If We Engineered Systems Like We Produce Movies

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Abstract If we engineered systems like we produce movies, would our enterprise and endeavors prove leaner and more agile? We daydream on the greener pastures of movie making, an industry whose signature practices were born out of necessity, to adapt to major regulatory upheavals in the 30's Hollywood, and have since proved remarkably effective & resilient. We journey through odd ways of tackling strangely familiar problems, subtly different organizational patterns, and seemingly unreasonable, yet strikingly efficient practices. Could we gain some insights or fresh ideas, to renew and better up our own 'complex system engineering' practices?

Keywords Processes, People, Lean, Agile, Movie Making, System Engineering

1 Introduction

Is a movie a system? Of the kind we routinely design & develop in our 'complex systems' industry? Such a discussion would probably prove entertaining, and possibly shed some semantic light on our daily struggle with system modeling. Yet, we choose to focus our own investigation on a different point of view, of a teleological rather than ontological nature.

There are at least two goals that are worth considering, and could be deemed as 'equivalent' in both worlds:

- Design and sell (or provide) a profitable product (or service). Obviously, movie producers invest money so as to gain strong return on investment in the process. With direct control of their stakes, they have strong incentive to make things right, and they generally have succeeded, with superior return and gains, despite some odd, spectacular failures. While profitability is certainly a goal we share in 'our

part of the world', we often fall short, as so clearly demonstrated e.g. in the software industry [2].
- The success of the 'End Product' lies in some 'good properties' that reflect a sound architecture. It would be a bit conceited to actually synthesize what makes a good movie in the same way as Vitruvius did a long time ago for Architecture[1] [3]. Nonetheless, 'good' movies are actually architecturally conceived, and we should look into this process.

As a preliminary, let us remark though that many modern movies or TV series are endeavors on a scale rivaling many traditional 'complex systems', involving millions of dollars spent each week, with tight, imperative schedules (24 episodes each year for a TV series), hundreds of contributing people, in distributed teams located in many countries & locations.

'How movies are made & produced' may appear, at first glance, quite alien & estranged from the way we classically engineer systems. After all, in his thought-provoking book [12], Goranson traces the key inspiration of many of these practices to the experience of the… Nantucket Whalers! On a closer look, though, we pick hints & ideas that resonate with our own daily issues in system engineering:

- Modern movies often have a complex lifecycle, as they are distributed through a growing variety of channels, from theaters to TV broadcast, DVD and video tapes, on-demand pay-per-view, in various markets, timeframe, formats, countries and languages.
- Shifting webs of relationships link stakeholders commanding these various channels, with opportunities (or regulatory requirements, e.g. in France) of complex risk & profit sharing schemes, cobranding and joint promotional efforts, including toys, books, music, sequels, prequels, derived comics, and all the paraphernalia of modern marketing.
- These result in significant up-front investments, either in concept definition, actual shooting, post-production, marketing and distribution. To perform these tasks, the industry enlists a bewildering variety of highly specialized companies and individuals, from unique special effects (FX) teams to dedicated insurers, or apparently mundane but key, specialized carpenters[2] or dedicated catering.

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[1] According to Vitruvius, a 'good' architecture shall meet the following *Vitruvian set of three*: ***firmitas*** (solidity or robustness), ***utilitas*** (convenience or usefulness), ***venustas*** (beauty or sensual delight).

[2] Goranson [12] gives an enlightening example with the shooting of the movie *Waterworld*, which required building up floating sets. Instead of trusting highly-paid & specialized carpenters & movie professionals with developing these sets (an expensive but sound, $3M solution), the studio decided, inspired by its new, novice Japanese owners, to pick up subcontractors specialized in sea-faring buildings. In so doing, they failed to capture the innumerous, implicit knowledge & language of movie-making professionals that, in so many crucial details, is critical to delivering movies on time, and in having all specialized teams dance in tune. The implied delays ended up costing about $80M…

