Confronting Projects Complexity

Designing towards a Best-Fit for Common Purpose

White-paper by A.R.M. (Rogier) Wolfert

December 2024

ODESYS
Fostering Constructive Dialogues, Co-Creation & Education
YOUR PARTNER IN CONFRONTING COMPLEXITY
T +31 650 225409 • E info@odesys.nl • W odesys.nl

Executive Summary

What prevents achieving results that best fit a common purpose? In today's complex project development landscape, wicked problems often lead to building what nobody wants, or projects that derail. Actually, projects don't *go* wrong — they *start* wrong. And when they start right, they can still *lose direction*. Even advanced design and project management practices can hit impasses, as decision-makers fail to recognize that their challenges are part of a larger, interconnected whole. Traditional decision-support methods often relies on retrospective analyses, offering little guidance for a constructive way forward. Mutual interconnection and collaboration are keys to unlocking complex projects best-fit for a common purpose. Through an open design systems approach, there seems to be no limit to the complexity we can handle effectively. Moreover, resolving creative conflicts requires transparent reflection while avoiding fixation or bias toward any particular outcome. By designing with both individual stakeholder freedom and systems degrees of freedom, we can work toward the best common ideal within physical reach.

The novel open design systems (Odesys) methodology provides a groundbreaking solution culminating in a best-fit design solution. Odesys focuses on how things ought to be, transforming complex situations into realistic, preferred ones. Odesys' three-step *Systems Thinking Slow..* process to —(1) .. *Agree First*, (2) .. *Act Feasibly*, (3) .. *Adapt Flexibly*— aims for synthesis to achieve purposeful outcomes best for projects and people. From this the following actionable supported decision-making is delivered to collaboratively confront complexity: • *No-Regret Plans* to build the right scope with a feasible plan from the (re)start; • *Best Mitigation Strategies*: to dynamically control projects on-the-run.

As its core, Odesys embraces the social threefold principles of freedom, equality, and fraternity, unlocking a best set of technical degrees of freedom within a design space that accounts for both (non)-physical constraints. Its integral and associative response ensures that individual needs are satisficed without ignoring others or nature. One can only succeed if they are part of the game and willing to relinquish self-interest for the benefit of the whole. These principles guide deliberative and participatory decision-making through the novel IMAP optimisation method, integrating people's preferences and weighted interests with physical performance. In this dynamic and open search for an optimum aggregation of stakeholders' preferences, Odesys employs the Preferendus—a robust, mathematically rigorous decision-support tool. The Preferendus simply reflects the complex problem and generates a single best design configuration, outperforming traditional (parametric) optimisation methods.

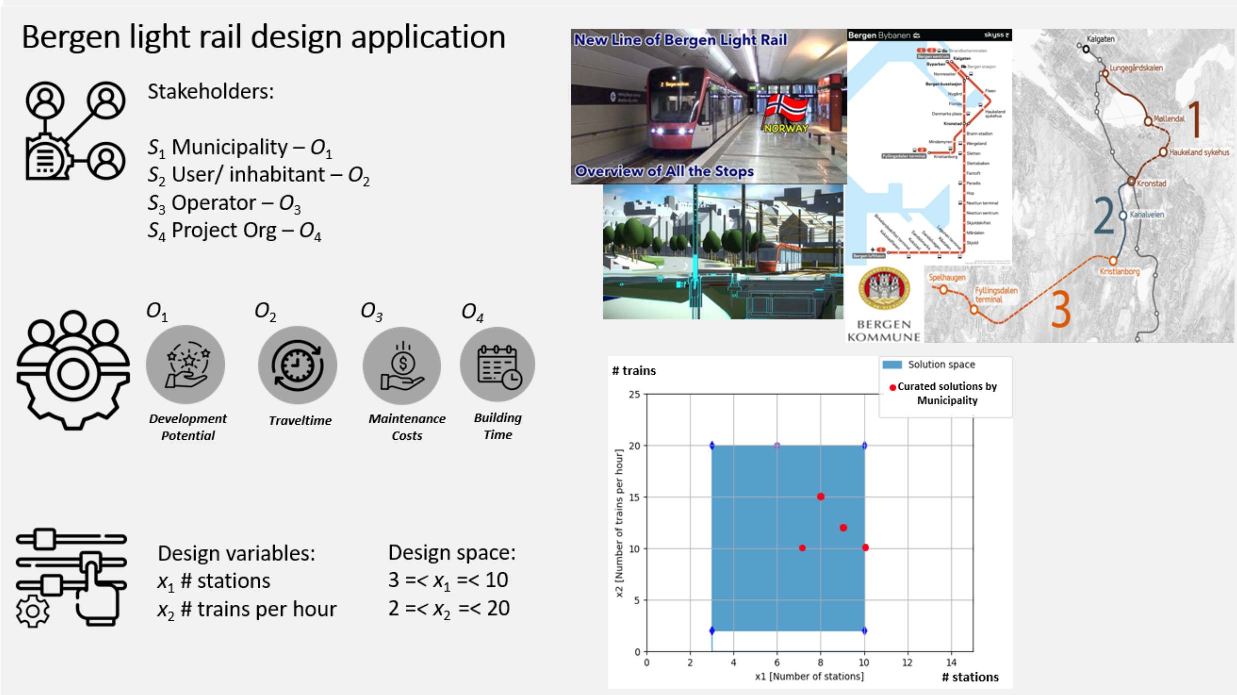
In doing so, Odesys turns design and decision-making upside down and right side up, elevating it toward a direct-democratic form that delivers unbiased, realistic results by: • *Reversing* sub-optimal compromises after the fact *to optimal strategic synthesis from the start*; • *Shifting* from a vertical top-down hierarchy *to a horizontal bottom-up association*; • *Transitioning* from a technical single-sided view *to a human-centered, ingenuity-driven approach*. This represents a significant leap in design and decision-making, where the concept of allegedly free choice— often restricted to selecting from curated options —evolves into genuinely designing from a neutral space of 'infinite' freedom, while uniting idealism and realism from the outset.

