state called “room temperature” fairly constant at a desired level. Any negative feedback loop needs a goal (the thermostat setting), a monitoring and signaling device to detect excursions from the goal (the thermostat), and a response mechanism (the furnace and/or air conditioner, fans, heat pipes, fuel, etc.).

A complex system usually has numerous negative feedback loops it can bring into play, so it can self-correct under different conditions and impacts. Some of those loops may be inactive much of the time — like the emergency cooling system in a nuclear power plant, or your ability to sweat or shiver to maintain your body temperature — but their presence is critical to the long-term welfare of the system.

One of the big mistakes we make is to strip away these “emergency” response mechanisms because they aren’t often used and they appear to be costly. In the short term we see no effect from doing this. In the long term, we drastically narrow the range of conditions over which the system can survive. One of the most heartbreaking ways we do this is in encroaching on the habitats of endangered species. Another is in encroaching on our own time for rest, recreation, socialization, and meditation.

The “strength” of a negative loop — its ability to keep its appointed stock at or near its goal — depends on the combination of all its parameters and links — the accuracy and rapidity of monitoring, the quickness and power of response, the directness and size of corrective flows. Sometimes there are leverage points here.

Take markets, for example, the negative feedback systems that are all but worshipped by economists — and they can indeed be marvels of self-correction, as prices vary to moderate supply and demand and keep them in balance. The more the price — the central piece of information signaling both producers and consumers — is kept clear, unambiguous, timely, and truthful, the more smoothly markets will operate. Prices that reflect full costs will tell consumers how much they can actually afford and will reward efficient producers. Companies and governments are fatally attracted to the price leverage point, of course, all of them determinedly pushing it in the wrong direction with subsidies, fixes, externalities, taxes, and other forms of confusion.

These folks are trying to weaken the feedback power of market signals by twisting information in their favor. The REAL leverage here is to keep them from doing it. Hence the necessity of anti-trust laws, truth-in-advertising laws, attempts to internalize costs (such as pollution taxes), the removal of perverse subsidies, and other ways of leveling market playing fields.

None of which get far these days, because of the weakening of another set of negative feedback loops — those of democracy. This great system was invented to put self-correcting feedback between the people and their government. The people, informed about what their elected representatives do, respond by voting those representatives in or out of office. The process depends upon the free, full, unbiased flow of information back and forth between electorate and leaders. Billions of dollars are spent to limit and bias and dominate that flow. Give the people who want to distort market price signals the power to pay off government leaders, get the channels of communication to be self-interested corporate partners themselves, and none of the necessary negative feedbacks work well. Both market and democracy erode.

The strength of a negative feedback loop is important RELATIVE TO THE IMPACT IT IS DESIGNED TO CORRECT. If the impact increases in strength, the feedbacks have to be strengthened too. A thermostat system may work fine on a cold winter day — but open all the windows and its corrective power will fail. Democracy worked better before the advent of the brainwashing power of centralized mass communications. Traditional controls on fishing were sufficient until radar spotting and drift nets and other technologies made it possible for a few actors to wipe out the fish. The power of big industry calls for the power of big government to hold it in check; a global economy makes necessary a global government and global regulations.

Here are some examples of strengthening negative feedback controls to improve a system’s self-correcting abilities:

* preventive medicine, exercise, and good nutrition to bolster the body’s ability to fight disease,
* integrated pest management to encourage natural predators of crop pests,
* the Freedom of Information Act to reduce government secrecy,
* monitoring systems to report on environmental damage,
* protection for whistleblowers,
* impact fees, pollution taxes, and performance bonds to recapture the externalized public costs of private benefits.

### 7. The gain around driving positive feedback loops.

A negative feedback loop is self-correcting; a positive feedback loop is self-reinforcing. The more it works, the more it gains power to work some more. The more people catch the flu, the more they infect other people. The more babies are born, the more people grow up to have babies. The more money you have in the bank, the more interest you earn, the more money you have in the bank. The more the soil erodes, the less vegetation it can support, the fewer roots and leaves to soften rain and runoff, the more soil erodes. The more high-energy neutrons in the critical mass, the more they knock into nuclei and generate more.

Positive feedback loops are sources of growth, explosion, erosion, and collapse in systems. A system with an unchecked positive loop ultimately will destroy itself. That’s why there are so few of them. Usually a negative loop will kick in sooner or later. The epidemic will run out of infectable people — or people will take increasingly strong steps to avoid being infected. The death rate will rise to equal the birth rate — or people will see the consequences of unchecked population growth and have fewer babies. The soil will erode away to bedrock, and after a million years the bedrock will crumble into new soil — or people will stop overgrazing, put up checkdams, plant trees, and stop the erosion.

In all those examples, the first outcome is what will happen if the positive loop runs its course, the second is what will happen if there’s an intervention to reduce its self-multiplying power. Reducing the gain around a positive loop — slowing the growth — is usually a more powerful leverage point in systems than strengthening negative loops, and much preferable to letting the positive loop run.

Population and economic growth rates in the world model are leverage points, because slowing them gives the many negative loops, through technology and markets and other forms of adaptation, all of which have limits and delays, time to function. It’s the same as slowing the car when you’re driving too fast, rather than calling for more responsive brakes or technical advances in steering.

Another example: there are many positive feedback loops in society that reward the winners of a competition with the resources to win even bigger next time. Systems folks call them “success to the successful” loops. Rich people collect interest; poor people pay it. Rich people pay accountants and lean on politicians to reduce their taxes; poor people can’t. Rich people give their kids inheritances and good educations; poor kids lose out. Anti-poverty programs are weak negative loops that try to counter these strong positive ones. It would be much more effective to weaken the positive loops. That’s what progressive income tax, inheritance tax, and universal high-quality public education programs are meant to do. (If rich people can buy government and weaken, rather than strengthen those of measures, the government, instead of balancing “success to the successful” loops, becomes just another instrument to reinforce them!)

The most interesting behavior that rapidly turning positive loops can trigger is chaos. This wild, unpredictable, unreplicable, and yet bounded behavior happens when a system starts changing much, much faster than its negative loops can react to it. For example, if you keep raising the capital growth rate in the world model, eventually you get to a point where one tiny increase more will shift the economy from exponential growth to oscillation. Another nudge upward gives the oscillation a double beat. And just the tiniest further nudge sends it into chaos.

I don’t expect the world economy to turn chaotic any time soon (not for that reason, anyway). That behavior occurs only in unrealistic parameter ranges, equivalent to doubling the size of the economy within a year. Real-world systems can turn chaotic, however, if something in them can grow or decline very fast. Fast-replicating bacteria or insect populations, very infectious epidemics, wild speculative bubbles in money systems, neutron fluxes in the guts of nuclear power plants. These systems are hard to control, and control must involve slowing down the positive feedbacks.

