Integrity

Defining , demonstrating and saving your own soul

Les Chambers

Deinos

I want you to do a Huckleberry Finn and picture yourself at your own funeral. The pastor stands and delivers the eulogy. "Les was kind, brave, honest, empathetic, humble, inclusive, serene in crisis, he committed and then he delivered, he was incorruptible with a solid sense of right and wrong, he did good and was good." (I wish). You'll never find these words in a resume, but when it's all over, really, it's the only thing that should matter and if you do a causal analysis on any of the great engineering disasters, it's the only thing that did matter.

We are all disposed to do good - but you know there have been times when you were - bad. The Greeks had a word for it: deinos. They traced the degradation of the human condition over time with the symbolism of metals - of progressively decreasing value. From the golden age when the lion laid down with the lamb and there was no war - through the ages of silver, bronze and iron - where brother murders brother, bad men use lies to be thought good and there is "no help against evil".

In 2008 I sat at a conference table and watched sworn enemies exchange pleasantries over weaponized software - with the occasional cup of tea. It was my 34th year as an engineer. The target system was combat management. Party A was offering Party B proven killing functionality. How so: proven? Because Party A regularly used it to lay waste to the cultural brethren of Party B. It was good stuff, proven in use.

Impassioned lovers would rather be miserable together than be apart. Impassioned engineers fall in love with technology without regret that their cleverness kills people.

This is deinos in practice. It's easy to rationalise because intimate distance is involved. There is nothing more intimate than killing someone, but it's done at such a distance in space and time, it's easy to ignore how terrible it is.

At the conference table there was talk of communication problems between tanks and aircraft in the battle zone and I realised that these were the guys who had recently dropped cluster bombs and fired artillery shells into built up areas. Later on some Spaniards taught me how battle had a rhythm and with the right surveillance networks and central control, tanks and aircraft could wipe out the enemy to the music of TCPIP with a skeletal army.

We were working hard so there was no time to reflect but in my quieter moments I wondered at the morality of what I was doing. I COULD use my skills to further the cause of humanity, instead here I was in the desert building a killing machine - doing murder from money. Was I acting with integrity?

On a day off we drove into the Rub' al Khali, the empty quarter, a thousand kilometers of rippling, rolling peach coloured sand hills, an eternity of majestic, beautiful, nothing.

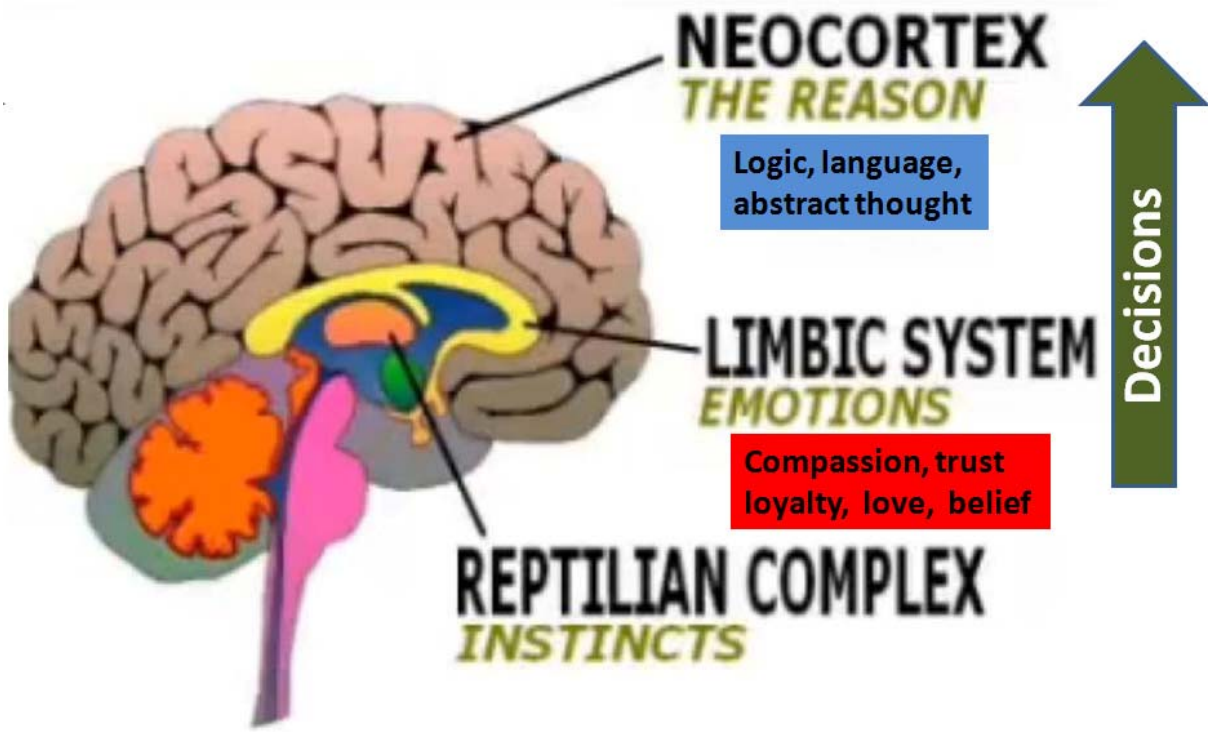
We stopped the four-wheel-drive, turned off the engine and stared into the void. In the silence of the desert you slip into a state of no-mind, unburdened by thought and open to everything. The 50 degree heat seeps into the brain and thoughts turn inwards - like walking into a darkened room and asking yourself, "Why am I here?".