Odesys was developed over the past decade at TU Delft and has been successfully validated across both public and private sectors. Odesys embodies design as art of problem-solving and fosters trust through glass-box decision modelling, empowering stakeholders to collaboratively create actionable solutions. Odesys builds 'freedom' bridges to effectively confront complexity.

Creative Conflict (1)

We first want to incite you into a typical creative conflict of interest. This is meant to open your mind and elucidate the problem of complexity.

A creative conflict of interests — agreeing first sounds simple, but how do you achieve that?
Consider a simple yet representative complex problem: extending a light rail to connect a suburban area to Bergen's city centre. In this problem, four stakeholders— the municipality, the users/inhabitants, the light rail operator, and the contractor—must jointly develop a best solution. Each stakeholder represents a different objective: development potential (municipality), travel time (users), maintenance costs (operator), and building time (project org). The design variables are the number of train stops (x_1) and the number of trains per hour (x_2). The (non)-physical constraints lead to a simplified design space defined by the ranges: $3 \leq x_1 \leq 10$ (number of stops) and $2 \leq x_2 \leq 20$. For this problem, the municipality, as one of the 'biased' stakeholders, has curated solutions for the other parties. But are these really the best fit for a common purpose? (See Chapter 8 for more in Wolfert, A.R.M. (2023). Open Design Systems. IOS Press).



Introductory Context

In today's complex landscape of project development in the built environment, 'wicked problems' often result in building what nobody wants or projects that derail. Even the most advanced design and project management practices can hit impasses, leaving decision-makers struggling with multifaceted challenges—unaware that their puzzle is merely one piece of a larger whole. Projects often end this way due to a lack of full stakeholder buy-in and a feasible plan from the outset. Along the way, projects can spiral out of control when managed as 'sealed systems,' unable to openly and dynamically adapt to a best-fit solution for a common purpose. This is exacerbated by current decision support systems, which are often non-inclusive, single-sided, and lack transparency, while the complexity of the project exceeds the comprehension of project managers.

While management science offers valuable insights, its retrospective focus often results in post-mortem project analyses rather than guiding actionable decisions during the process. Similarly, state-of-the-art systems engineering lacks a genuinely holistic approach, often overlooking the dynamic interplay between stakeholder preferences ('what they want') and system capabilities ('what it can'). Consequently, projects remain stuck, lacking an actionable response to deliver a tangible, best-fit solution for a common purpose. However, if complexity is approached synthetically by design through systems thinking, there seems to be no limit to the complexity we can effectively manage. Systems design focuses on how things ought to be, transforming existing situations into preferred ones based on people's intent, shared values, project performance and socio-technical constraints.

Problem Statement

What's needed is an open, holistic design approach capable of effectively confronting projects' complexity. This approach should be supported by robust participatory decision-making models that leverage collaborative intelligence to align aggregated stakeholder preferences with the best possible realisation — while avoiding the exclusion of potential solutions upfront (hence not limited to a set of curated options). This approach allows complexity to be unlocked by stepping away from predetermined outcomes, exploring optimal solutions within an open systems space, rather than settling for sub-optimal alternatives within a closed space. To achieve this, a model-based approach is essential, where the interconnectedness of elements is central, the subjective human experience is integrated, and no single component is considered absolute. We need an approach beyond pure 'bookkeeper's calculus', which starts with one-sidedness, and toward a 'system architect's' design approach, where the whole is greater than the sum of the parts, and their interactions define the whole.