- Already in the 30's in the United States, the movie industry was highly concentrated and competitive, leading them to adopt such "modern Lean" practices as flat organizations, just-in time or prequalified suppliers [12]
- Today, movie production is still a living example of "Lean" principles in action. Indeed, an obvious keystone of movie production is that customers define value: every movie aiming for profit focuses on a specific audience, and tackle to its expectations. Producers devote extensive care and critical attention to the project early on, studying it at length, getting feedback from numerous and various contributors, formulating 'the right project' before committing shooting resources, looking for an overarching and generative 'High Concept' [14], a fitting cast and crew, committed financers and distribution partners, and extensive research on potential risks, Intellectual Property and regulatory issues.
- Actual shooting will only proceed once pre-production has achieved a clear, shared vision of the project, targeted audience & success factors, and once potential risks have been properly identified, accounted for and mitigated. Shooting will then proceed at an amazingly fast pace, with the innumerous specialized contributors 'magically falling into place', seamlessly cooperating to shave out unnecessary delays or unplanned rework out of the value stream. To this end, scenes are shot out of order, some stars and actors will only appear on stage for a couple of days, sets will be prepared in parallel, and so on. Clearly, time is of the essence, the main cost driver at this stage, and the whole process is ruthlessly optimized accordingly.
- Actors on a stage may spend most of their days idly waiting, with a few seconds of shooting randomly interspersed, a seemingly shocking lack of productivity for high paid, otherwise demanding stars. For the clear focus of the whole production is not on the specific productivity of individual assets, but on ability of the whole production to deliver quality on time.
- Another feature of movie production is agility, in the sense of agile engineering. Although there are processes for making movies, directors will more likely interact directly with actors. They will also react in face of change (e.g. unexpected weather changes, star actor with food intoxication, or grossly out of shape, as Marlon Bando joining the shooting of *Apocalypse Now*), adapting on the spot, turning planning ordeals into artistic opportunity. And obviously the emphasis is on making a fitting movie, i.e. a valuable end product, rather than on generating plethoric documentation[3]. As a matter of fact these are the fundamental values of lean, agile engineering.
- Actually, documentation and support processes are not absent from movie making, and play a key role, e.g. when a script girl expediently notes, with amazing accuracy, all details of a scene. But these roles only exist insofar as they are critical to the quality and performance of the whole process – and, as such, are granted as much care and respect as other roles & tasks.
- In addition, many producers and directors will actively engage with the targeted audience throughout post-production, testing the movie on smaller focus groups.

[3] Although the paper edition of the scenario is part of a movie's collectibles, it is obviously not the purpose of the movie-making process!

This guides editing and cut, a critical step to tune the pace, tone, sense and impact of the movie, and to fit the music score, FX, rushes, and numerous other parts into a cohesive and expressive whole. Actually, in a 'design for flexibility' kind of way, the director will often take a few extra shots of a scene to hedge risks, explore alternatives, and gather supplementary material (in a cost efficient way), so as to enable 'real options' later on, at cutting stage.

- Obsession for 'the right product' thus percolates throughout the whole project, from the pervasive front-end exploration to the post-production and distribution stage, combining a process-oriented mindset (shooting) with serendipity and attention to key 'emergent properties' afforded by the consistent efforts of many, varied, specialized, cooperating talents.

2 New roles and organization for the system project team

2.1 From duo to triumvirate

Complex system projects are often lead by a duo: the project manager (aka director, or leader), and the system engineer (or system architect, or chief engineer, etc.), splitting *de facto* the project into two distinct, overlapping domains: engineering and management. There are numerous debates on who leads whom, who drives whom, who decides what, and so on. Actually, in our own, humble opinion, there is no convincing consensus yet as to the roles and the responsibilities of these two key players. Even the names of the roles are not so clear, as they keep changing through time & space.

For example, it is quite frequent in system engineering primers, to present the system engineer as a conductor of orchestra, a leader, enabling multiple disciplines to work together in a balanced and fruitful way. But a project leader claims also to be the leader… of the project (of course). And the importance of the composer, i.e. the one who thinks and designs the masterpiece to be then executed/realized, is often lost.