We are sentient beings. We feel and we think, and we observe what we're thinking, and I could not detect any sign of regret for what I was doing, no pangs of conscience no deep pain of the soul that you suffer when your actions do not align with your value systems.

Rationalisation

I felt no pain because I'd rationalized my involvement. We were building a defensive weapon, and for friends. I'd come to know the Arabs, I'd asked about their poets, they give me a beautifully bound copy of the Qur'ân and told me where to start reading (the part about Mary and the virgin birth). It turns out we've been brought up on the same stories. The thought of them being overrun by their nasty neighbours across the water, just gave me the horrors. Anyway, I was a bit player in this scenario, one member on a team of thirty. And the end result of my work was years into the future. And if by some trick of space-time, I was transported back to this desert in the aftermath of a battle I could speak to the dead without guilt, "You had it coming, you attacked my friends, I acted with integrity and I'm not responsible."

Rationalisation is more important than sex, we can do without sex for a lifetime, but try getting through a day without a rationalisation.



Neuroscientists tell us that rationalisation occurs in the neocortex, the home of logic and language. It justifies the thoughts that bubble up from our limbic system, that part of the brain that hosts our feelings of compassion, trust, loyalty and love - the place we hold our beliefs. If you're profoundly moved by a story, a painting, a song - but can't explain why, it's speaking to your limbic brain. It has no language but it's the place you make all your decisions.

As we shall see some rationalisations can be hazardous, justifying pathological behaviour and obscuring our vision of "what is". Sociologist Diane Vaughan called this “the normalization of deviance”.

Moral Realism

Let me now admit my fraud . I have not come here to lecture you on integrity, I have come for selfish reasons, I have come to confess. I don't want your absolution or your pity. Just the act of researching this talk has given me immense pleasure and some catharsis. In doing the reading I've discovered a moral vocabulary and a process of ethical analysis. Digging deeper I've found that practising total integrity is a goal that none of us will ever reach because we are human, as Lord Tennyson explained in his poem, Ulysses.

> *I am a part of all that I have met;*
> *Yet all experience is an arch wherethro'*
> *Gleams that untravell'd world whose margin fades*
> *For ever and forever when I move.*
>
> Tennyson, Ulysses

> *What a relief it was to find that it's okay to be flawed because everyone else is!*

But there's more: the quality of our lives is bound up, not in attaining perfection but in the intensity of our struggle. We seek happiness but are formed through suffering. The best of us stumbles, recovers, then tries again with renewed resolve.

The stumbling part is a moral reality - so well expressed by Immanuel Kant:

> *Out of the crooked timber of humanity, no straight thing was ever made.*

So be aware, if we build them a bomb they'll drop it on children, if we create an Internet they'll use it to rob banks, if we put a computer in an engine management system they'll use to cheat emissions tests. All of our inventions can be used for good or ill, so how much of this is our responsibility and why should we care? And the answer is:

> *If a system has integrity, it was put there by us. If a system lacks integrity, it has taken on our own crooked timber.*

The Bypass

"At the first turn of the screw, all debts are paid," said the sailor who went to sea to escape his creditors. For me, it was the first spin of the turbine. The project ended and I flew home, distance offering absolution from any doubt of my own integrity. Or so I thought.

As the undercarriage hit the tarmac my phone rang. It was an old client inside a state highway authority. The government was constructing a freeway that included a short tunnel.

The tunnel had water deluge and smoke extraction systems and the automated signage you need to safely shut down a freeway if there's an accident or fire in the tunnel. IEC 61508 had been mandated for the safety systems and they needed help with compliance. This was an "alliance project", executed by a friendly band of companies which included the client: the government. There were financial incentives for cooperation between contractors. There were penalties for late delivery and bonuses for early delivery.