Proposed Solution

In recent years, under the leadership of Prof Wolfert at TU Delft, the open design systems methodology known as 'Odesys' has been developed to optimally unite 'desirability' and 'capability' as an active response to complexity. Odesys is a pure form of socio-technical systems integration that proactively unlocks creative conflicts of multiple interests, right from the outset rather than after the fact. It embraces the paradox of conflict resolution: the closer you aim for a lasting solution, the longer you must stay away from a concrete outcome—calling for design as the art of problem-solving and decision-making. The only way to achieve results from complex problem-solving is to engage people at all levels in the process of design. Designing conflict resolutions requires a consciousness of 'inner-outer' dialoguing approach that transforms destructive patterns into constructive solutions. By considering both all stakeholder preferences and system performances, Odesys optimally explores and maximizes the solution space, leading to a best-fit for common purpose solution, where value extends beyond money or technology alone. It untangles wicked problems whilst embracing the social threefold principles of individual design freedom, human equality, and stakeholder fraternity, promoting a purposeful and balanced project compass. In doing so, Odesys offers both a tangible solution and a valuable contribution to the emergence of new forms of local communities and their direct-democratic decision-making processes. It also fosters enhanced public-private collaboration, enabling all parties to pursue the best outcomes for the project and people across the entire value chain, rather than settling for sub-optimal outcomes that benefit only individual stakeholders.

Odesys will turn decision-making upside down and right side up, guiding it toward a pure direct-democratic form that delivers realistic results in a neutral, unbiased manner, namely by: (1) reversing sub-optimal compromises after the fact to proactively generating a strategic design synthesis in one go, (2) shifting from a vertical top-down hierarchy to a horizontal net-work association, while participatorily balancing individual design freedom, human equality, and stakeholder fraternity, (3) transitioning from a technical, single-sided view to a holistic, human-centred perspective that integrates idealism with realism. This represents a paradigm shift in decision-making, where the principle of allegedly free choice — which is actually a selection from curated options — shifts into genuinely choosing from a neutral space of 'infinite' freedom. This process ultimately leads to a best-fit synthesis for a common purpose that is socio-technically feasible and acceptable to all stakeholders. Moreover, this design approach embraces the social threefold principles of freedom, equality, and fraternity, whilst unlocking a best set of degrees of freedom within a design space that accounts for both physical and non-physical constraints. In this manner, this multifaceted approach compasses toward satisficing, salutary and solidary project success with-in a solvable reach. All of this is ultimately aimed at purposeful results that are best for projects and people. That is to say, Odesys transforms the concept of allegedly free choice into an open and pure design process— one that best fits a common purpose — by integrating social and physical systems dynamics and associating the collective 'wisdom' of the group.

Odesys makes this all possible through its unique integrative multi-objective optimisation method, known as IMAP, which maximises the weighted aggregated preferences as functions of objectives and design performances within a multi-dimensional solution space. It delivers a set of controllable design variables —a best configuration— for this maximum preference aggregation. This novel multi-objective design optimisation (MODO) method integrates both objective and subjective objectives, which align in a way with the Vitruvian threefold of physics, utility and beauty ('firmitas, utilitas, and venustas'). These objectives that can only be goal-oriented by humans are expressions of his preference — what it is of value (or holds utility) to them. Preference reflects the degree of 'satisfaction' or 'well-being'– a human experience of infinity across all the senses. Notably, money, like other subjective objectives, is not a property of an object but is a subjective expression of an individual's actual willingness to pay —his appetite to exchange— reflecting what it is worth for him. Rooted in the theory of pure economics and preference functions modeling (PFM), IMAP operates from the paradigm of a-priori maximising preferences as a measure of overall 'well-being value' rather than minimising the lowest monetised costs. Effective decision-makers consider both economic, isonomic, and ecological systems aspects, recognizing that pure preference value extends beyond monetary terms. With this, everything that counts, even that which is defenceless, becomes valued and countable.

IMAP design optimisation provides substance to 'true free choice' and is consistent with the direct-democratic preferendum principle, as opposed to a referendum, which is a decision analysis based on curated options derived by others. One could actually argue that a 'curated solution' is a root cause of the problem. IMAP integrates people's preferences with physical performance, and associates different stakeholder weighted interests. In this dynamic search for the maximum group preference, Odesys employs a robust and mathematically rigorous decision-support tool called the Preferendus. This IMAP-based Preferendus aims for synthesis to arrive at a single best design-point, representing a set of design variables for an optimal configuration. IMAP outperforms traditional (parametric) optimisation methods, avoiding suboptimal compromises and invalid Pareto front solutions.