Let us imagine that we have both these distinct roles, as in music or in movies:

- The composer, or the writer, who we shall call the *System Scenarist*. He understands the complex problem to be solved, by taking into account the voices of the customers and the many potential stakeholders; he finds the solution, investigating and exploring numerous alternatives in the process; he generates, converges on and selects an efficient concept, capturing and defining the solution, based on his experience, the accumulated knowledge of its enterprise and, obviously, his own talent.
- The conductor, or the director, who we shall call the *System Director*. He leads the numerous people involved in the system development[4] process.

[4] We should take here an extended meaning for 'system development, not restricting it to the implementation process (as in ISO 15 288, or SE Handbook) but encompassing all the technical processes.

Note that both of them require a solid technical, scientific, mathematical (and so on) background. In other words, both are engineers, their differences lying rather in their behavioral skills and focus: one is leading, while the other is creating.

To 'achieve' successful movies, i.e. loved and cherished by the audience (the end customer, shall we say) and generate superior profits, we need, in fact, a third and critically important player: the *production*.

Quoting Film Training Manitoba [11], *"Producers are the driving force behind any project. They are essentially the 'managers' of a movie production. […] Many producers also have extensive experience in many aspects of filmmaking and have worked in many different positions on film or television projects. […] Producers secure investors and put together the financing for a production and they are ultimately responsible for all financial aspects of a film. They must have strong business management skills, […]."*

So let us add this key role to the two previous system roles:

- The *System Producer*, or perhaps shall we call him '*System lifecycle and profitability Manager'*. He will be in charge of the financial and contractual aspects of the system production all along the system lifecycle. As in movie production, he shall have a significant experience and a deep, practical knowledge on 'how to perform system engineering', being able to support the development team and give sound advice. In other words, not a 'yet another Excel sheet holder', but someone who is really, deeply involved and committed to the process.

2.2 Process is good, people are better

Even if the various roles of the triumvirate (*System Producer*, *System Scenarist* and *System Director*) are distinct and complementary, ensuring a 'per design' good balance in the leading team, much of the success lies in their actual interplay: how do they fit together, do they work on good terms, with mutual understanding and respect?

To these three core pillars of 'a movie-oriented system production', we should add, and not neglect, a complementary function that considerably fosters the success of a project: the *casting*.

Spotting the 'right' actors, and the right *mix* of actors, is a major and defining feature of movies success.

It is for instance striking to learn how the initial casting of 'LOST' had such a strong influence on the TV show (and its unquestionable success) [5, 6]. Some characters were added during the casting because it was recognized that the auditioned actor could bring significant value to the show, leading the writers to challenge themselves. Many young, talented women were auditioned for the role of Kate, but, when it was the turn of Evangeline Lilly (a totally unknown actress at the time), everything stopped. It *had to be* her, and no one else. Even the emotional tension that appears to certainly emerge between her and the character of Jack, played by Matthew Fox changed radically the initial script. Jack was actually supposed to die at the end of the

pilot! In a true agile form, everyone adapted to exploit this opportunity, unleashing new waves of creative thought & insights in the process.

Casting, or building up the right team is not restricted to 'recruiting' the good actors, but is extended to all supporting disciplines. A movie director will certainly strive to surround himself with his favorite cinematographer or his favorite artistic direction, according to the specifics of the project. These key players will come together around a specific project, around a common *purpose*. And, in a 'fail fast' kind of ways, early discussions between the key players may reveal irreconcilable takes on the project, leading some directors or star actors to quit the endeavor early, so as to open space for others that would better serve the project.

This leads us to question our usual way of assembling engineering teams. Too often we have seemingly blind faith in the process, as the one path to success and profitability. Since processes can be 'objectively' monitored through KPI (even the use of that acronym for key process indicators, so widely spread within the community, is almost a way of self-satisfactory reliance on ill-understood but smoothening habits!), they form a comfortable and lazy policy to rely on, and they lead to potentially *'Fail most successfully'* [13].

It is much more challenging to raise an actual policy of casting engineers, unleashing their combined talents to ensure success (as a pun to the reader, did you ever have a chance to do it in your practice?).