My early involvement was two days per week, some advice here, an audit there, pretty much low stress all care and no responsibility. But after a while it became clear that more was required. I was drawn in. I wrote a Functional Safety Plan which anointed me Project Safety Authority. As the opening date approached there was disagreement between the contractors responsible for fire protection and intelligent transportation systems. No one wanted to take responsibility for overall system testing. So, "in the spirit of the alliance" I volunteered. I was now full time, so I moved into a flat overlooking the ocean and set to work.

Life was good. With no wind the ocean swells at dawn were smooth as the Saudi sand hills and just as calming on the mind. And I loved the work, learning the minute details of how these systems worked and, as a tester, plotting their destruction. I wanted the responsibility and leaned into it. Like

back in the day when I held total responsibility for automating large chemical reactors. One of the great joys of that environment was the fellowship of competent like-minded engineers. That satisfying feeling of being part of something that is bigger than you, that was there before you came and will endure long after you're gone - for me, engineerng is both a profession and a vocation.

Encounter with Bert

System testing revealed that the behaviour of the integrated system was not strictly as per the requirements specification. We covered this with the client and "in the spirit of the alliance" the unspecified behaviour was accepted, but I was concerned. The defect density was high and the system was unstable. My other worry was the operators.

They were being trained with out-of-date information. System behaviour had changed. So I set about injecting some reality. My encounter with the training manager went something like this:

INTERNAL: CONFERENCE ROOM

Les approaches Bert who is standing in a corner.

Les: Bert, there's a 20 second delay between hitting the deluge switch and the water emitting from the nozzles. The operators might think the system has failed and turn it off. All your operators need to initiate a deluge at least once so they'll know.

Bert: No, we don't need to do that.

Les: Look mate! This is critical! Given that everything else works these operators will be the single point of failure in an emergency.

Bert: It's not necessary Les, I'll shoot them a memo.

Now Les knows that road to integrity cannot be travelled alone, we all need help from outside - exemplars to emulate, correct, encourage, support and inspire.
Also, moral outrage sharpens focus.
Crisis simplifies language.
So, Les moves in front of Bert so he cannot physically escape without knocking Les down and walking over his face.

Les: Bert! Fucking do it Bert!!

Bert: OK Les.

And thus it came to pass that the operators went down to the control room and dropped deluge after deluge on the face of the earth at a rate of 6000 litres per minute. And darkness was upon the face of the project manager for he was trying to paint lane markers at the time. But this was a golden moment for me, as the spirit of best practice had moved upon the face of these waters. I felt immense satisfaction, convinced I'd moved operational integrity a few inches forward. But that wasn't the end of it.

Encounter with Jack

We were months ahead of schedule but the push was on because the alliance partners stood to gain large bonuses for early delivery. Unfortunately, the intelligent transportation system contract had been let late so nature dictated it would be delivered late. So, it wasn't long before we found ourselves on the critical path, which qualified us for a visit from the manager of this half billion dollar project. I'll call him Jack. Jack was six foot two, good looking and a charming people person, unless and until you found your way onto his critical path. The encounter went something like this:

INTERNAL: CONFERENCE ROOM

The commissioning team is seated, chatting.
Jack enters and towers over them. His body language indicates that he is bent on oratory and not craving their conversation.
Jack points at the commissioning manager.

Jack: Here is the opening date. Put it in your schedule and work back from there.

Jack moves towards the door.

Les: We're not gonna meet that date Jack. We're not magicians. This is a safety critical system with stringent compliance requirements. We are forty test cases short of completion. So far I've logged over two hundred major defects. Just the rework and retesting of that lot will take weeks.

Jack makes a waving motion with his hand is if to fend off a fly.
He addresses the functional safety program.

Jack: Les, I thought we weren't going to do this.

Les stares blankly at Jack.
Jack exits the conference room.

I was struck dumb, incapable of rational thought, as anger snuffed out the lamp of my mind. For with that wave, Jack had trivialised the entire discipline of functional safety engineering, he had devalued my profession, my career, my vocation, he had disrespected all the people who toiled to keep the public safe - not only on this project but on all projects that have ever been and will come. I had no words, no vocabulary to counter his pronouncement. I watched silent as he left the room. Later he asked for my defect reports. He worked through them downgrading the severity levels thus proving that, "Problems? There were no problems."

Moral Analysis

There was crooked timber all over this scenario, but whose was it? Mine or Jacks?

Lets halt right there and do some analysis:

> *Anger is a delicious emotion but it has no remedial effect.*

Anger is one of the many symptoms of utilitarianism, that primal desire to satisfy our immediate needs. And so too are greed and pride. We see money; we've been without it in the past, so we grasp it when it's available. These are strong urges, hard to withstand.