Most recently, Odycon, an Odesys-based project management method, has been further developed for dynamic project planning and control. Current probabilistic planning methods fail to model the mitigation-driven behavior of project managers. Therefore, Odycon combines IMAP optimisation with probabilistic Monte Carlo simulation, offering an optimal synthesis for both the strategic project planning and dynamic project control phases. For the latter, Odycon enables an a-priori search for the best set of mitigation strategies on-the-run, rather than relying on a-posteriori evaluations of potentially sub-optimal and over-designed mitigation strategies, that often result when applying scheduling software such as Primavera P6.

Value Proposition

Odycon and Odesys are both multi-objective systems design approaches that generate optimal project development plans and dynamic planning and control strategies, surpassing human limitations to fully comprehend complexity. When confronting complexity, they employ a threefold process — *'Systems Thinking Slow to..'* : (1) .. *Agree First* , (2) .. A*ct Feasibly*, and (3) .. A*dapt Flexibly* —, to arrive at best-fit for common purpose solutions for the development, deployment and execution phases respectively. This 'systems thinking' approach follows the principle of "You need to step back to see the bigger picture". Moreover, this deliberative 'thinking slow' or systems-2 approach (as op-posed to the instinctive systems-1) prevents projects from going off track by starting in a well-supported, participatory, and realistic manner, while enabling deliberate, on-the-run adjustments throughout execution.

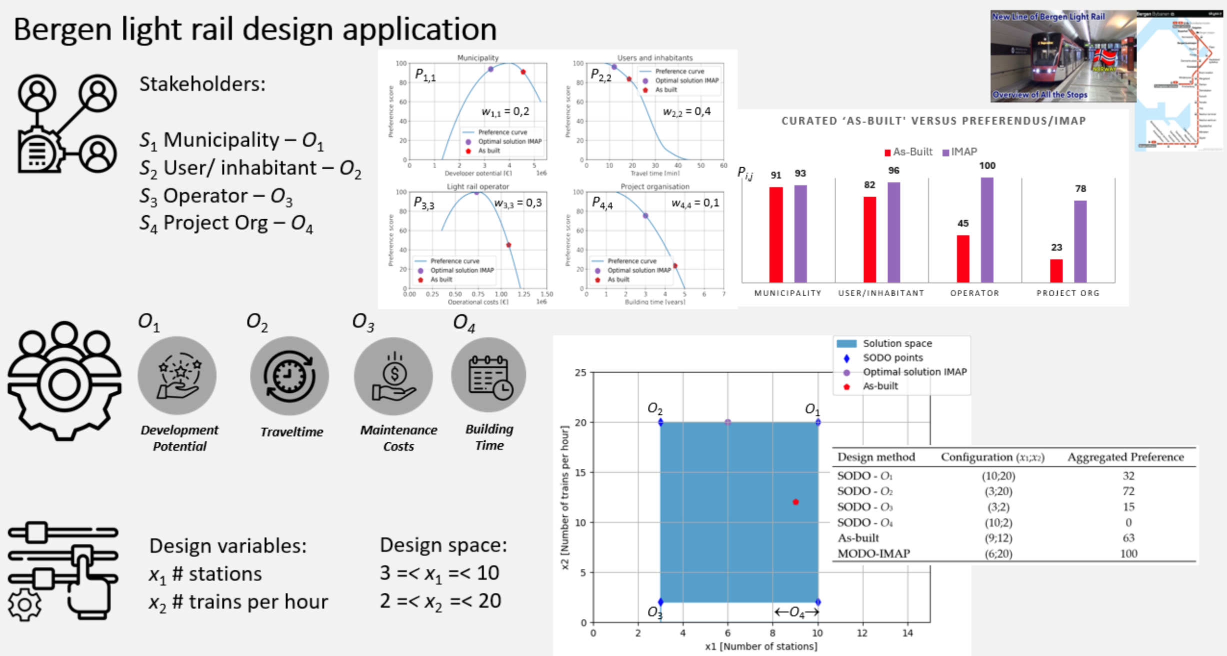
Overall, Odesys and Odycon support the delivery of: (1) creating *open, No-Regret project scopes and plans* rooted in common interest which establish the 'right' scope with a realistic plan to avoid 'sunk costs', and (2) *effective and efficient Dynamic Project Control* on-the-run through an open R&D-like mindset that maximizes 'best for project'. In doing so, they truly embody the sayings: "Better to turn back halfway than to go all the way wrong" or "You need to stand still in order to progress".

Confronting Conflict (2)

Now, we revisit the creative conflict of interest incitement and demonstrate the true, validated added value of the Preferendus/IMAP, offering a pure answer to confronting project complexity. For other elucidative design & management applications see the Appendix.

Confronting a conflict of interest — so, Odesys does it like this!