In more ordinary systems, look for leverage points around birth rates, interest rates, erosion rates, “success to the successful” loops, any place where the more you have of something, the more you have the possibility of having more.

### 6. The structure of information flows (who does and does not have access to information).

There was this subdivision of identical houses, the story goes, except that for some reason the electric meter in some of the houses was installed in the basement and in others it was installed in the front hall, where the residents could see it constantly, going round faster or slower as they used more or less electricity. With no other change, with identical prices, electricity consumption was 30 percent lower in the houses where the meter was in the front hall.

We systems-heads love that story because it’s an example of a high leverage point in the information structure of the system. It’s not a parameter adjustment, not a strengthening or weakening of an existing loop. It’s a NEW LOOP, delivering feedback to a place where it wasn’t going before.

A more recent example is the Toxic Release Inventory — the U.S. government’s requirement, instituted in 1986, that every factory releasing hazardous air pollutants report those emissions publicly every year. Suddenly every community could find out precisely what was coming out of the smokestacks in town. There was no law against those emissions, no fines, no determination of “safe” levels, just information. But by 1990 emissions dropped 40 percent. They’ve continued to go down since, not so much because of citizen outrage as because of corporate shame. One chemical company that found itself on the Top Ten Polluters list reduced its emissions by 90 percent, just to “get off that list.”

Missing feedback is one of the most common causes of system malfunction. Adding or restoring information can be a powerful intervention, usually much easier and cheaper than rebuilding physical infrastructure. The tragedy of the commons that is crashing the world’s commercial fisheries occurs because there is no feedback from the state of the fish population to the decision to invest in fishing vessels. (Contrary to economic opinion, the price of fish doesn’t provide that feedback. As the fish get more scarce and hence more expensive, it becomes all the more profitable to go out and catch them. That’s a perverse feedback, a positive loop that leads to collapse.)

It’s important that the missing feedback be restored to the right place and in compelling form. To take another tragedy of the commons, it’s not enough to inform all the users of an aquifer that the groundwater level is dropping. That could initiate a race to the bottom. It would be more effective to set a water price that rises steeply as the pumping rate begins to exceed the recharge rate.

Compelling feedback. Suppose taxpayers got to specify on their return forms what government services their tax payments must be spent on. (Radical democracy!) Suppose any town or company that puts a water intake pipe in a river had to put it immediately DOWNSTREAM from its own outflow pipe. Suppose any public or private official who made the decision to invest in a nuclear power plant got the waste from that plant stored on his/her lawn. Suppose (this is an old one) the politicians who declare war were required to spend that war in the front lines.

There is a systematic tendency on the part of human beings to avoid accountability for their own decisions. That’s why there are so many missing feedback loops — and why this kind of leverage point is so often popular with the masses, unpopular with the powers that be, and effective, if you can get the powers that be to permit it to happen (or go around them and make it happen anyway).

### 5. The rules of the system (incentives, punishments, constraints).

The rules of the system define its scope, its boundaries, its degrees of freedom. Thou shalt not kill. Everyone has the right of free speech. Contracts are to be honored. The president serves four-year terms and cannot serve more than two of them. Nine people on a team, you have to touch every base, three strikes and you’re out. If you get caught robbing a bank, you go to jail.

Mikhail Gorbachev came to power in the USSR and opened information flows (glasnost) and changed the economic rules (perestroika), and look what happened.

Constitutions are the strongest examples of social rules. Physical laws such as the second law of thermodynamics are absolute rules, whether we understand them or not or like them or not. Laws, punishments, incentives, and informal social agreements are progressively weaker rules.

To demonstrate the power of rules, I like to ask my students to imagine different ones for a college. Suppose the students graded the teachers, or each other. Suppose there were no degrees: you come to college when you want to learn something, and you leave when you’ve learned it. Suppose tenure were awarded to professors according to their ability to solve real-world problems, rather than to publish academic papers. Suppose a class got graded as a group, instead of as individuals.

As we try to imagine restructured rules like that and what our behavior would be under them, we come to understand the power of rules. They are high leverage points. Power over the rules is real power. That’s why lobbyists congregate when Congress writes laws, and why the Supreme Court, which interprets and delineates the Constitution — the rules for writing the rules — has even more power than Congress. If you want to understand the deepest malfunctions of systems, pay attention to the rules, and to who has power over them.

That’s why my systems intuition was sending off alarm bells as the new world trade system was explained to me. It is a system with rules designed by corporations, run by corporations, for the benefit of corporations. Its rules exclude almost any feedback from any other sector of society. Most of its meetings are closed even to the press (no information flow, no feedback). It forces nations into positive loops “racing to the bottom,” competing with each other to weaken environmental and social safeguards in order to attract corporate investment. It’s a recipe for unleashing “success to the successful” loops, until they generate enormous accumulations of power and huge centralized planning systems that will destroy themselves, just as the Soviet Union destroyed itself, and for similar systemic reasons.

### 4. The power to add, change, evolve, or self-organize system structure.

The most stunning thing living systems and some social systems can do is to change themselves utterly by creating whole new structures and behaviors. In biological systems that power is called evolution. In human economies it’s called technical advance or social revolution. In systems lingo it’s called self-organization.

Self-organization means changing any aspect of a system lower on this list — adding completely new physical structures, such as brains or wings or computers — adding new negative or positive loops, or new rules. The ability to self-organize is the strongest form of system resilience. A system that can evolve can survive almost any change, by changing itself. The human immune system has the power to develop new responses to (some kinds of ) insults it has never before encountered. The human brain can take in new information and pop out completely new thoughts.

The power of self-organization seems so wondrous that we tend to regard it as mysterious, miraculous, manna from heaven. Economists often model technology as literal manna — coming from nowhere, costing nothing, increasing the productivity of an economy by some steady percent each year. For centuries people have regarded the spectacular variety of nature with the same awe. Only a divine creator could bring forth such a creation.

Further investigation of self-organizing systems reveals that the divine creator, if there is one, does not have to produce evolutionary miracles. He, she, or it just has to write marvelously clever RULES FOR SELF-ORGANIZATION. These rules basically govern how, where, and what the system can add onto or subtract from itself under what conditions. As hundreds of self-organizing computer models have demonstrated, complex and delightful patterns can evolve from quite simple evolutionary algorithms. (That need not mean that real-world algorithms are simple, only that they can be.) The genetic code within the DNA that is the basis of all biological evolution contains just four different letters, combined into words of three letters each. That pattern, and the rules for replicating and rearranging it, has been constant for something like three billion years, during which it has spewed out an unimaginable variety of failed and successful self-evolved creatures.