Quoting Ed Catmull, cofounder and president of Pixar: *"We believe the creative vision propelling each movie comes from one or two people and not from either corporate executives or a development department. Our philosophy is: You get great creative people, you bet big on them, you give them enormous leeway and support, and you provide them with an environment in which they can get honest feedback from everyone."*

Did we do otherwise when racing to the Moon?

2.3 Engineers do only engineering

Nowadays, we are often trivializing engineering trade. A spreadsheet, a slideshow presentation tool and an email client make up the basic, essential toolset for engineers, increasingly overwhelmed with dumb reporting, administrative & management tasks.

On the other hand, in movie production people seem to be more focused on their core job, relying on the support of specific assistants. E.g. the movie director has a first assistant to track daily progress, prepare and organize the schedule of the day, make sure that logistics follow up…

This may appear luxurious, but it ensures at its best that when a major decision is made, everyone is properly aligned, and that the decision is properly enforced. When Georges Lucas chooses among many raised propositions, for a character appearing only for a few seconds [8], then all follow suit. The management process behind that not only works perfectly, but it does not need him at all (by the way, e.g. configuration management in movie productions such as *Star Wars* is no small feats).

When turning on a profit is of such paramount importance to movie producers, their apparently paradoxical solution is to engage extra people, so as to free key play-

ers from administrative or management tasks. This is Lean in action: optimize globally, focus on the flow, ban rework whenever possible, continuously measure & improve…

All of this is in stark contrast to current common practices in our industries, where engineers have to perform all the management work, because of a patent lack of assistance, and, from time to time, quit their beloved reports to perform a precious few seconds of actual engineering!

Let us imagine how profitability could be increased if we re-focused engineers to do engineering and only engineering, supporting them with appropriate assistants to perform all the management and logistics tasks.

For example, a System Scenarist will mainly work on the creation process to 'discover' the optimal concept, exploring a broad playground, generating and assessing bunches of alternatives. For that, he will reason on high-level abstraction of the system under study, reflect on prior arts, failures and attempts, and provide probably more literary insights of the system to be realized. Then the precise iconic or graphical models needed for the system development (be it storyboarding or digital 3D mock-up in movie production, descriptive models like the various views of an architecture framework in system engineering) will be entrusted to some technical assistants, both human and digital.

3 New main lines for engineering a system

3.1 Life-cycle management and cost models

Movie making focuses on cost issues from the start on, and these concerns will infuse all processes of movie production. The movie industry actually developed eons ago what is nowadays called Activity-Based Costing accounting practices, long before the term was coined, or even the need widely acknowledged.

Indeed, before a movie project starts shooting, its funding must be guaranteed, with a clear business case, and investment commensurate to the expected revenues (i.e. coming from the theatre projections, the sales of DVDs and all sorts of collectibles related to the movie).

Translated into system engineering, this would imply that acquisition costs are determined relatively to utilization costs and revenues. Although this is the general rule for large-scale complex systems requiring public-private partnership investments (such as construction of new airports or major constructions such as tunnels – e.g. the Channel tunnel – or bridges – e.g. the Millau bridge –), it is clearly not yet an honored practice in many actual processes in the industry. Usually, only lip service is devoted to genuine global cost & value management. Indeed, although agreement processes (acquisition and supply processes) are explicitly mentioned in the 15288 System Life-cycle Process, their imbrications with the technical engineering processes is hardly described.

The way a movie production team develops *ab initio* the financial support of the movie could be also a source of inspiration for system engineering. This activity is clearly a key focus of the System Producer.

Lifecycle management for movies is a continuous process: teasers are progressively introduced on the commercial distribution market while the movie is being shot, carefully crafted stories about star actors are leaked, and once the movie is released, advertisements and commercial exploitation of the movie last for some time, being replaced by other kinds of commercial exploitation once the movie is retired from screens and begins its new life as a source of private projection revenues or diffusion on television channels.

Analog concepts for system engineering could be introduced within the stages preceding in-fielding, which would profit ultimately the utilization phase, where acceptance of a new product or service is not always easy, and is hardly anticipated by the acquisition teams.