The IMAP/Preferendus result speaks for itself, outperforming both the curated 'as-built' and the SODO approaches. Even with significant differences, everyone in this case 'gets more value.' So when stakeholders dare to confront their conflicts and lay their 'cards' openly on the table, the possibility of achieving a pure, best-fit solution for common purpose becomes real. Is this a miracle? Certainly not. The reason lies in the traditional approach to solving complex problems: one dominant party (with primary interests and resources) takes the lead, proposing solutions that align with their goals, often supplemented by a limited set alternatives. These solutions are then tested against the interests of other stakeholders. It's like your mother buying three shirts for you to choose from. Will you be satisfied? Probably not—you'd rather pick the best shirt yourself in the store or even compile your own! (See Chapter 8 for more in Wolfert, A.R.M. (2023). *Open Design Systems*. IOS Press).



Design method	Configuration (x_1;x_2)	Aggregated Preference
SODO - O_1	(10;20)	32
SODO - O_2	(3;20)	72
SODO - O_3	(3;2)	15
SODO - O_4	(10;2)	0
As-built	(9;12)	63
MODO-IMAP	(6;20)	100

DEMO: https://deepnote.com/app/odesys-toolbox/Norwegian-Light-Rail-369966c2-b8c8-4684-8aa3-dd5b2c1e8f6a?utm_content=369966c2-b8c8-4684-8aa3-dd5b2c1e8f6a

Current Implementation

Odesys/Odycon have now proven their value in several infrastructure and estate planning applications, both in public and private contexts. Typical clients included Microsoft, Total Energies, Boskalis, and various municipalities and highway agency projects. Additionally, Odesys has been and continues to be applied in 50-75 student projects annually over the past five years. More specifically, through the "vertical" integration of desirability ('subject') and capability ('object'), they demonstrated that their solutions are both wanted and realisable. In this way, ideality, as expressed through stakeholders' preferences, is transformed into reality, ensuring physical feasibility, as nature cannot be deceived. Through the "horizontal" (network) association, individual stakeholder interests are aggregated to a maximum preferred value. It has been shown that when an individual stakeholder is willing to relinquish pure self-interest ('single-objective - SODO'), it becomes possible to create a best-fit for a common purpose that benefits the whole group the most ('multi-objective' - MODO). In other words, the IMAP-based MODO methodology always maximises the solution space and outperforms single-objective or other MODO optimization methods, such as the min-max approach. Unlike min-max, which relies on an ‘inclusive’ compromise solution to 'leave no one behind,' IMAP aims for ‘holistic’ synthesis to achieve a solution that serves the 'greater good'.

In all of these design applications, the IMAP-based Preferendus proved to be a central decision-support tool at the heart of the group decision-making process. It enabled a concrete transformation of people's plans and preferences from their minds into a best possible materialisation. This is an iterative and open design learning process in which the Preferendus reflects and ‘talks back’. By deploying the Preferendus, not only were several sufficing solutions found within a maximum solution space of collective stakeholder intelligences, but the Preferendus also built trust through its transparency and traceability. This shifted an initial process of mistrust and black box modeling into a glass box model that maximally supported the group in their socio-technical process, where the full potential of the participants could be realised by this way of open design learning. By embracing the principle of being ‘*for others*’, Odesys cultivates a collaborative design process that transcends self-interest and aims for feasible solutions that embody *brotherhood*, *equity*, and *purpose*. Such pure solutions emerge not through competition, but for each other — fostering a spirit of mutual-aid toward the best-fit.

Concluding Remark

In this context, Odesys and its Preferendus go a step beyond single-loop (DMI) and double-loop (DMII) learning by integrating their methodology into open-loops learning as part of the Odesys U-model. This process brings together the technical, social and purpose-driven open-loops (DMIII). Conflicts of interest are not only inevitable but also essential for a development process; they serve as opportunities for growth and co-creation by engaging in dialogue with the ‘inner-outer’ in the now. In a complex world, the most effective solutions come from dialogue, rather than through authoritative decision-making. This Odesys U-way of working has been successfully applied, validated, and further developed in public and private projects within the infrastructure and built environment sectors.

Odesys builds ‘actionable bridges to anywhere’, proven effective in fostering engineering asset management, project management, and construction management. Odesys unlocks wicked problems by navigating with their project compass, to ultimately achieve purposeful outcomes best for projects and people. Everyone has a designer within themselves; it is the art of Odesys to awaken this inner designer.

ODLc Education

To educate future Odesys professionals, a tailored educational concept called Open Design Learning (ODLc) has been developed. ODLc is an innovative, constructivist approach that integrates systems thinking with human-centered design learning. It connects personal learning with real-world challenges, fostering a collaborative, reflective dialogue.

Drawing on the principles of key educators such as Ackoff, Schön, and Steiner, ODLc promotes integrative learning. The educator's role is to unlock students' free will, guiding them through a three-cycle model that incorporates technical, social, and purposeful aspects. This framework empowers students to move beyond predefined problems, encouraging innovation and independent thinking. They learn to learn by unlearning.