Self-organization is basically a matter of an evolutionary raw material — a highly variable stock of information from which to select possible patterns — and a means for experimentation, for selecting and testing new patterns. For biological evolution the raw material is DNA, one source of variety is spontaneous mutation, and the testing mechanism is something like punctuated Darwinian selection. For technology the raw material is the body of understanding science has accumulated and stored in libraries and in the brains of its practitioners. The source of variety is human creativity (whatever THAT is) and the selection mechanism can be whatever the market will reward, or whatever governments and foundations will fund, or whatever meets human needs.

When you understand the power of system self-organization, you begin to understand why biologists worship biodiversity even more than economists worship technology. The wildly varied stock of DNA, evolved and accumulated over billions of years, is the source of evolutionary potential, just as science libraries and labs and universities where scientists are trained are the source of technological potential. Allowing species to go extinct is a systems crime, just as randomly eliminating all copies of particular science journals, or particular kinds of scientists, would be.

The same could be said of human cultures, of course, which are the store of behavioral repertoires, accumulated over not billions, but hundreds of thousands of years. They are a stock out of which social evolution can arise. Unfortunately, people appreciate the precious evolutionary potential of cultures even less than they understand the preciousness of every genetic variation in the world’s ground squirrels. I guess that’s because one aspect of almost every culture is the belief in the utter superiority of that culture.

Insistence on a single culture shuts down learning. Cuts back resilience. Any system, biological, economic, or social, that gets so encrusted that it cannot self-evolve, a system that systematically scorns experimentation and wipes out the raw material of innovation, is doomed over the long term on this highly variable planet.

The intervention point here is obvious, but unpopular. Encouraging variability and experimentation and diversity means “losing control.” Let a thousand flowers bloom and ANYTHING could happen! Who wants that? Let’s play it safe and push this leverage point in the wrong direction by wiping out biological, cultural, social, and market diversity!

### 3. The goals of the system.

Right there, the diversity-destroying consequence of the push for control, that demonstrates why the goal of a system is a leverage point superior to the self-organizing ability of a system. If the goal is to bring more and more of the world under the control of one particular central planning system (the empire of Genghis Khan, the world of Islam, the People’s Republic of China, Wal-Mart, Disney, whatever), then everything further down the list, physical stocks and flows, feedback loops, information flows, even self-organizing behavior, will be twisted to conform to that goal.

That’s why I can’t get into arguments about whether genetic engineering is a “good” or a “bad” thing. Like all technologies, it depends upon who is wielding it, with what goal. The only thing one can say is that if corporations wield it for the purpose of generating marketable products, that is a very different goal, a different selection mechanism, a different direction for evolution than anything the planet has seen so far.

As my little single-loop examples have shown, most negative feedback loops within systems have their own goals — to keep the bathwater at the right level, to keep the room temperature comfortable, to keep inventories stocked at sufficient levels, to keep enough water behind the dam. Those goals are important leverage points for pieces of systems, and most people realize that. If you want the room warmer, you know the thermostat setting is the place to intervene. But there are larger, less obvious, higher-leverage goals, those of the entire system.

Even people within systems don’t often recognize what whole-system goal they are serving. To make profits, most corporations would say, but that’s just a rule, a necessary condition to stay in the game. What is the point of the game? To grow, to increase market share, to bring the world (customers, suppliers, regulators) more and more under the control of the corporation, so that its operations becomes ever more shielded from uncertainty. John Kenneth Galbraith recognized that corporate goal — to engulf everything — long ago.[5](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#five) It’s the goal of a cancer too. Actually it’s the goal of every living population — and only a bad one when it isn’t balanced by higher-level negative feedback loops that never let an upstart power-loop-driven entity control the world. The goal of keeping the market competitive has to trump the goal of each corporation to eliminate its competitors (and brainwash its customers and swallow its suppliers), just as in ecosystems, the goal of keeping populations in balance and evolving has to trump the goal of each population to reproduce without limit.

I said awhile back that changing the players in the system is a low-level intervention, as long as the players fit into the same old system. The exception to that rule is at the top, where a single player can have the power to change the system’s goal. I have watched in wonder as — only very occasionally — a new leader in an organization, from Dartmouth College to Nazi Germany, comes in, enunciates a new goal, and swings hundreds or thousands or millions of perfectly intelligent, rational people off in a new direction.

That’s what Ronald Reagan did, and we watched it happen. Not long before he came to office, a president could say “Ask not what government can do for you, ask what you can do for the government,” and no one even laughed. Reagan said over and over, the goal is not to get the people to help the government and not to get government to help the people, but to get government off our backs. One can argue, and I would, that larger system changes and the rise of corporate power over government let him get away with that. But the thoroughness with which the public discourse in the U.S. and even the world has been changed since Reagan is testimony to the high leverage of articulating, meaning, repeating, standing up for, insisting upon new system goals.

### 2. The mindset or paradigm out of which the system — its goals, structure, rules, delays, parameters — arises.

Another of Jay Forrester’s famous systems sayings goes: it doesn’t matter how the tax law of a country is written. There is a shared idea in the minds of the society about what a “fair” distribution of the tax load is. Whatever the rules say, by fair means or foul, by complications, cheating, exemptions or deductions, by constant sniping at the rules, actual tax payments will push right up against the accepted idea of “fairness.”

The shared idea in the minds of society, the great big unstated assumptions — unstated because unnecessary to state; everyone already knows them — constitute that society’s paradigm, or deepest set of beliefs about how the world works. There is a difference between nouns and verbs. Money measures something real and has real meaning (therefore people who are paid less are literally worth less). Growth is good. Nature is a stock of resources to be converted to human purposes. Evolution stopped with the emergence of Homo sapiens. One can “own” land. Those are just a few of the paradigmatic assumptions of our current culture, all of which have utterly dumfounded other cultures, who thought them not the least bit obvious.

Paradigms are the sources of systems. From them, from shared social agreements about the nature of reality, come system goals and information flows, feedbacks, stocks, flows and everything else about systems. No one has ever said that better than Ralph Waldo Emerson:

Every nation and every man instantly surround themselves with a material apparatus which exactly corresponds to … their state of thought. Observe how every truth and every error, each a thought of some man’s mind, clothes itself with societies, houses, cities, language, ceremonies, newspapers. Observe the ideas of the present day … see how timber, brick, lime, and stone have flown into convenient shape, obedient to the master idea reigning in the minds of many persons…. It follows, of course, that the least enlargement of ideas … would cause the most striking changes of external things.[6](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#six)

The ancient Egyptians built pyramids because they believed in an afterlife. We build skyscrapers, because we believe that space in downtown cities is enormously valuable. (Except for blighted spaces, often near the skyscrapers, which we believe are worthless.) Whether it was Copernicus and Kepler showing that the earth is not the center of the universe, or Einstein hypothesizing that matter and energy are interchangeable, or Adam Smith postulating that the selfish actions of individual players in markets wonderfully accumulate to the common good, people who have managed to intervene in systems at the level of paradigm have hit a leverage point that totally transforms systems.