Other issues deal with the end of the lifecycle: disposal of a movie is never actually the case, although some movies fall into oblivion, which could be seen as a state of definite retirement. However many movies become then 'classics' which is another way of recycling them.

Similar situations for systems engineering would be implementing sort of a circular economy process within the systems engineering process, which would be well adapted to the newest trends permeating our society in quest for sustainability. This implies building differently the basics of the current widely spread engineering way of life, which relies heavily on sequential activities and iterations of that sequential process, but cannot cope with circularity.

3.2 Project phases and progress oriented

Focused to the only objective of the movie opening and exploitation, movie making processes involve a set of widely acknowledged stages: development, pre-production, production, post-production and distribution/exploitation [9, 10]. Each of these stages has clear objectives, tasks to be performed, and 'definitions of done' as preconditions to next-stages transition. For example, the pre-production is all about preparing the shooting. It includes tasks like storyboarding, casting, selecting locations, designing and building sets, and so on.

Even if project phases, synchronized with system lifecycle stages are part of all system engineering primers & handbooks, most standards expand the central idea that performing a system engineering approach boils down to deploying a set of processes (25 according the INCOSE SE Handbook [4]). When engaging or training seasoned professionals, we routinely observe that precious little consideration is paid to how these processes have to be actually run and adapted, in tune to the project progress.

For instance, to mimic the movie production, there could be a 'phase 0'[5] while developing a system, when the concepts and the business case are jointly elaborated. This requires a strong involvement and commitment of the System Scenarist, the System Director and the System Producer. In other words, designing the architecture of the system & engineering costs are the two faces of the same coin, and imperatively

[5] Naming this phase more precisely would raise endless discussions at this stage…

have to be jointly developed by the core team, with a comprehensive view of the whole system lifecycle.

3.3 Everything starts with an idea.

Let us add a few useful aphorisms to the bunch of heuristics system designers should use:

- You should build your 'thing' around a central idea or concept. Use this idea or concept to build everything (it is generative).
- If you cannot explain your concept, your idea to your grand 'ma, forget it.
- Don't hesitate to throw an idea away, and start with a fresh one.

These heuristics originate from the architecture [15], and have consistently proved useful both in movie making and in system design.

In movie production, the pitch, even the famous 'high concept' [14], is the starting of everything, and at least the minimal, shared understanding that everyone (the cast and the film crew) have to 'get' so as to deliver consistent & convergent results.

For instance, the 'pitch', or the original concept for the sci-fi TV show '*Battlestar Galactica*' (BSG), was explicitly & emphatically not to produce "yet another space opera show with nice FXs", but instead to explore the concept of "putting the humanity faced to its own finiteness and its own creation", thus setting up a clear, open, dramatic and generative basis for narration, thus for 'designing the system'.

Actually, when BSG was under development, the production submitted to prospective lead actors a script of the pilot including, by mistake, the production manifesto explaining, in a couple of pages, these key design choices & concepts [7]. It completely changed the way the actors approached reading the script, capturing their imagination & will, generated creative energy, inspiration, and alignment, and drew to the show talented stars that would have declined it otherwise. Such is the e.g. case with Edward J. Olmos, of Ridley Scott's movie '*Blade Runner'* fame, who was clearly instrumental in the success of BSG development.

Nowadays framework in system engineering tends to 'explain' their system through a bewildering multiplicity of system views and diagrams (9 different diagram kinds in SysML, 48 views in NAF 3.0, 52 views in DODAF 2.0! Can't wait for the third edition…), but most often fail to bring forward a holistic, global, generative view that sums up the intention into one big idea or comprehensive concept. In other words, system engineers are not trained or used to 'pitch' their system in one or few sentences, making us understand why 'we will love it', and how our work may contribute to the value overall.

4 Conclusion and Acknowledgment

It was 'off-the-record', unofficial work performed by the authors, who enjoyed themselves exploring these side topics, and trying to renew our vision of system engineering by exploring development practices in other industries. The analogy with

movie production proved to be fruitful and illustrative, and convinced us to push forward these early forays. Or, as goes the saying, with a rumble voice: We will be back!

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