The concept is built on the following key principles: (for more info see Chapter 9 out of Wolfert, A.R.M. (2023). Open Design Systems. IOS Press)

1. **ODL Self-chosen System of Interest** (SoI): Students apply knowledge to real-life contexts by selecting a personal area of interest, fostering, future-oriented designs through experiential learning with educators in a unique context.
2. **ODL Dialogue**: Mutual understanding and solution development arise through open-ended dialogue, encouraging creativity and vulnerability through active questioning and reflection.
3. **ODL Rhythm & Sessions**: The cyclical rhythm of weekly concept application, dialogue, and practical work, with masterclass sessions for collaborative reflection and problem-solving, fosters ongoing learning without formal evaluation.
4. **ODL Learning Goals**: Course objectives focus on engaging students with course concepts, applying them to real-life SoI, and generating new insights, leading to original responses and practical application.
5. **ODL Response**: A group deliverable based on a self-chosen SoI, demonstrating the transformation of course concepts into unique, collaborative designs, presented in an open format like a poster.
6. **ODL Commendation**: A grading rubric that deducts points from a base grade of 10 for missing or incomplete aspects, guiding both the SoI content and the student's learning process.
7. **ODL U-model**: A blended approach combining cognitive learning with hands-on experience, guiding students through co-creation, co-sensing, and co-reflection to achieve transformative, real-world problem-solving and reflective design.

ODLc has proven effective in fostering integrative learners who are capable of confronting complexity. Over the past 10 years, ODLc has been successfully integrated into various MSc curricula at TU Delft. The courses in the field of decision science and engineering—Engineering Systems Design, Engineering Asset Management, Engineering Project Management, and Construction Information Systems—along with the general course on Research & Development Methodology, have attracted a diverse range of MSc students (aged 21 and older), with participation varying between 25 and 350 students per course.

ODESYS Offer

ODESYS specializes in fostering constructive dialogues, co-creation and education through its Open Design Systems framework and ODL (Open Design Learning) education concept. It offers solutions for collaborative decision-making, empowering teams to resolve conflicts and untangle complex project challenges. By uniting objective performance with subjective preferences, ODESYS creates tailored solutions that are best for projects and people. Through this integrative approach, ODESYS can fill in the following key roles in confronting complexity:

- Clear-sighted problem identifier for complex systems of interest (SOI), offering precise diagnostics and problem set-up.
- Collaborative co-creator of tailored solutions, aligning diverse stakeholder objectives for effective SOIs results;
- Constructive trainer and educator, developing professionals ('in-company') and students ('university MSc/PhD') to become Odesys specialists.

ODESYS cv was founded early 2024 by Rogier Wolfert. ODESYS originated from a collaborative initiative of a number of (former) students from TU Delft. This group had become very enthusiastic about the potential of the ODESYS methodology through project and internship experiences at companies such as Total, Microsoft and Boskalis. Building on a longstanding relationship in the infrastructure sector, Ir. Pieter Mali MBA recently took a pivotal step to propel ODESYS forward, ensuring its methodologies gain traction and widespread application in the industry. ODESYS works together with independent 'Odesys professionals'.

For more information, visit the ODESYS website and/or the Open-Design School website:

www.odesys.nl
www.open-design.school

Author Information

Dr.ir. A.R.M. (Rogier) Wolfert is a distinguished professional in integrative design and management. He has over 30 years of experience working with leading service providers such as VolkerWessels, Hochtief, Fluor, T-Mobile, and Huawei, among others. Currently serving as a project director at Boskalis and managing associate at Odesys CV, he pioneers human-centred and model-based management approaches using open design systems while also educating 'young stars' to confront complex engineering management challenges. Through Odesys, Dr. Wolfert works with a network of former TU Delft students to implement his methodologies in projects for organizations like TotalEnergies, Microsoft, and Boskalis, fostering practical applications of participatory and systems-based thinking while mentoring the next generation of engineering leaders.

As a professor at Delft University of Technology, he held the chair in Engineering Asset Management and taught a diverse range of subjects, including project management systems, engineering systems design, and R&D methodology. His unique ability to bridge the gap between engineering and management, as well as between academia and industry, has made him a recognized leader in his field. Renowned for his pioneering educational contributions, he developed the Open Design Learning (ODL) concept, which equips students and professionals to tackle complexity through systems integration and collaborative decision-making. His efforts bridge the gap between engineering and management, academia and industry, as well as research and practice, enhancing performance, participation, and purpose across diverse sectors.

Dr.ir. Wolfert's work is driven by a unique synthesis of 'outer' technical observations and 'inner' human experiences, which he considers essential for navigating his odyssey into the emerging future. Whether guiding multi-stakeholder projects or advancing methodologies like Odycon for dynamic project planning, he consistently demonstrates his ability to connect disparate domains and stakeholders while maintaining their individual strengths.