Jack could see the early delivery bonus, he could see his name going up in lights; and here comes Les Chambers and his overzealous defect report. This geeky engineer, representing a generation of bad salesmen, intelligent but full of self doubt, peddling nothing. "Spend this million dollars," we say. "And what do we get for that," they ask. "Trust us," we say. "Nothing bad will befall you."

I had something Jack wanted - a commissioning date. To him that made me a villain who needed to be crushed like a bug. And that wasn't going to be hard because functional safety IS a hard sell. WE know what we are doing, but if you've never seen blood why should you buy? If you've never made a mistake that could (or did) kill someone, why should you care? "Pay money for nothing? Huh?"

And sometimes it's an impossible sell as evidenced by disasters such as Bhopal (1984), Chernobyl (1986), the Air France crash in the South Atlantic, and more recently the VW emissions scandal. All these disasters had their root cause in pathological human behaviour: inadequate pilot training and, in the case of VW, greed, pride and creeping dishonesty - the normalisation of deviance.

Adapt and Overcome

This is bad and this is sad but it's not our role to complain, it's our job to turn up with solutions, to adapt and to overcome.

The crooked timber school of moral reasoning says that Jack-like behaviour is with us forever. And it can only be overcome with a strong moral code that gives us certainty that what we are doing is right; a code that gives us the wherewithal to recognise manifestations of the crooked timber and the courage to oppose them. Integrity is a performance art, honed in the day-to-day, and only demonstrated under pressure - the greater the pressure, the deeper our discovery of our own true nature.

Had I not been so mad at Jack I might have separated "the dancer from the dance" and clinically diagnosed Jack's pathology as: "inexperienced project manager performing unrealistic-schedule-crashing".

If our profession had such a thing ...

I could have referenced classical hazardous event sequences that cause harm. I could have pointed to the page that read, "Untested systems are full of unintended consequences. Prepare for unpleasant surprises." I could have reeled off a list of inadequate test programs that ended in tears: Chernobyl, Obamacare, Queensland Health payroll ...

If our profession had such a thing ...

I could have referenced a shortlist of bad behaviours and called out the one Jack just executed. I could have tried persuasion with an appropriate metaphor. "Picture yourself in the dock Jack. You ignored professional advice, you engaged in documented bad behaviour, you got someone killed. The prosecutor approaches. What's your defence? "

Clinical behavioural analysis does work. It trades on the reality that not only do we think, but we are aware that we are thinking. They call this mindfulness. We are also aware that some of our thoughts might be toxic. No one but a complete megalomaniac is completely free of self doubt. A calm and clinical classification of a behaviour that separates the dance from the dancer can give the subject pause. Redemption is possible. Later, when I'd calmed down, I told my boss that Jack's behaviour was so common and so destructive that it'd been documented in the literature. This caught his attention. He asked for a citation. I couldn't give him one.

I've since created one on my blog: *Deus Ex Machina and Speaking Truth to Power* [2]. And the moral of that story is:

> *Pathological behaviour can be defeated first by classifying it and then by aggressively opposing it.*

And lastly I could have documented my prediction of what would come, and indeed what did come, and, if we had such a thing, put it into the professional canon as a warning to future safety authorities.

The Opening

The freeway opened with the commissioning team thirty test cases short of completion and a multitude of unresolved defects. In its first week of operation, the system failed executing an un-commanded shutdown of the north-south carriageway. Two days later it failed again shutting down the south-north carriageway. There were bad optical fibre joints that triggered network disconnects and reconnects. The system was designed to recover but on these two occasions a supervisory control computer blasted a stream of random bytes at a slave controller. One of those bytes had a single bit that was the tunnel shutdown control. The controller had no defence in depth. No one had thought to use a 16-bit word to defend against random controls.

Stationary motor vehicles on a freeway are a hazard. In freeway driving people fall into a somnambulistic state where anything stationary is unexpected and back-of-queue collisions are common. We were lucky. The shutdown sequence performed flawlessly and no one was hurt.

The morning after I drove into work to a chorus of lies. The crooked timber was manifesting on the radio: no problem, these were scheduled shutdown's, everything's under control. But through the lens of moral realism I could see only one truth:

> *That pathological behaviour by senior management, unopposed by a feckless safety authority had allowed the crooked timber of humanity to compromise the integrity of a safety critical system, putting the general public at risk.*
>
> *To put it bluntly:* ***I had come close to doing murder for money.***

The Wisdom

Wisdom isn't a body of knowledge it's a process of solving dilemmas in the presence of imperfect information. It can't be taught, it must be learnt through experience so here is mine.