You could say paradigms are harder to change than anything else about a system, and therefore this item should be lowest on the list, not second-to-highest. But there’s nothing physical or expensive or even slow in the process of paradigm change. In a single individual it can happen in a millisecond. All it takes is a click in the mind, a falling of scales from eyes, a new way of seeing. Whole societies are another matter — they resist challenges to their paradigm harder than they resist anything else.

So how do you change paradigms? Thomas Kuhn, who wrote the seminal book about the great paradigm shifts of science,[7](https://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/#seven) has a lot to say about that. In a nutshell, you keep pointing at the anomalies and failures in the old paradigm, you keep coming yourself, and loudly and with assurance from the new one, you insert people with the new paradigm in places of public visibility and power. You don’t waste time with reactionaries; rather you work with active change agents and with the vast middle ground of people who are open-minded.

Systems folks would say you change paradigms by modeling a system, which takes you outside the system and forces you to see it whole. We say that because our own paradigms have been changed that way.

### 1. The power to transcend paradigms.

There is yet one leverage point that is even higher than changing a paradigm. That is to keep oneself unattached in the arena of paradigms, to stay flexible, to realize that NO paradigm is “true,” that every one, including the one that sweetly shapes your own worldview, is a tremendously limited understanding of an immense and amazing universe that is far beyond human comprehension. It is to “get” at a gut level the paradigm that there are paradigms, and to see that that itself is a paradigm, and to regard that whole realization as devastatingly funny. It is to let go into Not Knowing, into what the Buddhists call enlightenment.

People who cling to paradigms (which means just about all of us) take one look at the spacious possibility that everything they think is guaranteed to be nonsense and pedal rapidly in the opposite direction. Surely there is no power, no control, no understanding, not even a reason for being, much less acting, in the notion or experience that there is no certainty in any worldview. But, in fact, everyone who has managed to entertain that idea, for a moment or for a lifetime, has found it to be the basis for radical empowerment. If no paradigm is right, you can choose whatever one will help to achieve your purpose. If you have no idea where to get a purpose, you can listen to the universe (or put in the name of your favorite deity here) and do his, her, its will, which is probably a lot better informed than your will.

It is in this space of mastery over paradigms that people throw off addictions, live in constant joy, bring down empires, get locked up or burned at the stake or crucified or shot, and have impacts that last for millennia.

### A Final Caution

Back from the sublime to the ridiculous, from enlightenment to caveats. There is so much that has to be said to qualify this list. It is tentative and its order is slithery. There are exceptions to every item that can move it up or down the order of leverage. Having had the list percolating in my subconscious for years has not transformed me into a Superwoman. The higher the leverage point, the more the system will resist changing it — that’s why societies have to rub out truly enlightened beings.

Magical leverage points are not easily accessible, even if we know where they are and which direction to push on them. There are no cheap tickets to mastery. You have to work hard at it, whether that means rigorously analyzing a system or rigorously casting off your own paradigms and throwing yourself into the humility of Not Knowing. In the end, it seems that mastery has less to do with pushing leverage points than it does with strategically, profoundly, madly letting go.

# 

**Crash costs**. These are a function of the number of vehicle kilometres travelled by each transport mode. Rail transport has much lower crash rates and related costs than road transport.

**Health and Liveability.** A consequenceof pollution and road safety impacts

**Maintenance**. Freight transported by trucks and trains creates wear and tear on roads and railway lines respectively. The cost of maintenance to rail lines is generally passed on to rail operators through rail access charges. Meanwhile, truck registration fees do not usually cover the full cost of damage that trucks do to roads

**Congestion.** Freight transported on roads adds to the number of vehicles on the road network. This increases congestion in both regional and metropolitan areas.   
Freight vehicles are usually larger and slower than most other vehicles and further contribute to congestion.

Despite opportunities for substantial savings in many areas trucks are still the most common mode of freight transportation, not just in Australia but globally. For example, trucking composes 77% of all freight transportation in Europe while rail only accounts for 8%.

There are many factors which have contributed to this trend. Some of these addressed in VAGO report June 2023 and the.

Opportunities to achieve efficiencies – a number of recommendations – aimed at improving infrastructure ie track etc but based on business as usual economic conditions

Bigger picture – trend upward and little time to act refer

Other issues – need to respond to a growing number of challenges –

Road transport – challenge of maintaining existing road infrastructure – energy intensive and the prospect of diminishing supply, particularly key elements such as bitumen and cement which are energy intensive to produce and future supply will become increasingly problematic (peak oil)

Also increasingly vulnerable to increasing temperature and extreme weather

Summary

Trucking and rail freight

Major challenges – limits to how much freight can be taken by rail but transferring as much as possible – particularly traffic such as bulk etc and container when freight should be the automatic choice

Need a freight plan

Must be an integral part of the transport sector as a whole – quote from paper

Need to evaluate all projects and rank them based on economic, social and environmental critieria – ie triple bottom line and use this as the basis for establishing government priorities

Implementation will require supporting measures – ie developed as a system etc etc to make it work