Rogier's LinkedIn:
https://www.linkedin.com/in/a-r-m-rogier-wolfert-a108b9303/

Rogier's recent book, entitled Open Design Systems and the related dynamic Odesys toolbox:
https://ebooks.iospress.nl/volume/open-design-systems
https://deepnote.com/workspace/odesys-toolbox-b19d12a3-be34-4200-ba86-e3687ed7b76f/recents

Acknowledgements

The author wishes to thank **Ir. P.C. (Pieter) Mali MBA**, Director at FLUOR Infrastructures, and **Dr.ir. R. (Ruud) Binnekamp**, Assistant Professor at Delft University of Technology, for their invaluable support, guidance, and reflections 'in- and on' action, which have significantly contributed to the development of this work.

Endorsements

From a confidential perspective, we can only mention here the following organizations with whom Odesys has successfully collaborated, without naming individuals: RWS/De Groene Boog, BAM, Boskalis, TotalEnergies, Microsoft, PrimaNed, Planmaat, and Gemeente Westland. Odesys' methodology has been personally commended by Prof. Friedrich Glasl, Prof. Simeon Reich, Prof. Boaz Golany, Prof. Lori Tavasszy, and Dr.ir. Sander Steenbrink. These commendations can be found in the opening of *Open Design Systems* by Wolfert, A.R.M. (2023, IOS Press).

Scientific References

A selection of recent publications, which relates to this white paper:

Teuber, L.G., Wolfert, A.R.M. (2024). Confronting Conflicts to Yes: Untangling Wicked Problems with Open Design Systems. *ArXiv*, https://doi.org/10.48550/arXiv.2409.10549

Teuber, L.G., van Heukelum, H.J., & Wolfert, A. R. M. (2024). Advancing strategic planning and dynamic control of complex projects. *ArXiv*, https://doi.org/10.48550/arXiv.2408.12422

Van Heukelum, H.J., Binnekamp, R., & Wolfert, A.R.M. (2023). Socio-technical systems integration and design: a multi-objective optimisation method based on integrative preference maximisation. *ArXiv* or *Structure & Infrastructure Engineering*, https://doi.org/10.48550/arXiv.2304.07168 or https://doi.org/10.1080/15732479.2023.2297891

Wolfert, A.R.M. (2023). *Open design systems* (Vol. 10). IOS Press. https://doi.org/10.3233/RIDS10

Van Heukelum, H.J., Steenbrink, A.C., Colomés, O., Binnekamp, R., & Wolfert, A.R.M. (2023). Preference-based service life design of floating wind structures. *Life-Cycle of Structures and Infrastructure Systems*, https://doi.org/10.1201/9781003323020-116

Shang, Y., Binnekamp, R., & Wolfert, A.R.M. (2023). Multi-stakeholder service life design for rail level crossings. *Life-Cycle of Structures and Infrastructure Systems*, https://doi.org/10.1201/9781003323020-115

Zhilyaev, D., Binnekamp, R., & Wolfert, A.R.M. (2022). Best fit for common purpose: A multi-stakeholder design optimization methodology for construction management. *Buildings*, https://doi.org/10.3390/buildings12050527

Appendix

A selection of Design & Management Applications structured along the **Systems Thinking Slow** threefold:

Agree First - https://doi.org/10.48550/arXiv.2409.10549

Complex problem statement

A pure open project design process –'Creative Conflict'

Stakeholders:
S_1 Wind energy provider
S_2 Local residents
S_3 Ecologists
S_4 RIVM-health orga

Preference functions & weights:
$P_{1,1..4}$ & $w_{1,1..4}$
$P_{2,1..4}$ & $w_{2,1..4}$
$P_{3,1..4}$ & $w_{3,1..4}$
$P_{4,1..4}$ & $w_{4,1..4}$

Profit	*Noise disturbance*	*Environment*	*Health*
O_1 Energy	O_2 Noise	O_3 Bird mortality	O_4 Particle pollution

Design variables:
x_1 Distance from city
x_2 # Turbines
x_3 Turbine height
x_4 Required wind speed*

Performance functions:
F_1 Power generated per day = $f(x_3, x_4, \mathbf{\underline{y}})$
F_2 Sound power per turbine = $f(x_1, x_3, x_4, \mathbf{\underline{y}})$
F_3 Bird mortality per area = $f(x_3, \mathbf{\underline{y}})$
F_4 Erosion rate per turbine = $f(x_4, \mathbf{\underline{y}})$

Design space:
$2 =< x_1 =< 10$
$0 < x_2 =< 12$
$50 =< x_3 =< 150$
$3 =< x_4 =< 15$