On reflection, I was faced with a common moral dilemma. A situation were two credible moral propositions conflict. On the one hand there was my duty of loyalty to the client and on the other, my duty of care to the public. So, where did my loyalty lie?

But moral propositions are seldom equal, some are more loved than others and probability is always involved. For example, a defect severity level is a matter of opinion so wisdom must be applied and the quality of that wisdom is a function of experience, I had 34 years, Jack had none. A hard line safety authority would have made two points:

1. Jack you are not competent to put a severity level on a complex systems defect
2. Jack, you have a massive conflict of interest in involving yourself in this process at all, given the bonuses you stand again if we ignore these defects.

But I was silent, and for two reasons:

1. **Self-doubt.** Was I being overzealous? Was 61508 SIL 2 compliance overkill for this project? Whenever I pushed hard they'd tell me, "For Christ's sake Les, chill out, this is only a 330 metre tunnel. It's an oversized underpass. She'll be right." And so, with this mantra, was deviance normalised.
2. **Personal bias.** I thought that the worst case failure would be an uncommanded deluge causing loss of visibility and vehicle collisions, but when we tested the system the downpour was no worse than a tropical storm, a regular occurrence in these parts. So I came to agree that she'd be right.

This made it easy to chose loyalty to the client (and the promise of further cash flow) over uncompromising compliance with best practice. I could have pushed harder as I did with Bert, I could have gone to the Fire Brigade or the State Premier and made the case for delay. But I didn't **and I was wrong**, and in this potentially catastrophic mistake lies the essence of integrity. Integrity is uncompromising adherence to a moral code. And the process whereby you develop the strength to achieve this is the subject of the rest of my talk.

Action

If the quality of your life is measured by the intensity of your struggle I was left wanting. The same could be said for our profession. It's under stress and it's failing. Many of the flood of new applications enabled by artificial intelligence and mobile computing are safety critical and there are simply not enough experienced engineers to guarantee their safety integrity.

Silicon Valley web app developers are programming driverless cars. The Tesla motor company is claiming safety integrity with a proven in use argument; even as their customers destroy the integrity of that claim with each software upgrade the download in their garages overnight.

Every day systems engineers untrained in safe systems development make decisions with the attendant risk of crooked timber finding its way into aircraft avionics, driverless cars, x-ray machines and body implants. Who will mentor them on integrity? Where are their exemplars?

Our profession needs work, any profession with members prepared to participate in a VW emissions spoof for eight years without a single whistle blower needs work.

Intervention is required.

> *The engineering profession must not only preach but also aggressively defend the integrity of systems engineering where ever it is practised. It must be seen as an authority to be reckoned with, an organisation dedicated to public safety, that supports engineers who act with integrity and therefore stands above the crooked timber.*

Solutions

We're engineers, we need to turn up with solutions. The essential elements of any strategy should include:

1. Defining integrity
2. Instilling integrity
3. Practising and maintaining integrity

Defining Integrity

How can you point at someone and say, "That person has integrity." I'll tell you that integrity is not a static property of a human being. Surface attributes such as speaking style, dress, stated values and attitudes, expressed when nothing is at risk mean nothing. Integrity is revealed through humanity in jeopardy and under pressure.

Integrity is adherence to a moral code. Practicing the code requires surrender to a set of rules that we did not make and faith in the accumulated wisdom of the engineering profession - a concept well stated by theologian Reinhold Niebuhr in 1952:

> "*Nothing that is worth doing can be achieved in our lifetime; therefore we must be saved by hope. Nothing which is true or beautiful or good makes complete sense in any immediate context of history; therefore we must be saved by faith. Nothing we do, however virtuous, can be accomplished alone; therefore we are saved by love.*"[1]

And that love must be strong because when the time comes for an engineer to demonstrate integrity **it will not be a sunny day**. It will happen in the pressured depths of a deadline death march, amongst the clash of big egos and the intimidating utilitarianism of Jack-like archetypes - where decades of best practice can be dismissed with the wave of a hand as the mob surges forth driven by greed, hubris, pride ... rather than logic.

> ***Hear my message:***
> ***If you find yourself in this situation where all around you have surrendered to toxic emotions, logic will not work, you must demonstrate INTEGRITY and become the NASTIEST GORILLA IN THE ROOM.***
> **Never underestimate the power of straight talk backed up be evidence - the power of "Fucking do it Bert!"**
>
> ***To do anything less is to risk doing murder for money.***

Instilling integrity

This "nasty gorilla" act requires confidence born of certainty. Engineering is not a religion but, put under stress, engineers do require the conviction of our "truths made sacred". At the point of meeting Jack, I'd spent more than three decades in safety critical systems and was certain of some sacred truths and where the red lines lay. The things you don't do under any circumstances - commission a system without adequate testing for instance.