There is a growing imperative to

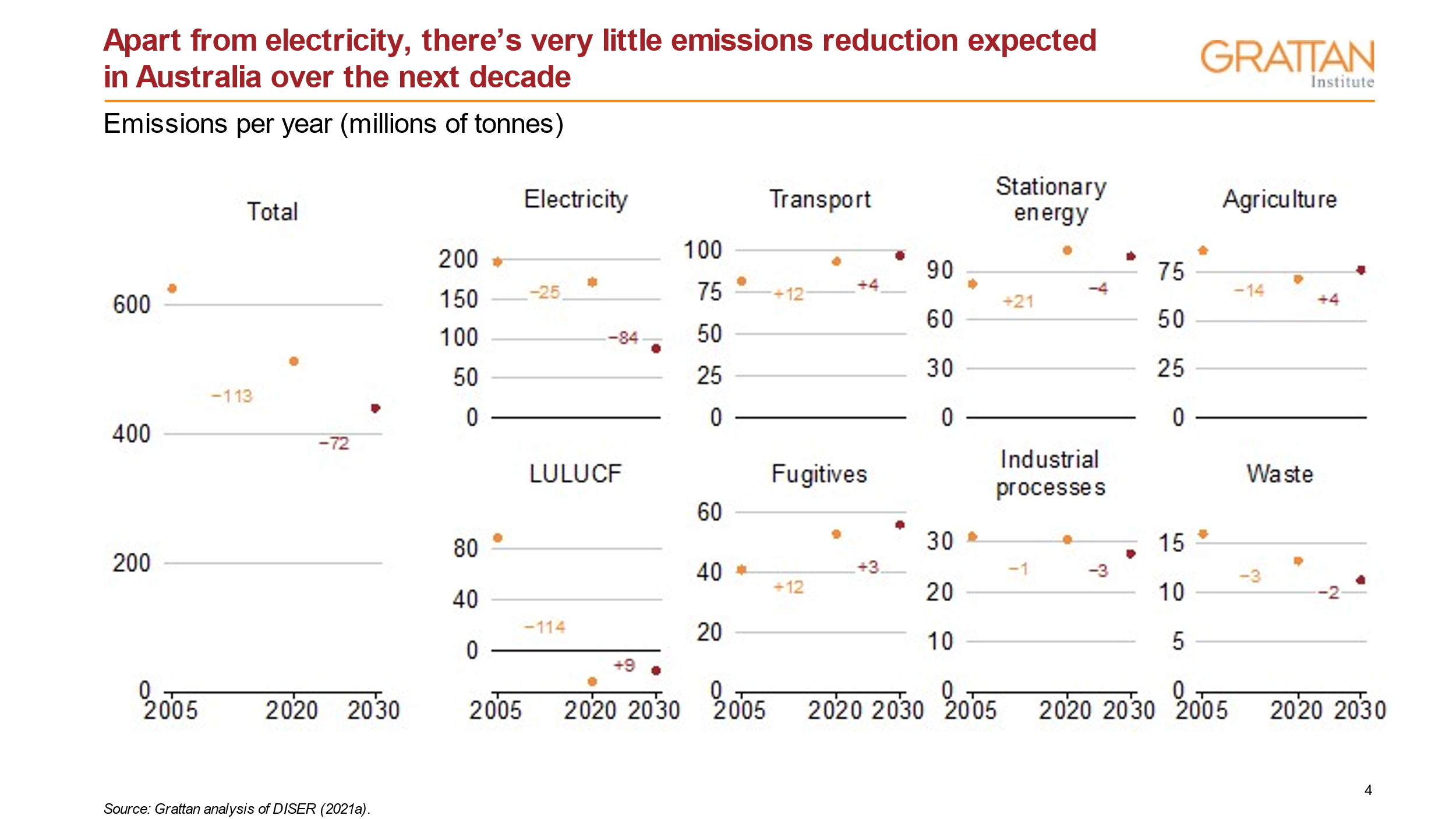
Current trends for transport emissions presented by

**Greenhouse Emission Reductions and Actions to Reduce Them**

**Context, Situation Appraisal and Review**

**Emission reduction trends**

* All heavy lifting to date done by electricity generation, driven to a large extent by roof top solar
* Minimal if any reductions in all other sectors, some still increasing
* Emission reductions from carbon capture proposals by government unproven and unlikely to be realised
* Transport: Car emissions still increasing, freight and aviation emissions are expected to increase
* No reductions by rail based public transport
* Transport emissions accelerated by
  + population and economic growth
  + urban growth/spread
  + infrastructure policies that promote mobility – particularly by car and other fossil fuel powered vehicles
  + declining fuel economy overall for passenger vehicles
  + absence of, or inadequate standards for fuel and vehicle emissions.



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**Facilitating sustainable development in the transport sector**

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Our rail network takes cars off the road and B-doubles off our highways. Greater use of rail reduces emissions through its intrinsic sustainability advantages and is a crucial part of our sustainable net zero future.

**Passenger services to support a healthier community**

Rail patronage on Australia’s passenger services is expected to grow two per cent per year, taking 12 million car journeys off the road from 2018-2026. Rail passenger travel generates 30 per cent less carbon emissions than road travel, supporting healthier communities in our cities and towns. In fact, each train of commuters reduces air pollution costs by $26,000 per year.

**Taking trucks off our highways and commuter roads**

Rail freight produces 16 times less carbon pollution than road freight for every tonne kilometre travelled. In fact, despite moving 57 per cent of national freight and four per cent of passenger movements, the national rail network accounts for just four per cent of the transport sector’s emission. This is compared to road transport, which is responsible for 86 per cent of transport emissions, with air (7%) and sea (2%) transport accounting for the remainder. As demand increases, it becomes more important to get more freight on rail, just a one per cent shift of freight from road to rail in Australia would reduce accident, emissions, and health costs by $71.9 million per year.

Why is so little Freight carried on Rail?

Rail Futures Institute Submission to Review of the National Freight and Supply Chain Strategy – September 2023

Quoting from the latest submission prepared by the Rail Futures Institute to Review the National Freight and Supply Chain Strategy, released on September 2023,

***“Rail is ideal for transporting bulk commodities and containerised cargoes, especially between regional terminals and ports. Less than 20 freight trains, each of 50 wagons, can fill a 50,000 tonne grain ship compared with at least 1,000 trucks. Freight trains save fuel, reduce road damage, emissions and road crashes. They also reduce residential amenity impacts and other environmental effects. Increased use of rail freight as the freight task grows has significant economic benefits. Most trucking organisations also support greater use of rail. “The freight task is going to grow and we won’t have enough trucks to carry it. We need rail and we need the rail network to develop”. (Peter Anderson, CEO Victorian Transport Association,13 May 2015).”***

Based on the above, one would expect rail freight to booming but the reverse is true. Rail freight traffic in this state continues to decline and much of the rail freight infrastructure required to support it has been severely neglected, ie poorly maintained and in need of upgrading or renewal. In the meantime freight on road is booming but at substantial cost by almost every indicator.

Quote List indirect cost comparisons – provide a table

The report (attached) includes numerous recommendations to address thi

No business cases provided – but based on preliminary estimates these are likely to provide a return on investment many times (possibly by orders of magnitude) the returns obtained from any of the major infrastructure projects being carried out in the governments big build

So the question that must be asked – how is it that essential freight projects are given little or no attention. The answer it clearly not on the basis of need and rational decision making or sound governance – the answer is clearly political reflecting the power of vested interests within the road and other lobby groups.