* 'disputable' exogenous factor as endogenous design parameter to unlock the problem

Act Feasibly - https://doi.org/10.48550/arXiv.2408.12422

Complex problem statement

A pure strategic probabilistic planning process –'Toothpaste factory'

Stakeholders:
S_1 Energy provider
S_2 Marine contractor

Preference functions & weights:
$P_{1,1..2}$ & $w_{1,1..2}$
$P_{2,3..4}$ & $w_{2,3..4}$

Duration	*Costs*	*Utilisation*	*Environment*
O_1 Project delivery	O_2 Installation costs	O_3 Fleet utilization	O_4 Fleet CO2 emissions

Design parameters:
x_1 # Small OCV
x_2 # Large OCV
x_3 # Barge
x_4 Anchor diameter
x_5 Anchor depth

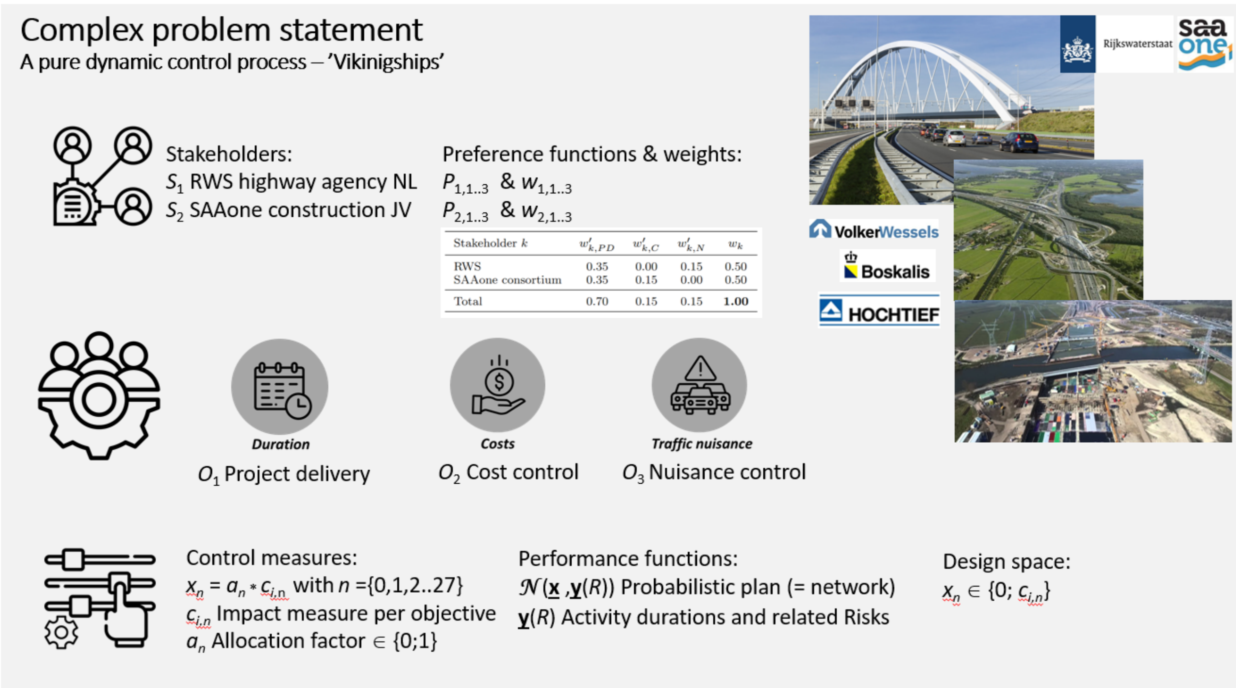
Uncontrollables:
$y_{1,1}$ soil 'strength'
$y_{1,1}$ anchor type
$y_{2,2}$ pre-tension line
$y_{2,2}$ platform type
...

Performance functions*:
F_6 Resistance force = $f(x_4, x_5, \mathbf{\underline{y}}_1)$
F_7 Anchor force = $f(\mathbf{\underline{y}}_2)$
$\mathcal{N}(\mathbf{\underline{x}}, \mathbf{\underline{y}}_0(R))$ Probabilistic plan (= DES)
$\mathbf{\underline{y}}_0(R)$ Activity durations and related risks

Design space:
$0 =< x_1 =< 3$
$0 =< x_2, x_3 =< 2$
$x_1 + x_2 + x_3 >= 1$
$x_4 \land x_5 > 0$
$F_6 > F_7$

* Integrated with OpenFAST : a surrogate multi-physics simulation tool for coupled wind turbines dynamics, see https://doi.org/10.1201/9781003323020

Adapt Flexibly - https://doi.org/10.48550/arXiv.2408.12422



ODESYS

YOUR PARTNER IN CONFRONTING COMPLEXITY