But for the less experienced, practising integrity must be an act of faith; where faith is belief without proof. Proof for me was a near miss were inadequately tested software almost destroyed a 6,000,000 dollar chemical reactor - and the mother of all proof: looking into the eyes of a man whose defective design had killed an operator. The eyes are a window into the soul and his was one tortured soul.

So, if you're a rooky engineer, certainty will come with experience but until that time consider yourself a camper in the valley of death. There are things you don't know, there are values you don't have and the lack of may expose you to a life of regret. So if your workplace does not provide the environment I am about to describe find another job.

If you supervise engineers it is your job to instil integrity. So consider this:

Integrity lies in the realm of belief. Beliefs are part of our emotional life. They cannot be commanded but they can be influenced. Because they reside in the limbic system, they don't respond well to logic. Only the neocortex traffics in logic, reason and language. From the literature we learn:

> *A person cannot direct his emotional life in the way he bids is motor system to reach for a cup. He cannot will himself to want the right thing or to love the right person or to be happy after a disappointment or even to be happy in happy times.*
>
> Thomas Lewis et al, *The General Theory of Love* p33

But there's good news, storytellers have known for millennia that:

> *an idea wrapped in an emotional charge has the power to engage and influence.*

Hence Lewis's conclusion that poetry is a bridge between the neocortical and limbic brains. In teaching behavioural analysis I could entreat you to be objective, to separate the behaviour from the person or I could just quote the poet Yeats:

> *Oh body swayed to music, O brightening glance*
> *How can we know the dancer from the dance?*

I could lecture you on the normalisation of deviance or I could tell you this story.

> *First they came for the Socialists,*
> *and I did not speak out –*
> *because I was not a socialist.*
> *Then they came for the trade unionists,*
> *and I did not speak out –*
> *because I was not a trade unionist.*
> *Then they came for the Jews,*
> *and I did not speak out –*
> *because I was not a Jew.*
> *Then they came for me –*
> *and there was no one left to speak for me.*
>
> *— Martin Niemoller, 1892 - 1984*

So try communicating through stories with images and metaphors. People don't remember what you say, but they do remember and internalise what they were visualising while you were talking. Give them something to imagine and it'll stick.

Repetition is the key because:

> *We become that on which we focus*
> *and it changes us*

So, wrap our ethical standards in stories and follow them with practice. Repeat, repeat and repeat, giving your charges cause to reflect on the meaning of best practice at least once every week. In chemical processing plants, this took the form of safety meetings where stories were told of safety incidents, the chains of events and the barriers that could have avoided them. Then we would go out into the plant and not return until we had found a hazard.

Then there is behaviour correction. Like Bert, everybody needs redemptive assistance from the outside. Tomes full of best practice are useless unless managers insist on compliance.

The most important goal of engineering design reviews, job performance appraisals and project audits is to correct behaviour. In the mid eighties I had my work reviewed by two Americans from the space shuttle program. Over a two hour Fagan review they clinically tore my work apart. I was in awe of their professionalism, I was never offended, they demonstrated the meaning of quality and changed my behaviour forever.

Finally everyone needs immersion with exemplars. Lack of integrity is seldom due to weakness of character: more often it springs from ignorance of what is good. Philosopher Alfred Whitehead argued that,

> *Moral education is impossible without the habitual vision of greatness.*

The civil engineers I worked with on the freeway project were highly competent in their own field but when it came to safety critical systems they just didn't know what they didn't know. They had never had an exemplar (just a swearing safety authority).

By a stroke of genuine good luck I was hired straight out of university by the Dow Chemical Company and immersed for 10 years in one of the world's strongest safety cultures. Highly experienced American chemical engineers taught me my trade. The fellowship of these exemplars is the reason I am here - swearing at you - today.

So, hear this truth that I hold fucking sacred:

> *That engineers who do not study and reflect on the meaning of integrity and do not have their integrity regularly tested, even in small ways, will not act with integrity in a crisis, as we have seen at VW, Chernobyl, Bhopal and on and on ...*

At University

The engineers' long journey into professionalism starts at University. In this place they must be taught the "truths made sacred". When they graduate they should at least know what good is and have the green shoots of motivation to do it.

