COCOMO II Exponent

- **The effort equation's scaling exponent is also used in the COCOMO II Schedule Equation**
  - Schedule = 3.67 * (Effort)^{F}
  - F = 0.28 + 0.2 * (E – 0.91)
- **Where the COCOMO II effort equation does not use schedule as an input, the data in the SRDR database could be used to solve for E**
  - E = [(ln(Schedule/3.67)/ln(Effort)) - 0.098)] / 0.2
- **E ranges from 0.91 to 1.2262**
- **Calculate E from the Schedule and Effort values of the SRDR database and remove values that are out of bounds**

COCOMO II Model – In-Bounds Accuracy

				Mean EAF			Median EAF		
Op Env	App Type	Language	Records	MMRE	PRED(30)	Delta	MMRE	PRED(30)	Delta
All	All	All	38	1.06	18.4%	-4.0%▼	1.05	18.4%	-9.0%▼
All	Cmd/Ctrl	All	8	2.07	25.0%	-5.8%▼	2.19	25.0%	-13.5%▼
All	Communications	All	4	1.74	25.0%	8.8%▲	1.71	25.0%	-20.9%▼
All	Custom AIS	All	5	0.68	40.0%	-18.3%▼	0.65	40.0%	-18.3%▼
All	Mission Planning	All	3	1.44	0.0%	-35.3%▼	1.45	0.0%	-17.6%▼
All	Real-Time Embedded	All	5	0.83	0.0%	-28.8%▼	0.80	0.0%	-28.8%▼
All	Scientific/Simulation	All	0						
All	Signal Processing	All	1	0.25	100.0%	59.1%▲	0.25	100.0%	54.5%▲
All	SW Tools	All	0						
All	Systems Software	All	4	0.60	25.0%	10.7%▲	0.60	25.0%	5.0%▲
All	Test/Meas/Diag Equip	All	0						
All	Training	All	0						
All	Vehicle Control	All	3	0.45	0.0%	-45.5%▼	0.44	0.0%	-40.9%▼
All	Vehicle Payload	All	5	0.40	20.0%	-58.6%▼	0.40	20.0%	-51.4%▼
All	All	C/C++	26	1.00	15.4%	-6.6%▼	0.97	15.4%	-10.4%▼
All	All	Ada	5	1.46	20.0%	-10.2%▼	1.45	20.0%	-17.7%▼
All	All	Java	7	1.00	28.6%	0.4%▲	1.02	28.6%	-12.5%▼
All	All	Other	0						
Air Veh, Manned	All	All	6	1.63	16.7%	-9.7%▼	1.60	16.7%	-7.9%▼
Air Veh, Unmanned	All	All	4	0.97	0.0%	-19.0%▼	0.96	0.0%	-33.3%▼
Ord Sys, Unmanned	All	All	7	0.67	14.3%	-22.8%▼	0.65	14.3%	-22.8%▼
Sea Sys, Manned	All	All	1	4.55	0.0%	-21.4%▼	4.55	0.0%	-32.1%▼
Sea Sys, Unmanned	All	All	0	0.00	0.0%	0.0%▼	0.91	8.2%	8.2%▲
Surface Fixed, Man	All	All	17	0.94	23.5%	0.5%▲	0.95	23.5%	-9.5%▼
Surface Mobile, Manned	All	All	0						
Surface Vehicle, Manned	All	All	3	0.56	33.3%	12.7%▲	0.56	33.3%	12.7%▲
Surface Vehicle, Unmanned	All	All	0						

- **Scaling Exponent boundaries remove 243 data points**
- **Calculating the Scaling Exponent from Schedule and Effort and removing the data points with "out of bounds" values eliminates almost all accuracy**
- **Prediction values almost universally drop to unusable values**

Paired Data

- A popular method with this type of database is stratifying by Operating Environment and Application Domain together to analyze data
- As more strata are introduced, less values are available
- What is the accuracy in terms of PRED(30) of the mean/median productivity calculations of paired data for both full and “in-bounds” data sets?
- Key assumption: Need at least 5 data points in a paired strata to be applicable

SLIM-Estimate Paired Data Performance

Unbounded:

		Cmd/Ctrl	Comms	Custom AIS	Miss Plng	RTE	Sci/Sim	Sig Proc	SW Tools	Sys SW	TMDE	Trng	Veh Ctrl	Veh Pay
Air Veh, Manned	Mean	12.5%				11.8%			0.0%	20.0%				33.3%
	Median	25.0%				23.5%			20.0%	40.0%				33.3%
Air Veh, Unmanned	Mean	20.0%				0.0%								
	Median	20.0%				0.0%								
Ord Sys, Unmanned	Mean	20.0%				16.7%		16.7%						
	Median	40.0%				16.7%		16.7%						
Sea Sys, Manned	Mean		0.0%			0.0%								
	Median		0.0%			0.0%								
Sea Sys, Unmanned	Mean													
	Median													
Surface Fixed, Man	Mean	15.8%	26.3%	11.1%	11.8%	23.5%	20.0%			27.3%				
	Median	15.8%	15.8%	33.3%	23.5%	5.9%	0.0%			18.2%				
Surface Mobile, Manned	Mean													
	Median													
Surface Vehicle, Manned	Mean					0.0%	30.8%						18.2%	
	Median					28.6%	7.7%						18.2%	
Surface Vehicle, Unmanned	Mean													
	Median													

- **Very few populated pairs (5 or more records)**
- **Accuracy is still low (none over 50%)**

SLIM-Estimate Paired Data Performance – In-Bounds

Bounded:

		Cmd/Ctrl	Comms	Custom AIS	Miss Plng	RTE	Sci/Sim	Sig Proc	SW Tools	Sys SW	TMDE	Trng	Veh Ctrl	Veh Pay
	Mean	0.0%				11.0%			0.0%	20.0%				
Air Veh, Manned	Median	0.0%				0.0%			20.0%	40.0%				
	Mean	20.0%				0.0%								
Air Veh, Unmanned	Median	20.0%				0.0%								
	Mean	20.0%												
Ord Sys, Unmanned	Median	40.0%												
	Mean													
Sea Sys, Manned	Median													
	Mean													
Sea Sys, Unmanned	Median													
	Mean	30.8%	29.4%	50.0%	18.8%	22.2%	20.0%			12.5%				
Surface Fixed, Man	Median	30.8%	35.3%	37.5%	18.8%	22.2%	0.0%			37.5%				
	Mean													
Surface Mobile, Manned	Median													
	Mean					20.0%							11.1%	
Surface Vehicle, Manned	Median					0.0%							11.1%	
	Mean													
Surface Vehicle, Unmanned	Median													

- **Fewer populated pairs (5 or more records)**
- **Accuracy is not improved (one at 50%)**

SEER-SEM Paired Data Performance

Unbounded:

		Cmd/Ctrl	Comms	Custom AIS	Miss Plng	RTE	Sci/Sim	Sig Proc	SW Tools	Sys SW	TMDE	Trng	Veh Ctrl	Veh Pay
Air Veh, Manned	Mean	14.3%				17.6%			0.0%	0.0%				16.7%
	Median	42.9%				29.4%			20.0%	40.0%				0.0%
Air Veh, Unmanned	Mean	20.0%				40.0%								
	Median	40.0%				20.0%								
Ord Sys, Unmanned	Mean					16.7%		0.0%						
	Median					50.0%		33.3%						
Sea Sys, Manned	Mean		42.9%			20.0%								
	Median		42.9%			20.0%								
Sea Sys, Unmanned	Mean													
	Median													
Surface Fixed, Man	Mean	5.6%	5.3%	33.3%	0.0%	5.9%				0.0%				
	Median	0.0%	36.8%	44.4%	5.9%	17.6%				18.5%				
Surface Mobile, Manned	Mean													
	Median													
Surface Vehicle, Manned	Mean					14.3%				8.3%			36.4%	
	Median					14.3%				16.7%			27.3%	
Surface Vehicle, Unmanned	Mean													
	Median													

- **Fewer populated pairs (5 or more records)**
- **Accuracy is not improved (one at 50%)**

SEER-SEM Paired Data Performance – In-Bounds

Bounded:

SEER (IB)														
		Cmd/Ctrl	Comms	Custom AIS	Miss Plng	RTE	Sci/Sim	Sig Proc	SW Tools	Sys SW	TMDE	Trng	Veh Ctrl	Veh Pay
Air Veh, Manned	Mean													
	Median													
Air Veh, Unmanned	Mean													
	Median													
Ord Sys, Unmanned	Mean													
	Median													
Sea Sys, Manned	Mean													
	Median													
Sea Sys, Unmanned	Mean													
	Median													
Surface Fixed, Man	Mean		0.0%	66.7%	16.7%	5.9%				0.0%				
	Median		66.7%	66.7%	0.0%	17.6%				20.0%				
Surface Mobile, Manned	Mean													
	Median													
Surface Vehicle, Manned	Mean													
	Median													
Surface Vehicle, Unmanned	Mean													
	Median													

- **Very few populated pairs – total dataset reduced to 69 records using Staffing Complexity boundary**
- **Accuracy does improve in populated pairs (some instances of 66.7%)**

COCOMO II Paired Data Performance

Unbounded:

COCOMO II (All)														
		Cmd/Ctrl	Comms	Custom AIS	Miss Plng	RTE	Sci/Sim	Sig Proc	SW Tools	Sys SW	TMDE	Trng	Veh Ctrl	Veh Pay
Air Veh, Manned	Mean	50.0%				23.5%			40.0%	40.0%				83.3%
	Median	62.5%				29.4%			60.0%	60.0%				83.3%
Air Veh, Unmanned	Mean	40.0%				0.0%								
	Median	40.0%				0.0%								
Ord Sys, Unmanned	Mean	40.0%				33.3%		33.3%						
	Median	60.0%				33.3%		33.3%						
Sea Sys, Manned	Mean		7.1%			60.0%								
	Median		64.3%			60.0%								
Sea Sys, Unmanned	Mean													
	Median													
Surface Fixed, Man	Mean	15.8%	42.1%	44.4%	35.3%	0.0%	60.0%			18.2%				
	Median	31.6%	36.8%	55.6%	17.6%	29.4%	60.0%			36.4%				
Surface Mobile, Manned	Mean													
	Median													
Surface Vehicle, Manned	Mean					14.3%	23.1%						36.4%	
	Median					28.6%	23.1%						63.6%	
Surface Vehicle, Unmanned	Mean													
	Median													

- **Several pairs with a PRED(30) of 50% or higher**
- **Median value for EAF in many pairs is more accurate than other models**

- **NOTE: Bounding the dataset by calculating the E exponent from schedule reduces the number of records to 38. There are no pairs of 5 records or more.**

Conclusions

- SRDR database can be normalized to be “CSCI-like” in size and limited to Design, Code, and Test phases
- Overall performance by using a calculated productivity variable (mean and median) for popular models does not always produce credible results
- Pairing strata is beneficial, but limited by the number of strata represented
- COCOMO II outperforms SEER-SEM and SLIM-Estimate models using this limited methodology
- COCOMO II loses all predictive capability when schedule is integrated into the selection
- Schedule integration in a cost model using SRDR data impacts prediction negatively

Future Research

- Performance against tool-calibrated model (Calico, SEER-SEM calibration, etc.)
- Regression Analysis on New SRDR Dataset
- Schedule Variable Impact

Questions