Imperative to change – future challenges and the need to respond – implications

External Costs Reducing the external costs of land freight transport deserves a lot more attention in the revised NFSCS than it receives in the present strategy. The former Inter-State Commission (ISC–1990, Road Use Charges and Vehicle Registration: A National Scheme, p89) noted that road external costs are "...costs imposed outside market transactions and they fall on a number of individuals or groups - road users other than those individuals who give rise to the costs, individuals other than road users (such as those who live in proximity to roads), or society as a whole." The ISC (loc.cit.) notes some external costs associated with road use as including "crash costs, congestion costs, noise pollution costs, and atmospheric pollution costs." Such external costs may also be imposed by rail freight. The Bureau of Transport Economics (BTE–1999, Competitive neutrality between road and rail) also addressed external costs. As part of a National Interstate Track Audit commissioned by the Australian Rail Track Corporation (ARTC - 2001), Booz•Allen and Hamilton (Appendix A, page 24) noted “...six external cost items of noise pollution, air pollution, greenhouse gas emissions, congestion costs, accident costs, and incremental road damage costs” and gave a Table of road and rail freight externalities.

External costs were revisited by the Independent Pricing and Regulatory Tribunal (IPART) of New South Wales in its 2012 Review of Access Pricing for the NSW Grain Line Network. This report noted, inter alia, the 2001 ARTC Track Audit estimates and the accident cost of road freight are some 0.60 cents per net tonne kilometre (cents per ntkm) for road freight as against 0.03 cents per ntkm for rail freight. This is a ratio of 20 to one. IPART noted 3, inter alia, unrecovered road system costs from long standing road user charges for heavy trucks are 1.0 cents per net tonne km. It also gave average values for external costs for road and rail freight in both urban and non-urban areas. These included estimates with an allowance for unrecovered road system costs from trucks (of 1 cent per net tonne km), accident costs, air pollution, noise, emissions and road congestion, in cents per net tonne kilometre (tkm), as follows. [CPI adjusted to March 2023 as per https://www.rba.gov.au/calculator]: 2.75 cents per ntkm for road haulage in urban areas [3.63 cents per ntkm] 1.98 cents per ntkm for road haulage in non-urban areas .. [2.62 cents per ntkm] 0.43 cents per ntkm for rail haulage in urban areas [0.57 cents per ntkm] 0.17 cents per ntkm for rail haulage in non-urban areas [0.22 cents per ntkm] By 2023, these 2012 IPART costs have likely increased by more than CPI. 3 This is because in Australia, road user charges for heavy trucks based on annual registration fees and discounted fuel excise are arguably too low for the heavier trucks travelling large distances each year. If one accepts that the long-standing New Zealand mass distance charges for heavy trucks are a proper reflection of user pays, the annual hidden subsidy to the operations of six axle articulated trucks and B Doubles in Australia amounts to over $2 billion per year. This works out to a hidden subsidy of about one cent per net tonne kilometre. 19 Rail Futures Institute – National Freight & Supply Chain Strategy Submission – September 2023 10.1 An application of external costs By way of example, we now seek to demonstrate the benefits for rail to be moving, in a good Victorian harvest, the share of grain that it did around 2007, when the Fischer “Switchpoint” grain transport review was underway. We estimate that it would be possible for rail, in a good harvest, to move an additional 3 million tonnes of grain. This would still leave work for the road freight industry. We now quantify the benefits in terms of reduced carbon emissions and reduced external costs including reduced road maintenance costs, improved road safety, and reduced road congestion. To do this, we use some assumptions. Firstly, we assume the average length of haul of the 3 million tonnes of grain is 240 km, the same whether it is for rail or road. This gives a 720 million tonne-km freight task. This length of haul is an average and we note that some grain from the north of Victoria may move over 400 km to a port at Geelong or Melbourne. For emissions, we use the fact that on average, for freight tasks moving grain to port, rail freight has one-third the emissions of road freight, with (ABS SMVU 2019-20) articulated trucks consuming 4,342 million litres of diesel to perform a 173.2 billion tonne-kilometre freight task. This is an average of 39.9 net tonne-km per litre so a 720m tkm road freight task would use about 18 million litres of diesel. If the same task was done by rail, it would use about 6 million litres of diesel. As combustion per litre of diesel produces about 2.7 kg of carbon dioxide, the reduction in emissions from switching from road to rail could be some 32,400 tonnes of CO2-e. Secondly, to achieve credible estimates of external costs, we use those based on the 2012 IPART, as outlined above. Using these estimates, assuming a 240 km haul and (say) 40 km of haulage through urban areas (so 200 km in non-urban areas) the external cost for haulage by road is about $6.70 per tonne. The external costs by rail are about $0.67. This is a ratio of ten to one. In this example, the difference between the external costs of road and rail haulage of grain is about $6 per tonne. If three million tonnes of grain per annum haulage to a port could revert from road to rail, the reduction in external costs would be about $19 million per annum. The difference includes a reduction in unrecovered road maintenance costs of $7.2 million per annum. This alone would warrant retention and extension of Victoria’s current Mode Shift Incentive Scheme to include grain. A reduction in road crash costs exceeds $4m million per annum. This, coupled with a reduction of carbon emissions from grain transport, is a further reason for transferring grain that was once on rail and is currently on road, back to rail. Rail Futures Institute recommends that policies designed to reduce the external costs of land freight transport, including emissions, deserve a lot more attention in the revised NFSCS than they get in the present strategy.

Under-investment in rail freight infrastructure, a regulatory and institutional environment which is not supportive of rail freight and changes in the freight transport sector have led to a significant decline in Australian regional and interstate rail freight volumes over the past 30 years. This requires major policy reform at all levels of government to assist the revitalisation of Australian rail freight. It is currently far more difficult to invest in and operate freight trains than trucks. It is a situation that the current National Freight and Supply Chain strategy has failed to effectively address.

**Emissions From Rail vs. Trucking**

**Sam Forman  
December 16, 2022**

**Submitted as coursework for**[**PH240**](http://large.stanford.edu/courses/2022/ph240/)**, Stanford University, Fall 2022**

**Introduction**

|  |
| --- |
|  |
| **Fig. 1:** Freight train transhipment. (Source: [Wikimedia Commons](https://commons.wikimedia.org/wiki/File:ACTS3.jpg)) |

The transportation sector plays a significant role in our daily lives, enabling us to move people and goods from one place to another. However, the emissions generated by transportation are also a major contributor to climate change, responsible for 26% of all global greenhouse gas (GHG) emissions. [1] In this paper, we will analyze rail and trucking energy consumption in the context of freight transportation.

We will begin by identifying the contributions to emissions of the two modes of transportation, and then examine their fuel efficiency. Well then discuss the economics of freight rail and trucking to discern the degree to which fuel efficiency influences overall cost structure. Finally, well discuss what the implications are on reducing emissions.