In teaching "good" let us NOT have self-contained subjects called Ethics, instead let's infuse all engineering subject matter with elements of the "truths". Let us:

1. **Shown them the meaning of integrity.** Work through case studies of classical moral dilemmas (as I've related) - find ways to put them under the same pressures they'll experience in real life
2. **Acquaint them with the horrors of failure in a visceral way.** Require study of great engineering disasters: the Armagh rail disaster, the Challenger explosion, Chernobyl,

Fukushima and so on. And by visceral I mean, show them what a human body looks like after it's hit the ocean at just under the speed of sound

3. **Introduce them to the crooked timber.** Teach them to recognise character archetypes and the pathological behaviours that end in disaster such as the normalisation of deviance and unrealistic schedule crashing
4. **Teach them to venerate exemplars.** Require them to study of the great engineers and technologists: Mary Somerville, Ada Byron, Maxwell, Tesla, Marconi, Edison, Monash (AIF WW I), Peggy Whitson, Deek Slayton and Neil Armstrong (NASA), Kelly Johnson (Lockheed Skunk Works), Marissa Mayer, Larry Page, Sergi Brin (Google & Yahoo) ...
5. **Socialise them with contemporary exemplars.** Working engineers who've seen blood need to come in from the field and tell their stories. Not once a semester - but once a week. In third year, the engineer who ran the computer's at Brisbane's Swanbank Powerhouse lectured me on computer control - this man launched me on a 43 year odyssey through fantastic islands and foreign lands - I've yet to return to Ithaca - I assume Penelope has remarried.
6. **Show them how integrity is validated in the real world.** Instruct them in the philosophies and the requirements of critical industry standards. For example, aspiring control systems engineers should have a detailed knowledge of IEC 61508.

In short, let us present engineering as both a career and a vocation. A career can be taken from you. You can be fired. But a vocation cannot. It is a calling, a mission, a purpose. It is what feeds your soul. It is not something you do but something you ARE.

So if you're an academic, grade yourself against this test.

> *Your graduating class is employed by VW. They're all assigned to write emissions spoofing software for an engine management system. How many of them would flat out refuse and quit?*

If you don't know you should know. So engage them on an emotional level where integrity lives. "**Do it Bert**" for yourself and for them.

> *For too long engineers have been raised by Wolves.*

Practising and Maintaining Integrity

So, engineering's a vocation. How then should we spread the "good" word?

Can we learn from history?

500 years ago, on All Hallows Eve 1517 Martin Luther, Catholic friar, Hermit of Saint Augustine , renegade and prophet - posted a broadsheet on the faculty bulletin board of Wittenberg University, in the German State of Saxony. It proclaimed his willingness to debate a series of propositions in public. These propositions questioned the basic beliefs of the church. He was against the mediaeval Catholic conviction that remission from sins could be purchased from a papal agent - the payments were called indulgences. You send the Pope gold, you get a voucher - your sins are forgiven. They renovated St Peter's basilica with that money. Luther's broadsheet and his following 95 theses sparked the Protestant Reformation that sought to separate capitalism from spirituality and yet we struggle.

This year VW will purchase remission from the US government for billions in currency.

Peccata tua dimissa sunt VW (your sins are forgiven).

Luther was a preaching friar, he spoke, not in Latin, but in plain language. He spoke, "out of love for the truth." He appealed openly to the emotions of his hearers. He published - making skilful use of the new fangled printing press. He was successful. By the mid sixteenth century, Catholicism and Lutheranism coexisted in Europe. And as a side effect a collective German identity was forged.

So where are our renegade prophets?

Point me at the 95 theses.

Where is the collective identity of the engineering profession?

And how can we separate money from our duty of care to the people who use our machines?

I know what success looks like. I watched the Queensland Ballet dance George Gershwin's Rhapsody in Blue - it was so beautiful it made me cry. And as I watched it occurred to me that Gershwin was incapable of writing bad music, the dancers were incapable of a misstep and the orchestra, to a musician, was incapable of playing a bad note.

> *This kind of virtuosity expressed in engineering would produce people incapable of delivering an unsafe system - incapable of surrender to the crooked timber.*

The first step is always training from a young age. The second is practice in a community of exemplars.

There are many examples of this work in progress. The Queensland Academies of Science, Mathematics and Technology (QASMT[4]) in Brisbane nurtures the children that will be our future scientists and engineers.

Where is it Written?

So where are they written? These "truths made sacred"?

There are industry standards and the literature of best practice. The IEC, IEEE, the ACM and the IET all have codes of ethics - which is good. But unfortunately, while they accept your indulgences (your membership fees) and may punish you for violations, they will not stand with you if you're fired for compliance. This is explicitly stated on the IET website:

> *The IET has very limited scope to support members who feel an obligation to make a public disclosure, i.e. to 'whistleblow'.*

At VW, in the eight years that the engine management team developed their cheating software, we now know there was dissent, there was remorse, but no concerns were ever voiced to an engineering society - because they'd get no support. This is sad because words on paper, however passionate or true that are not backed up by action in the heat of a crisis, do not promote professional integrity.

I looked at standards bodies. No luck. If you want to buy a copy of IEC 61508, it will cost you AUD4000 - more indulgences. What are they renovating?

Then one night I had dinner with an old friend. Judy. She stayed on with the Dow Chemical Company after I left and rose to be the safety and loss prevention manager for Dow's Pacific area operations. Jude is the real deal. A few molecules of dioxin will kill you. Ignite an ethylene oxide vapour cloud and you'll wipe out a neighbourhood. And she said,

> *"It doesn't matter what managers do Les. Safety integrity will be preserved as long as the people doing the work are physically incapable of an unsafe act."*

It turns out that Dow engineers never, and I mean never, lose an argument with accountants or salesmen or senior managers when safety is at risk.

So we've come full circle and returned to virtuosity - in the musician, the composer, the ballet dancer, the engineer.

> *The solution is strong belief systems in the individual.*

And I'll tell you where is it written. It's written in the culture of your company and if you are its manager it's your sacred duty to reinforce these principles. The culture you create must be too strong to be torn down by the pathological behaviour of a single individual. Even someone overseeing 10,000 employees like VW's Heinz-Jakob Neusser who's been indicted by a US grand jury for driving the emissions spoofing conspiracy.[1]

Indeed, as a high level corporate initiative, Integrity must be looking good to VW right now. Their lack of integrity will cost them more than ten billion dollars in the years to come. Union Carbide has no cause to reflect as it no longer exists. The Bhopal disaster destroyed it along with thousands of innocent lives.

The Greeks were right, "there is no help against evil" and Martin Luther is not coming to save us. You've got to do it yourself. So get on with your struggle, embrace integrity, do it for humanity, do it for yourselves because:

> *a good life is organized around a **vocation**. It's better than sex or money - these things are **cravings** that can never be sated - in contrast acting with integrity feeds the soul and gives immense satisfaction.*

Loyalty

During my tunnel crisis I kept asking myself, where my loyalty should lie? On reflection I have answers: **it lies with the ordinary folk, the collective identity of the engineering profession and it transcends capitalism**. Think it through - what would you say to the victims of your inaction.

At Bhopal what would I say to this little girl.

What would I say ...

[1] https://www.justice.gov/opa/pr/volkswagen-ag-agrees-plead-guilty-and-pay-43-billion-criminal-and-civil-penalties-six

Apology

What can I say
To your dead eyes
For your lost child songs
For the sun you won't see rise

What can I say
For your growing up denied
To the boy who's lost his sister
To the man without a bride

I should say something
But, how can I say
That when I could have saved you
I looked the other way

And I murdered you for money
And I murdered you for pride
And then when asked to please explain
I lied

Now the earth falls upon you
And rain drops on leaves
And in the quiet between the notes
Nothing deceives

While the merchants count their money
The maker's keeping score
Of each wrong note the player wrote
For the tune we signed up for

So engineers, forswear your company loyalty
Piss on company pride
The only loyalty you owe is to this little one
Who died

Let not your morals perish with her
But bare them deep where none can bar
And think not of engineer as what you do
But the sum of all you are

Thank you.

About the Speaker

Les Chambers is a consulting systems engineer with more than four decades of experience in developing life critical systems. He was among the first systems engineers to control chemical processing reactors with software. Other projects have included strike jet missile systems, railway signalling and road tunnel safety systems. Working in the U.S.A., Asia, the Middle East and Australia Les has been a project manager, quality manager, configuration manager, safety authority, requirements engineer, verification and validation engineer, design authority, system architect, controls engineer, software developer and hardware designer. He is currently Managing Director of Chambers & Associates Pty Ltd, a Systems Engineering, training and consulting company he founded in 1988. Les holds an Electrical Engineering Honours Degree from the University of Queensland.

Les' commentary on systems engineering issues is at: www.systemsengineeringblog.com

Further systems engineering resources are at: www.chambers.com.au

Email : les@chambers.com.au

References

[1] Brooks, David (2015), *The Road to Character*, Penguin Random House UK

[2] Chambers, Les (2012), *Deus Ex Machina and Speaking Truth to Power*, [Online], Available: http://www.systemsengineeringblog.com/deus_ex_machina/ [6 Jun 2016]

[3] Hirschfield, Jane (2015), *Ten Windows: How Great Poems Transform the World*, Alfred A Knopf, New York

[4] Queensland Academies. Science, mathematics and technology (QASMT). Information [Online], Available: https://qasmt.eq.edu.au/our-academy/strategic-vision-values/ [6 Jun 2016]

[5] Lewis, Thomas; Amini, Fari; Lannon, Richard (2000), *A General Theory of Love,* Random House New York