Overall, reducing emissions from the transportation sector is crucial for mitigating the impacts of climate change and creating a sustainable future. This paper aims to provide an overview of transportation emissions from freight rail and trucking, as well as the extent to which the difference in emissions plays a role in mode choice.

**Comparison of Freight Rail and Trucking**

As of 2014, freight rail resulted in 21.2 metric tons of GHG emissions per million ton-miles while trucks emitted 154.1 metric tons of GHG per million ton-miles. [2] ***This makes rail over seven times more energy efficient than trucking in terms of GHG emissions. This discrepancy carries into fuel efficiency as well. Trains measure in at 477 ton-miles per gallon of fuel, while for trucks it's only 145 ton-miles per gallon. [2,3] This is primarily because the rolling resistance of steel wheels on rails is less than that of rubber tires on the road.***

***Despite being far less fuel-efficient, trucks are still the most common mode of freight transportation globally.*** For example, trucking composes 77% of all freight transportation in Europe while rail only accounts for 8%. [4] **One reason why the difference in energy efficiency doesn't have a large impact on choice of mode is that fuel makes up a relatively small portion of costs, representing 21% of trucking costs and an even smaller portion for rail. [5] The process of transhipment (for example unloading containers from rail cars, loading them onto trucks, and then delivering goods to their final destination, as pictured in Fig. 1) represents 62% of cost for an average freight rail shipment. [6]**

**As a result, rail tends to be poorly suited for short trips**. Additionally, rail tends to be less reliable, making trucks more popular for high-value and time-sensitive goods. Therefore, shifting freight from truck to rail has little to do with improving fuel efficiency.

**Conclusion**

It is clear that reducing emissions from transportation is crucial for mitigating the impacts of climate change. Given that rail emits one-seventh of the greenhouse gasses as trucking per ton-mile, it's tempting to say that it should be the mode of transportation of choice for shippers. But the respective cost structures and reliability of each mode make the difference in fuel efficiency almost immaterial to cost and give trucking the upper hand.

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#### Economic impact of rail’s freight decline in share

Rail has carried a mostly stable volume of freight since 2013–14. This means trucks have carried almost all the increased freight traffic. This has negative economic impacts on the state, including by:

* reducing road safety
* increasing road maintenance costs
* reducing amenity for regional and metropolitan communities due to truck noise and vibration
* increasing traffic congestion
* increasing vehicle emissions.

#### Advantages of carrying more freight on rail

Carrying more freight on rail would reduce the number of trucks on Victoria’s roads. This would:

* decrease traffic congestion on freight routes
* lower truck-related emissions
* help the transport sector meet the state’s legislated commitment of net-zero emissions by 2050
* reduce traffic accidents and support Victoria’s road safety vision of zero road deaths by 2050.

##### Specific economic externality benefits

The department’s 2021 evaluation found that up to $4.9 million in savings on negative externalities could be attributed to the scheme, as Figure 2D shows.

**Figure 2D: Avoided externality costs and benefits from the scheme**

|  |  |
| --- | --- |
| Tree icon | **Environmental costs**. These include:   * greenhouse gas emissions * air pollution * noise pollution * water pollution * nature and landscape impacts * upstream and downstream impacts.   Rail freight is estimated to produce 16 times less carbon emissions than road freight per tonne-kilometre travelled. |
| Car crash icon | **Crash costs**. These are a function of the number of vehicle kilometres travelled by each transport mode. Rail transport has much lower crash rates and related costs than road transport. This results in potential benefits when freight shifts from road to rail. |
| Maintenance icon | **Maintenance**. Freight transported by trucks and trains creates wear and tear on roads and railway lines respectively. The cost of maintenance to rail lines is generally passed on to rail operators through rail access charges. Meanwhile, truck registration fees do not usually cover the full cost of damage that trucks do to roads. |
| Traffic icon | **Congestion**. Freight transported on roads adds to the number of vehicles on the road network. This increases congestion in both regional and metropolitan areas.  Freight vehicles are usually larger and slower than most other vehicles and further contribute to congestion. |

Source: VAGO, based on information from the department.

[Back to top](https://www.audit.vic.gov.au/report/effectiveness-rail-freight-support-programs?section=#feature)

### 1.3 Government investments to support rail freight

To achieve its policy intention, the government has invested in several rail freight support programs, including:

* the Mode Shift Incentive Scheme, a rebate to incentivise certain regional export freight handlers to use trains instead of trucks.
* an urban Port Rail Shuttle Network, a short-haul urban rail system that will give freight operators more direct dock access at the port.

Figure 1D shows the sites for these programs.

**Figure 1D: Mode Shift Incentive Scheme and Port Rail Shuttle Network sites**

Source: VAGO, using department information.

#### The scheme

The scheme aims to encourage road freight to move to rail by making rail freight more cost-effective.

Under the scheme, the government pays private operators of 4 regional intermodal terminals a rebate for each container they move by rail instead of road.

The scheme has operated since July 2012, when the government first allocated $10 million over 2 years.

The 2014–15 Budget included funding for the scheme over 4 years to 2017–18.

From 2018 to 2019, the government extended the scheme on a yearly basis. No other rail freight operators, beyond the current 4, have accessed the scheme since 2015.

According to the department’s Annual Report 2021–2022:

| **The intermodal terminal at…** | **Is serviced by …** |
| --- | --- |
| Dooen (near Horsham) | SCT Logistics (trading as Wimmera Container Line) |
| Merbein (near Mildura) | Seaway Intermodal |
| Tocumwal | Linx Portlink |
| Warrnambool | Seaway Intermodal |

In 2020–21, operators moved 36,478 containers by rail.

In 2022–23 the government allocated $3.5 million to the scheme. This translates to a target of 42,508 containers to move by rail.

#### Consultancy report on the viability of the shuttle network

The requested consultancy report confirms that the commercial viability of the shuttle network is not certain. It identified a number of challenges to resolve.

* Trucks are estimated to have a significant competitive advantage in pricing per metropolitan container compared to freight trains, based on current pricing models and operating procedures.
* Pricing, access and operating arrangements at the port’s new on-dock rail terminal are not yet finalised.
* Upon opening, the port’s on-dock terminal will not operate on weekends and only during daylight hours unless there is a commercial driver and enough volume to extend service hours. This may not align with available freight rail paths to the port, particularly from Dandenong South.
* Freight train paths for Somerton and Dandenong South cannot be allocated until rail operators are appointed for these sites.

The viability report also confirms that Webb Dock’s lack of a rail connection is a critical challenge to the success of the shuttle network.

Specifically, the report notes that without a rail connection at Webb Dock, this expected container growth could reduce the pool of ‘contestable’ containers that could be shifted from truck to train. The report estimates that this reduction could range from 33 to 40 per cent.

The department aims to advise the government in the second half of 2023 on potential interventions related to freight and port policy, regulation, pricing and operational procedures.

#### Availability of sufficient freight rail paths

Under the shuttle network contracts, the department is not responsible for procuring or supplying freight rail paths. Developers need to seek paths from rail network managers based on their own commercial requirements.

The shuttle network needs sufficient and suitable train paths to be successful. Leaving this to the private sector to resolve could lead to suboptimal commercial outcomes unless the department exercises sufficient influence and support.

Metro Trains Melbourne (Metro) manages the metropolitan rail network. Metro is responsible for allocating paths and granting access to rail operators wanting to run freight services that use metropolitan tracks.

Metro has analysed the current and future freight challenges for the metropolitan network. It has developed its own network plan, which examines the challenges that more rail freight paths will bring to the metropolitan rail network.

Specifically, Metro has noted the particular challenge of the Dandenong rail line, which has many competing demands and limited paths for freight trains.

The department has a role to lead and coordinate stakeholders to help deliver the government’s rail freight policy intent. It has not fully analysed potential freight train path conflicts with the publicly stated expectations by the government about the shuttle network’s capacity to divert more freight from trucks to trains.

The department’s actions to date have not resolved issues around freight train path certainty and availability. Nor have they resolved other potentially conflicting government commitments, such as the announcement that airport rail services will run every 10 minutes. This proposed passenger train frequency could reduce available freight rail paths on the Cranbourne line and make the Dandenong South shuttle network site less viable.

#### Recommendations about the shuttle network’s viability

| **We recommend that:** |  | **Response** |
| --- | --- | --- |
| Department of Transport and Planning | 6. Assess the Port Rail Shuttle Network’s wider commercial viability challenges identified by its commissioned research and advice, and work with its experts and advisory committee to provide an action plan to the government before the end of 2023 (see Section 3.4). | **Accepted by:** Department of Transport and Planning |
| 7. Use its leadership and coordination role in the transport and freight sector to deliver the government’s rail freight policy intent and the Port Rail Shuttle Network’s public commitments by:   * specifically analysing the rail network’s configuration and capacity and whether it is sufficient to deliver the contracted freight volumes or services * liaising with the Australian Rail Track Corporation on what freight paths will be needed by the private sector operators on the standard gauge network * advising the government on any other specific and practical actions that may be required to support operators to deliver their contracted volumes and services (see Section 3.5). |  |

##### reasons for rail freight’s decline from 2018–19 to 2021–22

Underperformance was largely outside the control of the freight operators that the scheme supports. The department told us the reasons include:

* climatic conditions, such as drought in 2018–19 and 2019–20 and wetter than normal weather conditions in 2022–23, which disrupted or delayed agricultural seasons and reduced freight volumes
* the COVID-19 pandemic, which disrupted container supply chains. This meant some operators could not source enough empty containers and reduced the rail freight carried
* rail freight operators not being certain whether the Port Rail Transformation Project would significantly improve the efficiency of regional rail trains at the port to make them more cost competitive with road transport
* **regulatory changes that have made road freight more efficient, increasing its cost advantage over rail. These include allowing high-productivity road freight vehicles and A-double trucks with bigger load limits on major highways**
* rail infrastructure works that disrupted some operators’ rail access.

##### Inclusion of some road freight in rail freight data

The reported data on actual container movements by rail under the scheme for 2020–21 and 2021–22 is inaccurate because the department included some containers that were moved by road under the scheme.

The scheme’s current funding agreement allows the government to pay operators to move containers by road where the government’s actions have directly led to a temporary and unscheduled loss of access to the relevant rail network.

One of the operators legitimately used this provision. It moved over 2,000 containers by road under the scheme between 2020–21 and 2022–23.

##### Opportunities for the department to gain more assurance

Despite these provisions, the department has not:

* used its right under the funding agreement to audit funding recipients to verify the accuracy of claimed container movements
* sought to verify the accuracy of container movements that scheme recipients reported against the rail or port operators’ information on actual container movements, except for the relatively infrequent and limited container movements where recipients are seeking funding under the scheme for containers moved by road
* enforced funding recipients’ requirement under the scheme to include details on the specific dates of container movements on invoices. Only one of the 4 funding recipients consistently complies with this requirement.

The department could have done more to gain assurance about the validity of around $39 million in scheme funding paid out to recipients from July 2012 to December 2022.

Activities such as audits and cross-checking of invoices against data sourced from third-party rail or port operators would give the department more assurance about the scheme’s expenditure.

##### Funding spent on activities other than moving freight

Between 2018–19 and 2021–22 around $3.2 million, or just over 20 per cent, of the funding available under the scheme was not spent on directly supporting rail freight.

Instead, the government approved the department’s requests to spend this money on other related activities. These included evaluations and business cases for the scheme.

##### Findings of the review of the shuttle network’s viability

The consultancy report confirmed that the commercial viability of the shuttle network was not certain. It identified a number of challenges to resolve:

* Pricing, access and operating arrangements at the new on-dock rail terminal at the port are uncertain because the future operator has not yet published its rates.
* Trucks are estimated to have a significant competitive advantage over rail per metropolitan container, based on current pricing and port-precinct operating models.
* The new on-dock terminal, in its initial operating phase, will not operate on weekends and only during the daylight hours of 6 am to 6 pm. This is unlikely to align with available rail paths to the port, especially from Dandenong South, as well as the shuttle network operators' operational needs.
* No freight train paths for Somerton or Dandenong South can be allocated until a rail operator is appointed for these sites. This will need to happen closer to when they are ready to start services.

##### The department’s role as a rail freight coordinator

Beyond the contractual and operational activities it oversees and delegates, the department leads and coordinates many stakeholders to help deliver the government’s policy intentions for rail freight.

The department has established a number of ongoing and ad hoc forums that consider rail freight issues. These include:

* the Freight Executive, which gives consolidated freight advice to the department’s executive. It has members from various areas of the department as well as senior representatives from V/Line and VicTrack
* intergovernmental committees, which oversee key Australian Government-funded investments. These can specifically focus on co-funded projects, like the shuttle network, at particular delivery stages
* ad hoc committees that include the shuttle network’s private sector developers.

We observed that the department liaises with the ARTC and Metro mainly about operational rail issues, not whether practices or policies align with the Victorian Government’s broader policy goals to increase the usage of rail freight.

The department will need to develop a more formal and strategic relationship with ARTC in the next few years, particularly when the building of the 2 proposed Inland Rail terminals gets under way.